City of San Diego

CONTRACTOR'S NAME: J.R. Filanc Construction Company, Inc.
ADDRESS: 740 N. Andreasen Drive, Escondido, CA 92029
TELEPHONE NO.: 760-941-7130
CITY CONTACT: Antoinette Sanfilippo, Contract Specialist **Email:** ASanfilippo@sandiego.gov
Phone No. (619) 533-3439
I. da Rosa / J. Borja / L. Idlebird

BIDDING DOCUMENTS

e - Bidding

FINAL

FOR

ULTRAVIOLET DISINFECTION SYSTEM REPLACEMENT

BID NO.: **K-19-1809-DBB-3**
SAP NO. (WBS/IO/CC): **B-18031**
CLIENT DEPARTMENT: **2000**
COUNCIL DISTRICT: **8**
PROJECT TYPE: **BO**

THIS CONTRACT WILL BE SUBJECT TO THE FOLLOWING:

- PHASED-FUNDING
- THE CITY'S SUBCONTRACTING PARTICIPATION REQUIREMENTS FOR SLBE PROGRAM
- PREVAILING WAGE RATES: STATE ☒ FEDERAL ☐
- APPRENTICESHIP

BID DUE DATE:

2:00 PM
MAY 2, 2019

CITY OF SAN DIEGO'S ELECTRONIC BIDDING SITE, PLANETBIDS

http://www.sandiego.gov/cip/bidopps/index.shtml

ENGINEER OF WORK

The engineering Specifications and Special Provisions contained herein have been prepared by or under the direction of the following Registered Engineer:

Amritendu Maji 3/26/2019

1) Registered Engineer — Date

Seal:

Brian Vitelle 3/26/19

2) For City Engineer — Date

Seal:

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NOTICE INVITING BIDS

1. **SUMMARY OF WORK:** This is the City of San Diego's (City) solicitation process to acquire Construction services for **ULTRAVIOLET DISINFECTION SYSTEM REPLACEMENT.** For additional information refer to Attachment A.

2. **FULL AND OPEN COMPETITION:** This solicitation is subject to full and open competition and may be bid by Contractors on the City's approved Prequalified Contractors List. For information regarding the Contractors Prequalified list visit the City's web site: http://www.sandiego.gov.

3. **ESTIMATED CONSTRUCTION COST:** The City's estimated construction cost for this project is **$3,660,000**.

4. **BID DUE DATE AND TIME ARE: May 2, 2019 at 2:00 PM.**

5. **PREVAILING WAGE RATES APPLY TO THIS CONTRACT:** Refer to Attachment D.

6. **LICENSE REQUIREMENT**: To be eligible for award of this contract, Prime contractor must possess the following licensing classification: **A.**

7. **SUBCONTRACTING PARTICIPATION PERCENTAGES**: Subcontracting participation percentages apply to this contract.

7.1. The City has incorporated voluntary subcontractor participation percentage to enhance competition and maximize subcontracting opportunities as follows.

7.2. The following voluntary subcontractor participation percentage for DBE, DVBE, WBE, MBE, SLBE, and ELBE certified Subcontractors shall apply to this contract:

7.2.1. Total voluntary subcontractor participation percentage for this project is 10%.

8. PRE-BID MEETING:

8.1. Prospective Bidders are **required** to attend the Pre-Bid Meeting. The purpose of the meeting is to discuss the scope of the Project, submittal requirements, the pre-qualification process and any Equal Opportunity Contracting Program requirements and reporting procedures. To request a sign language or oral interpreter for this visit, call the Public Works Contracts Division at (619) 533-3450 at least 5 Working Days prior to the meeting to ensure availability. Failure to attend the Mandatory Pre-Bid Meeting may result in the Bid being deemed non-responsive. The Pre-Bid meeting is scheduled as follows:

Date: **April 11, 2019**
Time: **10:00 AM**
Location: **525 B Street, Ste 750, San Diego, CA 92101 (Wada Conf Rm)**

Attendance at the Pre Bid Meeting will be evidenced by the Bidder's representative's signature on the attendance roster. It is the responsibility of the Bidder's representative to complete and sign the attendance roster.

Bidders may not be admitted after the specified start time of the mandatory Pre-Bid Meeting.

9. PRE-BID SITE VISIT: All those wishing to submit a bid **MUST** visit the Work Site with the Engineer. The purpose of the Site visit is to acquaint Bidders with the Site conditions. To request a sign language or oral interpreter for this visit, call the Public Works Contracts at (619) 533-3450 at least 5 Working Days prior to the meeting to ensure availability. The Pre-Bid Site Visit is scheduled as follows:

Time: **11:00 AM**
Date: **April 11, 2019**
Location: **2411 Dairy Mart Road San Diego, Ca 92154**

10. AWARD PROCESS:

10.1. The Award of this contract is contingent upon the Contractor's compliance with all conditions of Award as stated within these documents and within the Notice of Intent to Award.

10.2. Upon acceptance of bids and determination of the apparent low bidder, the City will prepare the contract documents for execution within approximately 21 days of the date of the bid opening. The City will then award the contract upon receipt of properly signed Contract, bonds, and insurance documents.

10.3. This contract will be deemed executed and effective only upon the signing of the Contract by the Mayor or his designee and approval as to form by the City Attorney's Office.

10.4. The low Bid will be determined by the Base Bid.

10.5. Once the low bid has been determined, the City may, at its sole discretion, award the contract for the Base Bid alone.

11. SUBMISSION OF QUESTIONS:

11.1. The Director (or Designee) of Public Works Department is the officer responsible for opening, examining, and evaluating the competitive Bids submitted to the City for the acquisition, construction and completion of any public improvement except when otherwise set forth in these documents. Any questions related to this solicitation shall be submitted to:

Public Works Contracts
525 B Street, Suite 750 (7th Floor)
San Diego, California, 92101
Attention: Antoinette Sanfilippo

OR:

asanfilippo@sandiego.gov

11.2. Questions received less than 14 days prior to the date for opening of Bids may not be considered.

11.3. Questions or clarifications deemed by the City to be material shall be answered via issuance of an addendum and posted to the City's online bidding service.

11.4. Only questions answered by formal written addenda shall be binding. Oral and other interpretations or clarifications shall be without legal effect. It is the Bidder's responsibility to be informed of any addenda that have been issued and to include all such information in its Bid.

12. PHASED FUNDING: For Phased Funding Conditions, see Attachment B.

1. PREQUALIFICATION OF CONTRACTORS:

1.1. Contractors submitting a Bid must be pre-qualified for the total amount proposed, including all alternate items, prior to the date of submittal. Bids from contractors who have not been pre-qualified as applicable and Bids that exceed the maximum dollar amount at which contractors are pre-qualified may be deemed **non-responsive** and ineligible for award.

1.2. The completed application must be submitted online no later than 2 weeks prior to the bid opening.

1.3. **Joint Venture Bidders Cumulative Maximum Bidding Capacity:** For projects with an engineer's estimate of $30,000,000 or greater, Joint Ventures submitting bids may be deemed responsive and eligible for award if the cumulative maximum bidding capacity of the individual Joint Venture entities is equal to or greater than the total amount proposed.

1.3.1. Each of the entities of the Joint Venture must have been previously prequalified at a minimum of $15,000,000.

1.3.2. Bids submitted with a total amount proposed of less than $30,000,000 are not eligible for Cumulative Maximum Bidding Capacity prequalification. To be eligible for award in this scenario, the Joint Venture itself or at least one of the Joint Venture entities must have been prequalified for the total amount proposed.

1.3.3. Bids submitted by Joint Ventures with a total amount proposed of $30,000,000 or greater on a project with an engineer's estimate of less than $30,000,000 are not eligible for Cumulative Maximum Bidding Capacity prequalification.

1.3.4. The Joint Venture designated as the Apparent Low Bidder shall provide evidence of its corporate existence and furnish good and approved bonds in the name of the Joint Venture within 14 Calendar Days of receipt by the Bidder of a form of contract for execution.

1.4. Complete information and links to the on-line prequalification application are available at:

http://www.sandiego.gov/cip/bidopps/prequalification.shtml

1.5. Due to the City's responsibility to protect the confidentiality of the contractors' information, City staff will not be able to provide information regarding contractors' prequalification status over the telephone. Contractors may access real-time information about their prequalification status via their vendor profile on PlanetBids™.

2. ELECTRONIC FORMAT RECEIPT AND OPENING OF BIDS: Bids will be received in electronic format (eBids) EXCLUSIVELY at the City of San Diego's electronic bidding (eBidding) site, at: http://www.sandiego.gov/cip/bidopps/index.shtml and are due by the date, and time shown on the cover of this solicitation.

2.1. BIDDERS MUST BE PRE-REGISTERED with the City's bidding system and possess a system-assigned Digital ID in order to submit and electronic bid.

2.2. The City's bidding system will automatically track information submitted to the site including IP addresses, browsers being used and the URLs from which information was submitted. In addition, the City's bidding system will keep a history of every login instance including the time of login, and other information about the user's computer configuration such as the operating system, browser type, version, and more. Because of these security features, Contractors who disable their browsers' cookies will not be able to log in and use the City's bidding system.

2.3. The City's electronic bidding system is responsible for bid tabulations. Upon the bidder's or proposer's entry of their bid, the system will ensure that all required fields are entered. **The system will not accept a bid for which any required information is missing.** This includes all necessary pricing, subcontractor listing(s) and any other essential documentation and supporting materials and forms requested or contained in these solicitation documents.

2.4. BIDS REMAIN SEALED UNTIL BID DEADLINE. eBids are transmitted into the City's bidding system via hypertext transfer protocol secure (https) mechanism using SSL 128-256 bit security certificates issued from Verisign/Thawte which encrypts data being transferred from client to server. Bids submitted prior to the "Bid Due Date and Time" are not available for review by anyone other than the submitter who has until the "Bid Due Date and Time" to change, rescind or retrieve its proposal should it desire to do so.

2.5. BIDS MUST BE SUBMITTED BY BID DUE DATE AND TIME. Once the bid deadline is reached, no further submissions are accepted into the system. Once the Bid Due Date and Time has lapsed, bidders, proposers, the general public, and City staff are able to immediately see the results on line. City staff may then begin reviewing the submissions for responsiveness, EOCP compliance and other issues. The City may require any Bidder to furnish statement of experience, financial responsibility, technical ability, equipment, and references.

2.6. RECAPITULATION OF THE WORK. Bids shall not contain any recapitulation of the Work. Conditional Bids may be rejected as being non-responsive. Alternative proposals will not be considered unless called for.

2.7. **BIDS MAY BE WITHDRAWN** by the Bidder only up to the bid due date and time.

2.7.1. Important Note: Submission of the electronic bid into the system may not be instantaneous. Due to the speed and capabilities of the user's internet service provider (ISP), bandwidth, computer hardware and other variables, it may take time for the bidder's submission to upload and be received by the City's eBidding system. It is the bidder's sole responsibility to ensure their bids are received on time by the City's eBidding system. The City of San Diego is not responsible for bids that do not arrive by the required date and time.

2.8. **ACCESSIBILITY AND AMERICANS WITH DISABILITIES ACT (ADA) COMPLIANCE:** To request a copy of this solicitation in an alternative format, contact the Public Works Contract Specialist listed on the cover of this solicitation at least five (5) working days prior to the Bid/Proposal due date to ensure availability.

3. ELECTRONIC BID SUBMISSIONS CARRY FULL FORCE AND EFFECT

3.1. The bidder, by submitting its electronic bid, acknowledges that doing so carries the same force and full legal effect as a paper submission with a longhand (wet) signature.

3.2. By submitting an electronic bid, the bidder certifies that the bidder has thoroughly examined and understands the entire Contract Documents (which consist of the plans and specifications, drawings, forms, affidavits and the solicitation documents), and that by submitting the eBid as its bid proposal, the bidder acknowledges, agrees to and is bound by the entire Contract Documents, including any addenda issued thereto, and incorporated by reference in the Contract Documents.

3.3. The Bidder, by submitting its electronic bid, agrees to and certifies under penalty of perjury under the laws of the State of California, that the certification, forms and affidavits submitted as part of this bid are true and correct.

3.4. The Bidder agrees to the construction of the project as described in Attachment "A – Scope of Work" for the City of San Diego, in accordance with the requirements set forth herein for the electronically submitted prices. The Bidder guarantees the Contract Price for a period of 120 days from the date of Bid opening. The duration of the Contract Price guarantee shall be extended by the number of days required for the City to obtain all items necessary to fulfill all conditions precedent.

4. **BIDS ARE PUBLIC RECORDS:** Upon receipt by the City, Bids shall become public records subject to public disclosure. It is the responsibility of the respondent to clearly identify any confidential, proprietary, trade secret or otherwise legally privileged information contained within the Bid. General references to sections of the California Public Records Act (PRA) will not suffice. If the Contractor does not provide applicable case law that clearly establishes that the requested information is exempt from the disclosure requirements of the PRA, the City shall be free to release the information when required in accordance with the PRA, pursuant to any other applicable law, or by order of any court or government agency, and the Contractor will hold the City harmless for release of this information.

5. CONTRACTOR REGISTRATION AND ELECTRONIC REPORTING SYSTEM:

5.1. **Prior** to the Award of the Contract or Task Order, you and your Subcontractors and Suppliers must register with the City's web-based vendor registration and bid management system. For additional information go to:

http://www.sandiego.gov/purchasing/bids-contracts/vendorreg.shtml.

5.2. The City may not award the contract until registration of all subcontractors and suppliers is complete. In the event this requirement is not met within the time frame specified in the Notice of Intent to Award letter, the City reserves the right to rescind the Notice of Award / Intent to Award and to make the award to the next responsive and responsible bidder / proposer.

6. JOINT VENTURE CONTRACTORS: Provide a copy of the Joint Venture agreement and the Joint Venture license to the City within 14 Calendar Days after receiving the Contract forms.

7. INSURANCE REQUIREMENTS:

7.1. All certificates of insurance and endorsements required by the contract are to be provided upon issuance of the City's Notice of Intent to Award letter.

7.2. Refer to sections within 5-4, "INSURANCE" of the Supplementary Special Provisions (SSP) for the insurance requirements which must be met.

8. REFERENCE STANDARDS: Except as otherwise noted or specified, the Work shall be completed in accordance with the following standards:

Title	Edition	Document Number
Standard Specifications for Public Works Construction ("The GREENBOOK") http://www.greenbookspecs.org/	2018	PWPI010119-01
City of San Diego Standard Specifications for Public Works Construction ("The WHITEBOOK")* https://www.sandiego.gov/publicworks/edocref/greenbook	2018	PWPI010119 -02
City of San Diego Standard Drawings* https://www.sandiego.gov/publicworks/edocref/standarddraw	2018	PWPI010119 -03
Citywide Computer Aided Design and Drafting (CADD) Standards https://www.sandiego.gov/publicworks/edocref/drawings	2018	PWPI010119 -04
California Department of Transportation (CALTRANS) Standard Specifications – http://www.dot.ca.gov/des/oe/construction-contract-standards.html	2018	PWPI030119-05
CALTRANS Standard Plans http://www.dot.ca.gov/des/oe/construction-contract-standards.html	2018	PWPI030119-06

Title	Edition	Document Number
California Manual on Uniform Traffic Control Devices Revision 3 (CA MUTCD Rev 3) http://www.dot.ca.gov/trafficops/camutcd/	2014	PWPI030119-07
NOTE: *Available online under Engineering Documents and References at: http://www.sandiego.gov/publicworks/edocref/index.shtml ***Electronic updates to the Standard Drawings may also be found in the link above		

9. **CITY'S RESPONSES AND ADDENDA:** The City, at its discretion, may respond to any or all questions submitted in writing via the City's eBidding web site in the **form of an addendum**. No other responses to questions, oral or written shall be of any force or effect with respect to this solicitation. The changes to the Contract Documents through addenda are made effective as though originally issued with the Bid. The Bidders shall acknowledge the receipt of Addenda at the time of bid submission.

10. **CITY'S RIGHTS RESERVED:** The City reserves the right to cancel the Notice Inviting Bids at any time, and further reserves the right to reject submitted Bids, without giving any reason for such action, at its sole discretion and without liability. Costs incurred by the Bidder(s) as a result of preparing Bids under the Notice Inviting Bids shall be the sole responsibility of each bidder. The Notice Inviting Bids creates or imposes no obligation upon the City to enter a contract.

11. **CONTRACT PRICING:** This solicitation is for a Lump Sum contract with Unit Price provisions as set forth herein. The Bidder agrees to perform construction services for the City of San Diego in accordance with these contract documents for the prices listed below. The Bidder further agrees to guarantee the Contract Price for a period of 120 days from the date of Bid opening. The duration of the Contract Price guarantee may be extended, by mutual consent of the parties, by the number of days required for the City to obtain all items necessary to fulfill all contractual conditions.

12. **SUBCONTRACTOR INFORMATION:**

12.1. **LISTING OF SUBCONTRACTORS**. In accordance with the requirements provided in the "Subletting and Subcontracting Fair Practices Act" of the California Public Contract Code, the Bidder shall provide the **NAME** and **ADDRESS** of each Subcontractor who will perform work, labor, render services or who specially fabricates and installs a portion [type] of the work or improvement, in an amount in excess of 0.5% of the Contractor's total Bid. The Bidder shall also state within the description, whether the subcontractor is a **CONSTRUCTOR**, **CONSULTANT** or **SUPPLIER**. The Bidder shall state the **DIR REGISTRATION NUMBER** for all subcontractors and shall further state within the description, the **PORTION** of the work which will be performed by each subcontractor under this Contract. The Contractor shall list only one Subcontractor for each portion of the Work. The **DOLLAR VALUE** of the total Bid to be performed shall be stated for all subcontractors listed. Failure to comply with this requirement may result in the Bid being rejected as **non-responsive** and ineligible for award. The Bidder's attention is directed to the Special Provisions – Section 3-2, "SELF-PERFORMANCE", which stipulates the percent of the Work to be performed with the

Bidders' own forces. The Bidder shall list all SLBE, ELBE, DBE, DVBE, MBE, WBE, OBE, SDB, WoSB, HUBZone, and SDVOSB Subcontractors for which Bidders are seeking recognition towards achieving any mandatory, voluntary (or both) subcontracting participation goals.

Additionally, pursuant to California Senate Bill 96 and in accordance with the requirements of Labor Code sections 1771.1 and 1725.5, by submitting a bid or proposal to the City, Contractor is certifying that he or she has verified that all subcontractors used on this public work project are registered with the California Department of Industrial Relations (DIR). **The Bidder shall provide the name, address, license number, DIR registration number of any Subcontractor – regardless of tier** - who will perform work, labor, render services or specially fabricate and install a portion [type] of the work or improvement pursuant to the contract.

12.2. LISTING OF SUPPLIERS. Any Bidder seeking the recognition of Suppliers of equipment, materials, or supplies obtained from third party Suppliers towards achieving any mandatory or voluntary (or both) subcontracting participation goals shall provide, at a minimum, the **NAME**, **LOCATION (CITY), DIR REGISTRATION NUMBER** and the **DOLLAR VALUE** of each supplier. The Bidder will be credited up to 60% of the amount to be paid to the Suppliers for materials and supplies unless vendor manufactures or substantially alters materials and supplies, in which case, 100% will be credited. The Bidder is to indicate within the description whether the listed firm is a supplier or manufacturer. If no indication is provided, the listed firm will be credited at 60% of the listed dollar value for purposes of calculating the Subcontractor Participation Percentage.

12.3. LISTING OF SUBCONTRACTORS OR SUPPLIERS FOR ALTERNATES. For subcontractors or suppliers to be used on additive or deductive alternate items, in addition to the above requirements, bidder shall further note "ALTERNATE" and alternate item number within the description.

13. SUBMITTAL OF "OR EQUAL" ITEMS: See Section 4-6, "Trade Names" in The WHITEBOOK and as amended in the SSP.

14. AWARD:

14.1. The Award of this contract is contingent upon the Contractor's compliance with all conditions precedent to Award.

14.2. Upon acceptance of a Bid, the City will prepare contract documents for execution within approximately 21 days of the date of the Bid opening and award the Contract approximately within 7 days of receipt of properly executed Contract, bonds, and insurance documents.

14.3. This contract will be deemed executed and effective only upon the signing of the Contract by the Mayor or his designee and approval as to form the City Attorney's Office.

15. **SUBCONTRACT LIMITATIONS**: The Bidder's attention is directed to Standard Specifications for Public Works Construction, Section 3-2, "SELF-PERFORMANCE" in The GREENBOOK and as carefully the Project Site, the Plans and Specifications, other materials as described in the Special Provisions, Section 3-9, "TECHNICAL STUDIES AND SUBSURFACE DATA" and the proposal forms (e.g., Bidding Documents). The submission of a Bid shall be conclusive evidence that the Bidder has investigated and is satisfied as to the conditions to be encountered, as to the character, quality, and scope of Work, the quantities of materials to be furnished, and as to the requirements of the Bidding Documents Proposal, Plans, and Specifications

16. **AVAILABILITY OF PLANS AND SPECIFICATIONS:** Contract Documents may be obtained by visiting the City's website: http://www.sandiego.gov/cip/. Plans and Specifications for this contract are also available for review in the office of the City Clerk or Public Works Contracts.

17. **ONLY ONE BID PER CONTRACTOR SHALL BE ACCEPTED:** No person, firm, or corporation shall be allowed to make, file, or be interested in more than one (1) Bid for the same work unless alternate Bids are called for. A person, firm or corporation who has submitted a sub-proposal to a Bidder, or who has quoted prices on materials to a Bidder, is not hereby disqualified from submitting a sub-proposal or quoting prices to other Bidders or from submitting a Bid in its own behalf. Any Bidder who submits more than one bid will result in the rejection of all bids submitted.

18. **SAN DIEGO BUSINESS TAX CERTIFICATE:** The Contractor and Subcontractors, not already having a City of San Diego Business Tax Certificate for the work contemplated shall secure the appropriate certificate from the City Treasurer, Civic Center Plaza, First floor and submit to the Contract Specialist upon request or as specified in the Contract Documents. Tax Identification numbers for both the Bidder and the listed Subcontractors must be submitted on the City provided forms within these documents.

19. **BIDDER'S GUARANTEE OF GOOD FAITH (BID SECURITY) FOR DESIGN-BID-BUILD CONTRACTS:**

19.1. For bids $250,000 and above, bidders shall submit Bid Security at bid time. Bid Security shall be in one of the following forms: a cashier's check, or a properly certified check upon some responsible bank; or an approved corporate surety bond payable to the City of San Diego for an amount of not less than 10% of the total bid amount.

19.2. This check or bond, and the monies represented thereby, will be held by the City as a guarantee that the Bidder, if awarded the contract, will in good faith enter into the contract and furnish the required final performance and payment bonds.

19.3. The Bidder agrees that in the event of the Bidder's failure to execute this contract and provide the required final bonds, the money represented by the cashier's or certified check will remain the property of the City; and the Surety agrees that it will pay to the City the damages, not exceeding the sum of 10% of the amount of the Bid, that the City may suffer as a result of such failure.

19.4. At the time of bid submission, bidders must upload and submit an electronic PDF copy of the aforementioned bid security. Whether in the form of a cashier's check, a properly certified check or an approved corporate surety bond payable to the City of San Diego, the bid security must be uploaded to the City's eBidding system. Within twenty-four (24) hours after the bid due date and time, the first five (5) apparent low bidders must provide the City with the original bid security.

19.5. Failure to submit the electronic version of the bid security at the time of bid submission AND failure to provide the original within twenty-four (24) hours may cause the bid to be rejected and deemed **non-responsive**.

20. AWARD OF CONTRACT OR REJECTION OF BIDS:

20.1. This contract may be awarded to the lowest responsible and reliable Bidder.

20.2. Bidders shall complete ALL eBid forms as required by this solicitation. Incomplete eBids will not be accepted.

20.3. The City reserves the right to reject any or all Bids, to waive any informality or technicality in Bids received, and to waive any requirements of these specifications as to bidding procedure.

20.4. Bidders will not be released on account of their errors of judgment. Bidders may be released only upon receipt by the City within 3 Working Days of the bid opening, written notice from the Bidder which shows proof of honest, credible, clerical error of a material nature, free from fraud or fraudulent intent; and of evidence that reasonable care was observed in the preparation of the Bid.

20.5. A bidder who is not selected for contract award may protest the award of a contract to another bidder by submitting a written protest in accordance with the San Diego Municipal Code.

20.6. The City of San Diego will not discriminate in the award of contracts with regard to race, religion creed, color, national origin, ancestry, physical handicap, marital status, sex or age.

20.7. Each Bid package properly signed as required by these specifications shall constitute a firm offer which may be accepted by the City within the time specified herein.

20.8. The City reserves the right to evaluate all Bids and determine the lowest Bidder on the basis of the base bid and any proposed alternates or options as detailed herein.

21. BID RESULTS:

21.1. The availability of the bids on the City's eBidding system shall constitute the public announcement of the apparent low bidder. In the event that the apparent low bidder is subsequently deemed non-responsive or non-responsible, a notation of such will be made on the eBidding system. The new ranking and apparent low bidder will be adjusted accordingly.

21.2. To obtain the bid results, view the results on the City's web site, or request the results by U.S. mail and provide a self-addressed, stamped envelope. If requesting by mail, be sure to reference the bid name and number. The bid tabulations will be mailed to you upon their completion. The results will not be given over the telephone.

22. THE CONTRACT:

22.1. The Bidder to whom award is made shall execute a written contract with the City of San Diego and furnish good and approved bonds and insurance certificates specified by the City within 14 days after receipt by Bidder of a form of contract for execution unless an extension of time is granted to the Bidder in writing.

22.2. If the Bidder takes longer than 14 days to fulfill these requirements, then the additional time taken shall be added to the Bid guarantee. The Contract shall be made in the form adopted by the City, which includes the provision that no claim or suit whatsoever shall be made or brought by Contractor against any officer, agent, or employee of the City for or on account of anything done or omitted to be done in connection with this contract, nor shall any such officer, agent, or employee be liable hereunder.

22.3. If the Bidder to whom the award is made fails to enter into the contract as herein provided, the award may be annulled and the Bidder's Guarantee of Good Faith will be subject to forfeiture. An award may be made to the next lowest responsible and reliable Bidder who shall fulfill every stipulation embraced herein as if it were the party to whom the first award was made.

22.4. Pursuant to the San Diego City Charter section 94, the City may only award a public works contract to the lowest responsible and reliable Bidder. The City will require the Apparent Low Bidder to (i) submit information to determine the Bidder's responsibility and reliability, (ii) execute the Contract in form provided by the City, and (iii) furnish good and approved bonds and insurance certificates specified by the City within 14 Days, unless otherwise approved by the City, in writing after the Bidder receives notification from the City, designating the Bidder as the Apparent Low Bidder and formally requesting the above mentioned items.

22.5. The award of the Contract is contingent upon the satisfactory completion of the above-mentioned items and becomes effective upon the signing of the Contract by the Mayor or designee and approval as to form by the City Attorney's Office. If the Apparent Low Bidder does not execute the Contract or submit required documents and information, the City may award the Contract to the next lowest responsible and reliable Bidder who shall fulfill every condition precedent to award. A corporation designated as the Apparent Low Bidder shall furnish evidence of its corporate existence and evidence that the officer signing the Contract and bond for the corporation is duly authorized to do so.

23. EXAMINATION OF PLANS, SPECIFICATIONS, AND SITE OF WORK: The Bidder shall examine carefully the Project Site, the Plans and Specifications, other materials as described in the Special Provisions, Section 3-9, "TECHNICAL STUDIES AND SUBSURFACE DATA", and the proposal forms (e.g., Bidding Documents). The submission of a Bid shall be conclusive evidence that the Bidder has investigated and is satisfied as to the conditions to be

encountered, as to the character, quality, and scope of Work, the quantities of materials to be furnished, and as to the requirements of the Bidding Documents Proposal, Plans, and Specifications.

24. CITY STANDARD PROVISIONS: This contract is subject to the following standard provisions. See The WHITEBOOK for details.

24.1. The City of San Diego Resolution No. R-277952 adopted on May 20, 1991 for a Drug-Free Workplace.

24.2. The City of San Diego Resolution No. R-282153 adopted on June 14, 1993 related to the Americans with Disabilities Act.

24.3. The City of San Diego Municipal Code §22.3004 for Contractor Standards.

24.4. The City of San Diego's Labor Compliance Program and the State of California Labor Code §§1771.5(b) and 1776.

24.5. Sections 1777.5, 1777.6, and 1777.7 of the State of California Labor Code concerning the employment of apprentices by contractors and subcontractors performing public works contracts.

24.6. The City's Equal Benefits Ordinance (EBO), Chapter 2, Article 2, Division 43 of The San Diego Municipal Code (SDMC).

24.7. The City's Information Security Policy (ISP) as defined in the City's Administrative Regulation 90.63.

25. PRE-AWARD ACTIVITIES:

25.1. The contractor selected by the City to execute a contract for this Work shall submit the required documentation as specified in the herein and in the Notice of Award. Failure to provide the information as specified may result in the Bid being rejected as **non-responsive.**

25.2. The decision that bid is non-responsive for failure to provide the information required within the time specified shall be at the sole discretion of the City.

PERFORMANCE BOND, LABOR AND MATERIALMEN'S BOND

FAITHFUL PERFORMANCE BOND AND LABOR AND MATERIALMEN'S BOND:

J.R. Filanc Construction Company, Inc., a corporation, as principal, and Everest Reinsurance Company, a corporation authorized to do business in the State of California, as Surety, hereby obligate themselves, their successors and assigns, jointly and severally, to The City of San Diego a municipal corporation in the sum of Three Million Three Hundred Ninety-One Thousand Six Hundred Thirty-Six Dollars and Zero Cents ($3,391,636.00) for the faithful performance of the annexed contract, and in the sum of Three Million Three Hundred Ninety-One Thousand Six Hundred Thirty-Six Dollars and Zero Cents ($3,391,636.00) for the benefit of laborers and materialmen designated below.

Conditions:

If the Principal shall faithfully perform the annexed contract with the City of San Diego, California, then the obligation herein with respect to a faithful performance shall be void; otherwise it shall remain in full force.

If the Principal shall promptly pay all persons, firms and corporations furnishing materials for or performing labor in the execution of this contract, and shall pay all amounts due under the California Unemployment Insurance Act then the obligation herein with respect to laborers and materialmen shall be void; otherwise it shall remain in full force.

The obligation herein with respect to laborers and materialmen shall inure to the benefit of all persons, firms and corporations entitled to file claims under the provisions of Article 2. Claimants, (iii) public works of improvement commencing with Civil Code Section 9100 of the Civil Code of the State of California.

Changes in the terms of the annexed contract or specifications accompanying same or referred to therein shall not affect the Surety's obligation on this bond, and the Surety hereby waives notice of same.

PERFORMANCE BOND, LABOR AND MATERIALMEN'S BOND (continued)

The Surety shall pay reasonable attorney's fees should suit be brought to enforce the provisions of this bond.

Dated May 17, 2019

Approved as to Form

Mara W. Elliott, City Attorney

By _____
Deputy City Attorney

Approved:

By _____
Stephen Samara
Principal Contract Specialist
Public Works Department

J.R. Filanc Construction Company, Inc.
Principal

By _____

DAVID J. KIESS, VICE PRES.
Printed Name of Person Signing for Principal

Everest Reinsurance Company
Surety

By _____
Lawrence F. McMahon -Attorney-in-fact

P.O. Box 70
Local Address of Surety

Orange, CA 92856
Local Address (City, State) of Surety

(714) 371-9653
Local Telephone No. of Surety

Premium $ 28,829.00
Premium is for Contract Term & Subject to Adjustment Based on Final Contract Price

Bond No. ES00002573

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT Civil Code § 1189

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document, to which this certificate is attached, and not the truthfulness, accuracy or validity of that document.

STATE OF CALIFORNIA }

County of San Diego

On MAY 17 2019 (Date) before me, Rachel A. Mullen (Insert Name of Notary exactly as it appears on the official seal), Notary Public,

personally appeared Lawrence F. McMahon (Name(s) of Signer(s))

who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

Witness my hand and official seal.

Signature Rachel A. Mullen (Signature of Notary Public) Rachel A. Mullen

RACHEL A. MULLEN
Notary Public - California
San Diego County
Commission # 2181212
My Comm. Expires Jan 23, 2021

Place Notary Seal Above

OPTIONAL

Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of the form to another document.

Description of Attached Document

Title or Type of Document: _____

Document Date: _____ Number of Pages: _____

Signer(s) Other Than Named Above: _____

Capacity(ies) Claimed by Signer(s)

Signer's Name: _____
- ☐ Individual
- ☐ Corporate Officer — Title(s): _____
- ☐ Partner ☐ Limited ☐ General
- ☑ Attorney in Fact
- ☐ Trustee
- ☐ Guardian or Conservator
- ☐ Other: _____

Signer is Representing:
Surety Company

RIGHT THUMBPRINT OF SIGNER
Top of thumb here

Signer's Name: _____
- ☐ Individual
- ☐ Corporate Officer — Title(s): _____
- ☐ Partner ☐ Limited ☐ General
- ☐ Attorney in Fact
- ☐ Trustee
- ☐ Guardian or Conservator
- ☐ Other: _____

Signer is Representing:

RIGHT THUMBPRINT OF SIGNER
Top of thumb here

EVEREST.

ES046R10182

POWER OF ATTORNEY
EVEREST REINSURANCE COMPANY
DELAWARE

KNOW ALL PERSONS BY THESE PRESENTS: That Everest Reinsurance Company, a corporation of the State of Delaware ("Company") having its principal office located at 477 Martinsville Road, Liberty Corner, New Jersey 07938, do hereby nominate, constitute, and appoint:

Lawrence F. McMahon, Ryan E. Warnock, Christopher Conte, Sarah Myers, Rachel A. Mullen, Janice Martin

its true and lawful Attorney(s)-in-fact to make, execute, attest, seal and deliver for and on its behalf, as surety, and as its act and deed, where required, any and all bonds and undertakings in the nature thereof, for the penal sum of no one of which is in any event to exceed UNLIMITED, reserving for itself the full power of substitution and revocation.

Such bonds and undertakings, when duly executed by the aforesaid Attorney(s)-in-fact shall be binding upon the Company as fully and to the same extent as if such bonds and undertakings were signed by the President and Secretary of the Company and sealed with its corporate seal.

This Power of Attorney is granted and is signed by facsimile under and by the authority of the following Resolutions adopted by the Board of Directors of Company ("Board") on the 28th day of July 2016:

***RESOLVED**, that the President, any Executive Vice President, and any Senior Vice President and Anthony Romano are hereby appointed by the Board as authorized to make, execute, seal and deliver for and on behalf of the Company, any and all bonds, undertakings, contracts or obligations in surety or co-surety with others and that the Secretary or any Assistant Secretary of the Company be and that each of them hereby is authorized to attest to the execution of any such bonds, undertakings, contracts or obligations in surety or co-surety and attach thereto the corporate seal of the Company.*

***RESOLVED, FURTHER**, that the President, any Executive Vice President, and any Senior Vice President and Anthony Romano are hereby authorized to execute powers of attorney qualifying the attorney named in the given power of attorney to execute, on behalf of the Company, bonds and undertakings in surety or co-surety with others, and that the Secretary or any Assistant Secretary of the Company be, and that each of them is hereby authorized to attest the execution of any such power of attorney, and to attach thereto the corporate seal of the Company.*

***RESOLVED, FURTHER**, that the signature of such officers named in the preceding resolutions and the corporate seal of the Company may be affixed to such powers of attorney or to any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signatures or facsimile seal shall be thereafter valid and binding upon the Company with respect to any bond, undertaking, contract or obligation in surety or co-surety with others to which it is attached.*

IN WITNESS WHEREOF, Everest Reinsurance Company has caused their corporate seals to be affixed hereto, and these presents to be signed by their duly authorized officers this 28th day of July 2016.

Everest Reinsurance Company

Everest Reinsurance Company CORPORATE SEAL 1973 DELAWARE

Attest: Nicole Chase, Assistant Secretary

By: Anthony Romano, Vice President

On this 28th day of July 2016, before me personally came Anthony Romano, known to me, who, being duly sworn, did execute the above instrument; that he knows the seal of said Company; that the seal affixed to the aforesaid instrument is such corporate seal and was affixed thereto; and that he executed said instrument by like order.

LINDA ROBINS
Notary Public, State of New York
No 01R06239736
Qualified in Queens County
Term Expires April 25, 2023

Linda Robins, Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Company, at the Liberty Corner, this _____ day of _____ 20____.

MAY 17 2019

HEAT SENSITIVE SHIELD FADES WITH HEAT OR TOUCH

ES 00 01 04 16 *Document #04546 contains a security pantograph, blue background, heat-sensitive ink, coin-reactive watermark, and microtext printing on border.*

ATTACHMENTS

ATTACHMENT A

SCOPE OF WORK

SCOPE OF WORK

1. **SCOPE OF WORK:** The work in this Contract comprises of 1) demolition of existing UV units in the tertiary UV basin, UV control panels, and related conduits and supports from UV control building to the tertiary building, 2) furnishing and installation of two new UV system units and ballasts to treat 15 MGD of reclaimed water. 3) modification to existing tertiary UV basin for the installation of new UV units per manufacturer's recommendations, 4) installation of power distribution units, control panels, and other electrical and I&C work, 5) maintain SBWRP plant operations in secondary UV basin during construction or as required by the City, 6) building, electrical, mechanical and plumbing permits for upgrades to a City owned water treatment plant..

1.1. The Work shall be performed in accordance with:

1.1.1. The Notice Inviting Bids and Plans numbered **40775-01-D** through **40775-37-D**, inclusive.

2. **LOCATION OF WORK: The location of the Work is as follows:**

Location Map Appendix E

3. **CONTRACT TIME:** The Contract Time for completion of the Work shall be **366 Working Days**

ATTACHMENT B

PHASED FUNDING PROVISIONS

PHASED FUNDING PROVISIONS

1. PRE-AWARD

1.1. Within 10 Working Days of the Notice of Intent to Award, the Contractor must contact the Project Manager to discuss fund availability for each phase and shall also submit the following:

1.1.1. Construction Cost Loaded Schedule in accordance with 6-1,"CONSTRUCTION SCHEDULE AND COMMENCEMENT OF THE WORK" and 7-3, "PAYMENT.

1.2. Contractor's failure to perform any of the following may result cancelling the award of the Contract:

1.2.1. Meeting with the City's Project Manager to discuss the Phased Funding Schedule.

1.2.2. Agreeing to a Phased Funding Schedule within **thirty** days of meeting with the City's Project Manager.

2. POST-AWARD

2.1. Do not start any construction activities for the next phase until the Notice to Proceed (NTP) has been issued by the City. The City will issue a separate NTP for each phase.

2.2. The City may issue the NTP for a subsequent phase before the completion of the preceding phase.

PHASED FUNDING SCHEDULE AGREEMENT

The particulars left blank below, such as the total number of phases and the amounts assigned to each phase, will be completed with funding specific information from the Pre-Award Schedule and Construction Cost Loaded Schedule submitted to and approved by the City.

BID NUMBER: K-19-1809-DBB-3

CONTRACT OR TASK TITLE: Ultraviolet Disinfection System Replacement

CONTRACTOR: J.R. Filanc Construction Company, Inc.

Funding Phase	Phase Description	Phase Start	Phase Finish	Not-to-Exceed Amount
1	Bonds, Mobilization, and Project Initiation including Submittal and Equipment Procurement	NTP	9/30/2019	$1,000,000.00
2	Project Construction , Start-up	10/01/2019	NOC	$2,391,636.00
3				
			Contract Total	$3,391,636.00

Notes:
1) WHITEBOOK section 7-3.10, "Phased Funding Compensation" applies.
2) The total of all funding phases shall be equal to the TOTAL BID PRICE as shown on BID SCHEDULE 1 - PRICES.
3) This PHASED FUNDING SCHEDULE AGREEMENT will be incorporated into the CONTRACT and shall only be revised by written modifications to the CONTRACT.

CITY OF SAN DIEGO

PRINT NAME: Dino Clafre-Garay, PE
for **Construction Manager**

Signature:

Date: 7/16/19

PRINT NAME: Brian Vitelle, PE
Senior Project Manager

Signature:

Date: 7/15/19

CONTRACTOR

PRINT NAME: David Keiss

Title: Vice-President

Signature:

Date: 7/15/2019

ATTACHMENT C

RESERVED

ATTACHMENT D

PREVAILING WAGES

PREVAILING WAGES

1. PREVAILING WAGE RATES: Pursuant to San Diego Municipal Code section 22.3019, construction, alteration, demolition, repair and maintenance work performed under this Contract is subject to State prevailing wage laws. For construction work performed under this Contract cumulatively exceeding $25,000 and for alteration, demolition, repair and maintenance work performed under this Contract cumulatively exceeding $15,000, the Contractor and its subcontractors shall comply with State prevailing wage laws including, but not limited to, the requirements listed below.

1.1. Compliance with Prevailing Wage Requirements. Pursuant to sections 1720 through 1861 of the California Labor Code, the Contractor and its subcontractors shall ensure that all workers who perform work under this Contract are paid not less than the prevailing rate of per diem wages as determined by the Director of the California Department of Industrial Relations (DIR). This includes work performed during the design and preconstruction phases of construction including, but not limited to, inspection and land surveying work.

1.1.1. Copies of such prevailing rate of per diem wages are on file at the City and are available for inspection to any interested party on request. Copies of the prevailing rate of per diem wages also may be found at http://www.dir.ca.gov/OPRL/DPreWageDetermination.htm. Contractor and its subcontractors shall post a copy of the prevailing rate of per diem wages determination at each job site and shall make them available to any interested party upon request.

1.1.2. The wage rates determined by the DIR refer to expiration dates. If the published wage rate does not refer to a predetermined wage rate to be paid after the expiration date, then the published rate of wage shall be in effect for the life of this Contract. If the published wage rate refers to a predetermined wage rate to become effective upon expiration of the published wage rate and the predetermined wage rate is on file with the DIR, such predetermined wage rate shall become effective on the date following the expiration date and shall apply to this Contract in the same manner as if it had been published in said publication. If the predetermined wage rate refers to one or more additional expiration dates with additional predetermined wage rates, which expiration dates occur during the life of this Contract, each successive predetermined wage rate shall apply to this Contract on the date following the expiration date of the previous wage rate. If the last of such predetermined wage rates expires during the life of this Contract, such wage rate shall apply to the balance of the Contract.

1.2. Penalties for Violations. Contractor and its subcontractors shall comply with California Labor Code section 1775 in the event a worker is paid less than the prevailing wage rate for the work or craft in which the worker is employed. This shall be in addition to any other applicable penalties allowed under Labor Code sections 1720 – 1861.

1.3. **Payroll Records.** Contractor and its subcontractors shall comply with California Labor Code section 1776, which generally requires keeping accurate payroll records, verifying and certifying payroll records, and making them available for inspection. Contractor shall require its subcontractors to also comply with section 1776. Contractor and its subcontractors shall submit weekly certified payroll records online via the City's web-based Labor Compliance Program. Contractor is responsible for ensuring its subcontractors submit certified payroll records to the City.

1.3.1. Contractor and their subcontractors shall also furnish records specified in Labor Code section 1776 directly to the Labor Commissioner in the manner required by Labor Code section 1771.4.

1.4. **Apprentices.** Contractor and its subcontractors shall comply with California Labor Code sections 1777.5, 1777.6 and 1777.7 concerning the employment and wages of apprentices. Contractor is held responsible for the compliance of their subcontractors with sections 1777.5, 1777.6 and 1777.7.

1.5. **Working Hours.** Contractor and their subcontractors shall comply with California Labor Code sections 1810 through 1815, including but not limited to: (i) restrict working hours on public works contracts to eight hours a day and forty hours a week, unless all hours worked in excess of 8 hours per day are compensated at not less than 1½ times the basic rate of pay; and (ii) specify penalties to be imposed on contractors and subcontractors of $25 per worker per day for each day the worker works more than 8 hours per day and 40 hours per week in violation of California Labor Code sections1810 through 1815.

1.6. **Required Provisions for Subcontracts.** Contractor shall include at a minimum a copy of the following provisions in any contract they enter into with a subcontractor: California Labor Code sections 1771, 1771.1, 1775, 1776, 1777.5, 1810, 1813, 1815, 1860 and 1861.

1.7. **Labor Code Section 1861 Certification.** Contractor in accordance with California Labor Code section 3700 is required to secure the payment of compensation of its employees and by signing this Contract, Contractor certifies that "I am aware of the provisions of Section 3700 of the California 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."

1.8. **Labor Compliance Program**. The City has its own Labor Compliance Program authorized in August 2011 by the DIR. The City will withhold contract payments when payroll records are delinquent or deemed inadequate by the City or other governmental entity, or it has been established after an investigation by the City or other governmental entity that underpayment(s) have occurred. For questions or assistance, please contact the City of San Diego's Prevailing Wage Unit at 858-627-3200.

1.9. Contractor and Subcontractor Registration Requirements. This project is subject to compliance monitoring and enforcement by the DIR. A contractor or subcontractor shall not be qualified to bid on, be listed in a bid or proposal, subject to the requirements of section 4104 of the Public Contract Code, or engage in the performance of any contract for public work, unless currently registered and qualified to perform public work pursuant to Labor Code section 1725.5 It is not a violation of this section for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 at the time the contract is awarded.

1.9.1. A Contractor's inadvertent error in listing a subcontractor who is not registered pursuant to Labor Code section 1725.5 in response to a solicitation shall not be grounds for filing a bid protest or grounds for considering the bid non-responsive provided that any of the following apply: (1) the subcontractor is registered prior to bid opening; (2) within twenty-four hours after the bid opening, the subcontractor is registered and has paid the penalty registration fee specified in Labor Code section 1725.5; or (3) the subcontractor is replaced by another registered subcontractor pursuant to Public Contract Code section 4107.

1.9.2. By submitting a bid or proposal to the City, Contractor is certifying that he or she has verified that all subcontractors used on this public work project are registered with the DIR in compliance with Labor Code sections 1771.1 and 1725.5, and Contractor shall provide proof of registration for themselves and all listed subcontractors to the City at the time of bid or proposal due date or upon request.

1.10. Stop Order. For Contractor or its subcontractors engaging in the performance of any public work contract without having been registered in violation of Labor Code sections 1725.5 or 1771.1, the Labor Commissioner shall issue and serve a stop order prohibiting the use of the unregistered contractors or unregistered subcontractor(s) on ALL public works until the unregistered contractor or unregistered subcontractor(s) is registered. Failure to observe a stop order is a misdemeanor.

1.11. List of all Subcontractors. The Contractor shall provide the list of subcontractors (regardless of tier), along with their DIR registration numbers, utilized on this Contract prior to any work being performed; and the Contractor shall provide a complete list of all subcontractors with each invoice. Additionally, Contractor shall provide the City with a complete list of all subcontractors (regardless of tier) utilized on this contract within ten working days of the completion of the contract, along with their DIR registration numbers. The City shall withhold final payment to Construction Management Professional until at least thirty (30) days after this information is provided to the City.

1.12. Exemptions for Small Projects. There are limited exemptions for installation, alteration, demolition, or repair work done on projects of $25,000 or less. The Contractor shall still comply with Labor Code sections 1720 et. seq. The only recognized exemptions are listed below:

1.12.1. Registration. The Contractor will not be required to register with the DIR for small projects. (Labor Code section 1771.1

1.12.2. Certified Payroll Records. The records required in Labor Code section 1776 shall be required to be kept and submitted to the City of San Diego, but will not be required to be submitted online with the DIR directly. The Contractor will need to keep those records for at least three years following the completion of the Contract. (Labor Code section 1771.4).

1.12.3. List of all Subcontractors. The Contractor shall not be required to hire only registered subcontractors and is exempt from submitting the list of all subcontractors that is required in section 4.20.11 above. (Labor code section 1773.3).

ATTACHMENT E

SUPPLEMENTARY SPECIAL PROVISIONS

SUPPLEMENTARY SPECIAL PROVISIONS

The following Supplementary Special Provisions (SSP) modifies the following documents:

1. The **2018 Edition** of the Standard Specifications for Public Works Construction (The "GREENBOOK").
2. The **2018 Edition** of the City of San Diego Standard Specifications for Public Works Construction (The "WHITEBOOK"), including the following:
   a) General Provisions (A) for all Construction Contracts.

SECTION 1 – GENERAL, TERMS, DEFINITIONS, ABBREVIATIONS, UNITS OF MEASURE, AND SYMBOLS

1-2 TERMS AND DEFINITIONS. To the "WHITEBOOK", item 54, "Normal Working Hours", ADD the following:

The **Normal Working Hours** are **7:00 AM** to **3:00 PM**.

SECTION 3 – CONTROL OF THE WORK

3-2 SELF-PERFORMANCE. To the "GREENBOOK", DELETE in its entirety and SUBSTITUTE with the following:

1. You shall perform, with your own organization, Contract Work amounting to at least 50% of the base Bid.

3-10 SURVEYING. To the "GREENBOOK", DELETE in its entirety and SUBSTITUTE with the following:

3-10 SURVEYING.

1. You shall locate and mark all features related to the building and site, including landscaping and hardscape, using industry standard contractor's construction tools.

2. You shall preserve construction survey stakes, control points, and other survey related marks described in 3-10.1, "Survey Services Provided by the City" for the duration of the Project. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be performed by the City at your expense.

3-10.1 Survey Services Provided by the City.

1. The City will provide surveying services and on-site survey staking for the following:
   a) Locations of any property lines, boundaries, or easement surveys within the project boundaries as required by the project.
   b) Locations of up to four corners per building.
   c) Verification of building pad finish surface elevation.
   d) A maximum of 4 site control points.
   e) Location and perpetuation of survey monuments within the project boundary in accordance with 400-2, "Permanent Survey Markers".
2. Notify the Resident Engineer in writing at least 2 Working Days prior to requesting survey services provided by the City.

3-10.2 Line and Grade.

1. The Work shall conform to the lines, elevations, and grades shown on the Plans. Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Engineer. In the absence of such report, you shall be responsible for any error in the grade of the Work.
2. Grades for underground conduits will be set at the surface of the ground. You shall transfer them to the bottom of the trench.

3-10.3 Payment.

1. The payment for survey services Work shall be included in the Contract Price.

SECTION 4 - CONTROL OF MATERIALS

4-3.6 Preapproved Materials. To the "WHITEBOOK", ADD the following:

3. You shall submit in writing a list of all products to be incorporated in the Work that are on the AML.

4-6 TRADE NAMES. To the "WHITEBOOK", ADD the following:

11. You shall submit your list of proposed substitutions for an "equal" item **no later than 5 Working Days after the determination of the Apparent Low Bidder** and on the City's Product Submittal Form available at:

    http://www.sandiego.gov/publicworks/edocref/index.shtml

SECTION 5 – LEGAL RELATIONS AND RESPONSIBILITIES

5-4 **INSURANCE.** To the "GREENBOOK", DELETE in its entirety and SUBSTITUTE with the following:

5-4 INSURANCE.

1. The insurance provisions herein shall not be construed to limit your indemnity obligations contained in the Contract.

5-4.1 Policies and Procedures.

1. You shall procure the insurance described below, at its sole cost and expense, to provide coverage against claims for loss including injuries to persons or damage to property, which may arise out of or in connection with the performance of the Work by you, your agents, representatives, officers, employees or Subcontractors.
2. Insurance coverage for property damage resulting from your operations is on a replacement cost valuation. The market value will not be accepted.
3. You shall maintain this insurance for the duration of this Contract and at all times thereafter when you are correcting, removing, or replacing Work in accordance with this Contract. Your liabilities under the Contract, e.g., your indemnity obligations, is not deemed limited to the insurance coverage required by this Contract.
4. The payment for insurance shall be included in the Contract Price as bid by you. Except as specifically agreed to by the City in writing, you are not entitled to any additional payment. Do not begin any Work under this Contract until you have provided and the City has approved all required insurance.
5. Policies of insurance shall provide that the City is entitled to 30 Days (10 Days for cancellation due to non-payment of premium) prior written notice of cancellation or non-renewal of the policy. Maintenance of specified insurance coverage is a material element of the Contract. Your failure to maintain or renew coverage or to provide evidence of renewal during the term of the Contract may be treated by the City as a material breach of the Contract.

5-4.2 Types of Insurance.

5-4.2.1 Commercial General Liability Insurance.

1. Commercial General Liability Insurance shall be written on the current version of the ISO Occurrence form CG 00 01 07 98 or an equivalent form providing coverage at least as broad.
2. The policy shall cover liability arising from premises and operations, XCU (explosions, underground, and collapse), independent contractors, products/completed operations, personal injury and advertising injury, bodily injury, property damage, and liability assumed under an insured's contract (including the tort liability of another assumed in a business contract).

3. There shall be no endorsement or modification limiting the scope of coverage for either "insured vs. insured" claims or contractual liability. You shall maintain the same or equivalent insurance for at least 10 years following completion of the Work.

4. All costs of defense shall be outside the policy limits. Policy coverage shall be in liability limits of not less than the following:

General Annual Aggregate Limit	Limits of Liability
Other than Products/Completed Operations	$2,000,000
Products/Completed Operations Aggregate Limit	$2,000,000
Personal Injury Limit	$1,000,000
Each Occurrence	$1,000,000

5-4.2.2 Commercial Automobile Liability Insurance.

1. You shall provide a policy or policies of Commercial Automobile Liability Insurance written on the current version of the ISO form CA 00 01 12 90 or later version or equivalent form providing coverage at least as broad in the amount of $1,000,000 combined single limit per accident, covering bodily injury and property damage for owned, non-owned, and hired automobiles ("Any Auto").

2. All costs of defense shall be outside the limits of the policy.

5-4.2.5 Contractors Builders Risk Property Insurance..

1. You shall provide at your expense, and maintain until Final Acceptance of the Work, a Special Form Builders Risk Policy or Policies. This insurance shall be in an amount equal to the replacement cost of the completed Work (without deduction for depreciation) including the cost of excavations, grading, and filling. The policy or policies limits shall be 100% of this Contract value of the Work plus 15% to cover administrative costs, design costs, and the costs of inspections and construction management.

2. Insured property shall include material or portions of the Work located away from the Site but intended for use at the Site and shall cover material or portions of the Work in transit. The policy or policies shall include as insured property scaffolding, falsework, and temporary buildings located at the Site. The policy or policies shall cover the cost of removing debris, including demolition.

3. The policy or policies shall provide that all proceeds thereunder shall be payable to the City as Trustee for the insured, and shall name the City, the Contractor, Subcontractors, and Suppliers of all tiers as named insured. The City, as Trustee, will collect, adjust, and receive all monies which may become due and payable under the policy or policies, may compromise any and all claims thereunder, and will apply the proceeds of such insurance to the repair, reconstruction, or replacement of the Work.

4. Any deductible applicable to the insurance shall be identified in the policy or policies documents and responsibility for paying the part of any loss not covered because of the application of such deductibles shall be apportioned among the parties except for the City as follows: if there is more than one claimant for a single occurrence, then each claimant shall pay a pro-rata share of the per occurrence deductible based upon the percentage of their paid claim to the total paid for insured. The City shall be entitled to 100% of its loss. You shall pay the City any portion of that loss not covered because of a deductible at the same time the proceeds of the insurance are paid to the City as trustee.

5. Any insured, other than the City, making claim to which a deductible applies shall be responsible for 100% of the loss not insured because of the deductible. Except as provided for under California law, the policy or policies shall provide that the City is entitled to 30 Days prior written notice (10 Days for cancellation due to non-payment of premium) of cancellation or non-renewal of the policy or policies.

5-4.3 **Rating Requirements.** Except for the State Compensation Insurance Fund, all insurance required by this Contract as described herein shall be carried only by responsible insurance companies with a rating of, or equivalent to, at least "A-, VI" by A.M. Best Company, that are authorized by the California Insurance Commissioner to do business in the State, and that have been approved by the City.

5-4.3.1 **Non-Admitted Carriers.** The City will accept insurance provided by non-admitted, "surplus lines" carriers only if the carrier is authorized to do business in the State and is included on the List of Approved Surplus Lines Insurers (LASLI list).

All policies of insurance carried by non-admitted carriers shall be subject to all of the requirements for policies of insurance provided by admitted carriers described herein.

5-4.4 **Evidence of Insurance.** Furnish to the City documents e.g., certificates of insurance and endorsements evidencing the insurance required herein, and furnish renewal documentation prior to expiration of this insurance. Each required document shall be signed by the insurer or a person authorized by the insurer to bind coverage on its behalf. We reserve the right to require complete, certified copies of all insurance policies required herein.

5-4.5 **Policy Endorsements.**

5-4.5.1 **Commercial General Liability Insurance.**

5-4.5.1.1 **Additional Insured.**

1. You shall provide at your expense policy endorsement written on the current version of the ISO Occurrence form CG 20 10 11 85 or an equivalent form providing coverage at least as broad.

2. To the fullest extent allowed by law e.g., California Insurance Code §11580.04, the policy shall be endorsed to include the City and its respective elected officials, officers, employees, agents, and representatives as additional insured.

3. The additional insured coverage for projects for which the Engineer's Estimate is $1,000,000 or more shall include liability arising out of:

   a) Ongoing operations performed by you or on your behalf,
   b) your products,
   c) your Work, e.g., your completed operations performed by you or on your behalf, or
   d) premises owned, leased, controlled, or used by you.

4. The additional insured coverage for projects for which the Engineer's Estimate is less than $1,000,000 shall include liability arising out of:

   a) Ongoing operations performed by you or on your behalf,
   b) your products, or
   c) premises owned, leased, controlled, or used by you.

5-4.5.1.2 **Primary and Non-Contributory Coverage.** The policy shall be endorsed to provide that the coverage with respect to operations, including the completed operations, if appropriate, of the Named Insured is primary to any insurance or self-insurance of the City and its elected officials, officers, employees, agents and representatives. Further, it shall provide that any insurance maintained by the City and its elected officials, officers, employees, agents and representatives shall be in excess of your insurance and shall not contribute to it.

5-4.5.1.3 **Project General Aggregate Limit.** The policy or policies shall be endorsed to provide a Designated Construction Project General Aggregate Limit that will apply only to the Work. Only claims payments which arise from the Work shall reduce the Designated Construction Project General Aggregate Limit. The Designated Construction Project General Aggregate Limit shall be in addition to the aggregate limit provided for the products-completed operations hazard.

5-4.5.2 Commercial Automobile Liability Insurance.

5-4.5.2.1 **Additional Insured.** Unless the policy or policies of Commercial Auto Liability Insurance are written on an ISO form CA 00 01 12 90 or a later version of this form or equivalent form providing coverage at least as broad, the policy shall be endorsed to include the City and its respective elected officials, officers, employees, agents, and representatives as additional insured, with respect to liability arising out of automobiles owned, leased, hired or borrowed by you or on your behalf. This endorsement is limited to the obligations permitted by California Insurance Code §11580.04.

5-4.5.5 Builders Risk Endorsements.

5-4.5.5.1 **Waiver of Subrogation.** The policy or policies shall be endorsed to provide that the insurer will waive all rights of subrogation against the City, and its respective elected officials, officers, employees, agents, and representatives for losses paid under the terms of the policy or policies and which arise from Work performed by the Named Insured for the City.

5-4.5.5.2 **Builders Risk – Partial Utilization.** If the City desires to occupy or use a portion or portions of the Work prior to Acceptance in accordance with this Contract, the City will notify you and you shall immediately notify your Builder's Risk insurer and obtain an endorsement that the policy or policies shall not be cancelled or lapse on account of any such partial use or occupancy. You shall obtain the endorsement prior to the City's occupation and use.

5-4.6 **Deductibles and Self-Insured Retentions.** You shall pay for all deductibles and self-insured retentions. You shall disclose deductibles and self-insured retentions to the City at the time the evidence of insurance is provided.

5-4.7 **Reservation of Rights.** The City reserves the right, from time to time, to review your insurance coverage, limits, deductibles and self-insured retentions to determine if they are acceptable to the City. The City will reimburse you, without overhead, profit, or any other markup, for the cost of additional premium for any coverage requested by the Engineer but not required by this Contract.

5-4.8 **Notice of Changes to Insurance.** You shall notify the City 30 Days prior to any material change to the policies of insurance provided under this Contract.

5-4.9 **Excess Insurance.** Policies providing excess coverage shall follow the form of the primary policy or policies e.g., all endorsements.

5-4.10 **Architects and Engineers Professional Insurance (Errors and Omissions Insurance)**.

1. For Contracts with required engineering services (e.g., Design-Build, preparation of engineered Traffic Control Plans (TCP), and etc) by you, you shall keep or require all of your employees or Subcontractors, who provide professional engineering services under this contract, Professional Liability coverage with a limit of $**1,000,000** per claim and $**2,000,000** annual aggregate in full force and effect.

2. You shall ensure the following:

   a) The policy retroactive date is on or before the date of commencement of the Project.

   b) The policy will be maintained in force for a period of 3 years after completion of the Project or termination of this Contract, whichever occurs last. You agree that for the time period specified above, there will be no changes or endorsements to the policy that affect the specified coverage.

3. If professional engineering services are to be provided solely by the Subcontractor, you shall:

   a) Certify this to the City in writing and

   b) Agree in writing to require the Subcontractor to procure Professional Liability coverage in accordance with the requirements set forth above.

5-4.11 Workers' Compensation Insurance and Employers Liability Insurance.

1. In accordance with the provisions of §3700 of the California Labor Code, you shall provide at your expense Workers' Compensation Insurance and Employers Liability Insurance to protect you against all claims under applicable state workers compensation laws. The City, its elected officials, and employees will not be responsible for any claims in law or equity occasioned by your failure to comply with the requirements of this section.

2. Limits for this insurance shall be not less than the following:

Workers' Compensation	Statutory Employers Liability
Bodily Injury by Accident	$1,000,000 each accident
Bodily Injury by Disease	$1,000,000 each employee
Bodily Injury by Disease	$1,000,000 policy limit

3. By signing and returning the Contract you certify that you are aware of the provisions of §3700 of the Labor Code which requires every employer to be insured against liability for worker's compensation or to undertake self-insurance in accordance with the provisions of that code and you shall comply with such provisions before commencing the Work as required by §1861 of the California Labor Code.

5-4.11.1. Waiver of Subrogation. The policy or policies shall be endorsed to provide that the insurer will waive all rights of subrogation against the City and its respective elected officials, officers, employees, agents, and representatives for losses paid under the terms of the policy or policies and which arise from Work performed by the Named Insured for the City.

5-13 ELECTRONIC COMMUNICATION. To the "WHITEBOOK", ADD the following:

2. Virtual Project Manager shall be used on this Contract. For more information, refer to the VPM traning videos at the location below:

   https://www.sandiego.gov/publicworks/edocref

SECTION 6 – PROSECUTION AND PROGRESS OF THE WORK

6-1.1 Construction Schedule. To the "WHITEBOOK", item 1, subsection "s", DELETE in its entirety and SUBSTITUTE with the following:

s) Submit an updated cash flow forecast with every pay request (for each Project ID or WBS number provided in the Contract) showing periodic and cumulative construction billing amounts for the duration of the Contract Time. If there has been any Extra Work since the last update, include only the approved amounts.

   i. Refer to the Sample City Invoice materials in **Appendix D – Sample City Invoice with Cash Flow Forecast** and use the format shown.

ii. See also the "Cash Flow Forecast Example" at the location below:

https://www.sandiego.gov/publicworks/edocref

6-1.5.2 Excusable Non-Compensable Delays. To the "WHITEBOOK", DELETE in its entirety.

ADD:

6-1.5.2 Excusable Non-Compensable and Concurrent Delays.

1. The City shall only issue an extension of time for Excusable Delays that meet the requirements of 6-4.2, "Extensions of Time" for the following circumstances:
   a) Delays resulting from Force Majeure.
   b) Delays caused by weather.
   c) Delays caused by changes to County, State, or Federal law.
2. When a non-excusable delay is concurrent with an Excusable Delay, you shall not be entitled to an extension of Contract Time for the period the non-excusable delay is concurrent with the Excusable Delay.
3. When an Excusable Non-Compensable Delay is concurrent with an Excusable Compensable Delay, you shall be entitled to an extension of Contract Time, but shall not be entitled to compensation for the period the Excusable Non-Compensable Delay is concurrent with the Excusable Compensable Delay.

6-4.2 Extensions of Time. To the "WHITEBOOK", DELETE in its entirety and SUBSTITUTE with the following:

1. The Contract Time shall not be modified except by Change Order.
2. You shall notify the City in writing within **1 Working Day** after the occurrence and discovery of an event that impacts the Project Schedule.
   a) If you believe this event requires a Change Order, you shall submit a **written Change Order request with a report to** the City that explains the request for Change Order within **5 Working Days**. The Change Order request must include supporting data, a general description of the discovery, the basis for extension, and the estimated length of extension. The City may grant an extension of time, in writing, for the Change Order request if you require more time to gather and analyze data.
3. The Engineer shall not grant an extension of Contract Time in accordance with 6-1.5, "Excusable Delays" unless you demonstrate, through an analysis of the critical path, the following:
   a) The event causing the delay impacted the activities along the Project's critical path.
   b) The increases in the time to perform all or part of the Project beyond the Contract Time arose from unforeseeable causes beyond your

control and without your fault or negligence and that all project float has been used.

4. Any modifications to the Contract Time will be incorporated into the weekly document that the Engineer issues that stipulates the Contract Time. If you do not agree with this document, submit to the Engineer for review a written protest supporting your objections to the document within **30 Calendar Days** after receipt of the statement. Your failure to file a timely protest shall constitute your acceptance of the Engineer's weekly document.

   a) Your protest will be considered a claim for time extension and shall be subject to 2-10.1, "Claims".

ADD:

6-6.1.1 Environmental Document.

1. The City of San Diego has prepared a **Notice of Exemption and Notice of Right to Appeal Environmental Determination** for **SBWRP Ultraviolet (UV) Disinfection System Replacement**, **Project No. B-18031**, as referenced in the Contract Appendix. You shall comply with all requirements of the **Notice of Exemption and Notice of Right to Appeal Environmental Determination** as set forth in **Appendix A.**

2. Compliance with the City's environmental document shall be included in the Contract Price, unless separate bid items have been provided.

6-6.4 Written Notice and Report. To the "WHITEBOOK", DELETE in its entirety and SUBSTITUTE with the following:

1. Your failure to notify the Resident Engineer within **1 Working Day** OR provide a Change Order request within **5 Working Days** after the event, in accordance with 6-4.2, "Extensions of Time", will be considered grounds for refusal by the City to consider such request if your failure to notify prejudices the City in responding to the event**.**

SECTION 1001 – CONSTRUCTION BEST MANAGEMENT PRACTICES (BMPs)

1001-1 GENERAL. To the "WHITEBOOK", ADD the following:

7. Based on a preliminary assessment by the City, this Contract is subject to WPCP.

END OF SUPPLEMENTARY SPECIAL PROVISIONS (SSP)

TECHNICALS

City of San Diego

CONTRACT DOCUMENTS for

South Bay Water Reclamation Plant Ultraviolet (UV) Disinfection System Replacement

MASTER TECHNICAL SPECIFICATIONS – DIVISIONS 01 THROUGH 16

SPECIFICATION NO. H-156464

UV DISINFECTION SYSTEM REPLACEMENT
SOUTH BAY WATER RECLAMATION PLANT

CONTRACT NO. H-156464

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SECTION 01014 - WORK SEQUENCE

PART 1 -- GENERAL

1.1. THE REQUIREMENT

A. The CONTRACTOR shall coordinate the scheduling of construction activities so that the operation of the existing treatment plant and the flow of sewage shall not be disrupted.

1.2. RELATED WORK SPECIFIED ELSEWHERE

A. Section 02050 Demolition

B. Section 03300 Cast-In-Place Structural Concrete

C. Section 11300 Ultra-Violet Disinfection System

D. Section 13300 Instrumentation and Control

E. Section 13350 Commissioning

1.3. CONTRACTOR SUBMITTALS

In addition to the Construction Schedule required by the General Requirements, the CONTRACTOR shall submit a detailed sequence of operation plan and schedule. The plan shall address the detailed implementation steps necessary to accomplish the scope of WORK, WORK specified herein, and WORK per the Contract Documents. The detailed implementation steps shall address and include, but not be limited to, the following conditions and restrictions:

A. Specific restrictions and conditions specified in these Specifications.

B. A detailed outage plan and time schedule for operations.

C. The detailed plan shall describe the CONTRACTOR's method of operation and the length of time required to complete said operation.

D. Systems or individual equipment items that will be isolated, dewatered, decommissioned, de-energized, or depressurized in accordance with the detailed outage plan and schedule. Notify the Construction Manager in writing at least one week in advance of the planned operation.

E. The CONTRACTOR shall provide detailed plans and details showing temporary shoring and protection of existing pipelines and utilities. Detailed plan shall be designed and signed by Registered Engineer in the State of California and approved by the Construction Manager per Section 02200, Earthwork.

F. The CONTRACTOR can elect to dismantle the existing canopy over the UV channel and store it. The City may not be able to provide storage space for the canopy and the CONTRACTOR will need to rent storage space offsite at no additional cost to the City. After the WORK is complete, the CONTRACTOR shall reinstall the canopy at or better than the existing condition. The CONTRACTOR shall photograph and document the existing condition of the canopy in

detail before dismantling it for storage. The CONTRACTOR shall submit the documentation of the existing condition and the location where the canopy will be stored safely to the Construction Manager for review and approval.

G. In order to complete construction and have it approved, the CONTRACTOR shall submit all the shop drawings and calculations required for deferred submittals to the Engineer within three weeks of the Notice to Proceed. In case the submittals need to be revised and resubmitted, the CONTRACTOR shall revise and resubmit them within two weeks from receiving the comments from the Engineer and the City. Once the submittals and the calculations are accepted by the Engineer and the City, the CONTRACTOR shall submit the items including calculations included in the deferred submittals to the DSD within one week. The CONTRACTOR shall coordinate with the DSD including revising and resubmitting shop drawings and calculations as required by the DSD within one week from receiving comments from the DSD. The CONTRACTOR shall coordinate the inspection work with the DSD to ensure that the system can be brought online on schedule.

H. The CONTRACTOR shall conduct the Bioassay Tests, prepare a report based on the test results and submit it for review and approval to the State DDW. The acceptance of the project is contingent upon the State DDW determination that the test results and the report submitted by the CONTRACTOR meets the State's requirements.

1.4. CONTINUITY OF SYSTEM OPERATIONS

A. The existing South Bay Water Reclamation Plant is currently and continuously receiving and treating wastewater, and those functions shall not be interrupted except as specified herein. The CONTRACTOR shall coordinate the WORK to avoid any interference with normal operation of the system.

1.5. SEWAGE SPILLS

A. Spills of untreated or partially treated sewage to surface waters or drainage courses is prohibited. In the event of a spill caused by the CONTRACTOR's operations, the City shall immediately be entitled to employ others to stop the spill without giving written notice to the CONTRACTOR.

B. Cost of penalties imposed on the City as a result of a spill caused by the actions of the CONTRACTOR, its employees, or subcontractors, shall be borne in full by the CONTRACTOR, including legal fees and other expenses to the City resulting directly or indirectly from the spill.

1.6. PLANNED OUTAGES TO FACILITATE CONSTRUCTION

A. The UV disinfection of the effluent will be shut down from January 02, 2020 through February 28, 2020 (58 calendar days) to allow the CONTRACTOR to demolish the existing UV disinfection system, install, test and commission the new system per approved test protocol. This time includes the time required for Bioassay testing, report preparation, and submittal of the report and testing results to the State of California's Division of Drinking Water (DDW). This time also includes any inspections that need to be performed by the City's DSD and issue the necessary permits. The 58 calendar days also includes a minimum of 2 week notice that the CONRACTOR needs to provide to the manufacturer of the UV System to certify that the system installation is complete. This planned outage time (1/2/2020

to 2/28/2020) does not include the review time required by the State DDW to review and approve the bioassay testing and report submitted by the Contractor. However, if the State DDW finds the report deficient, the Contractor will have to perform remedial work, retest, revise and resubmit the bioassay report. The time to perform the above-mentioned work and the time required by the State DDW to review the revised report will be counted against the approved outage time. The elapsed time till the State finds the report acceptable will be counted against the approved outage time.

B. The City will not be able to supply reclaimed water to the users during this outage and will have to make other arrangements that it will result in additional expenses to the City. As a result, the City will assess liquidated damages every day the CONTRACTOR is not able to bring the system online past the last date mentioned above.

C. The Plant personnel are present during the hours of 7am through 3pm, Monday through Thursday, and 7am through 3pm every alternate Friday. The CONTRACTOR shall schedule WORK only during the hours when Plant personnel are present except during the shutdown period mentioned above.

D. During the shutdown period mentioned above, the City will schedule plant personnel to be present 7 days a week, 6am through 4pm. The CONTRACTOR will be allowed to WORK during those hours only.

PART 2 -- PRODUCTS

2.1 CONTRACTOR shall provide all required equipment and personnel necessary to perform WORK specified herein. Any approved deviations from WORK herein shall be borne in full by the CONTRACTOR at no additional cost to the City.

2.2 Redlines: CONTRACTOR shall keep the Contract Documents continuously redlined based on modifications as a result of RFI responses, submittal comments and approvals, and approved deviations. Redlines include markups to the Contract Drawings as well as the Contract Specifications. The CONTRACTOR shall maintain onsite at least one redline set.

PART 3 -- EXECUTION

3.1 SEQUENCE OF WORK:

Listed below is an outline of the workflow in sequential order. Not all items are listed, and the detailed schedules shall be provided by the CONTRACTOR per the Contract Requirements.

A. Within 21 calendar days from the NTP, the CONTRACTOR shall submit the Shop Drawings for the demolition of the existing UV System, new UV System and other related items including those required for the DSD deferred submittal. The System will not be shut down till all the required submittals are approved by the Engineer of Record.

B. Install new items that do not affect the operation and maintenance of the existing UV system and related equipment.

C. Report to Construction Manager about ready for outage.

D. Concurrent WORK:

1. After the City starts the Outage, demolish existing UV equipment.

2. Install equipment outside of UV channel that are not affected by demolition.

3. Coordinate with the City's COMNET Group to ensure they are ready to incorporate the new UV system into the City's DCS.

E. Install new UV equipment and all ancillary equipment.

F. Test and commission new UV equipment.

G. Perform Bioassay Tests, prepare and submit report to the State's DDW, confer with DDW, and make any changes needed to gain approval

H. Punch List and Closeout after approval from the State's DDW is received.

3.2 STATE DDW PERMITTING OF FINISHED WORK:

The CONTRACTOR shall perform Bioassay Tests and prepare and submit the test results and reports required by the State's DDW to review and approve the installation of the new UV Disinfection System so that the City can start distribution of reclaimed water. The CONTRACTOR shall hire a Professional Engineer licensed in the State of California who has experience with UV Disinfection Systems for Wastewater and have previously prepared protocol and bioassay testing and validation for such systems to perform the testing and prepare the protocol and bioassay report(s). It is assumed that the State will take 28 calendar days from the time the CONTRACTOR has submitted a report that the State deems complete and begins their review process. If the State takes more than 28 calendar days, the CONTRACTOR will be granted an extension of time for the days the State exceeded this assumed time.

After the State grants the approval, the Construction Manager will conduct a walk-through and generate a Punch List of items that the CONTRACTOR will need to complete before the WORK is deemed complete and the lien period will begin thereafter. The CONTRACTOR will have 3 days to schedule the walk through with the Construction Manager and 7 days from the completion of the walk-through to complete the Punch List WORK. Please note that due to the critical nature of this project, the time allocated for notifications and Punch List work is different from the "WHITEBOOK" Section 3-13.1.2.

*** *END OF SECTION * ***

SECTION 01025 – MEASUREMENT AND PAYMENT

PART 1 -- GENERAL (Not Used)

PART 2 -- MATERIALS

2.1 GENERAL (MEASUREMENT)

A. Measurement for unit price quantities shall be based upon the appropriate bid item in the proposal. The actual quantity of measurement shall be as constructed by the CONTRACTOR in place in conformance with the Plans and Specifications.

B. In case of conflict between requirements shown in the plans and specifications, the more stringent condition will apply, i.e., the CONTRACTOR shall include the more expensive option in the bid.

2.2 LINEAR MEASUREMENTS

A. Pipeline and related facility measurements shall be made horizontally along the centerline of the pipeline and related facilities through tees, bends, valves, fittings, and as shown on the Plans for its limits or as otherwise specified in the Special Technical Provisions.

2.3 AREA MEASUREMENTS

A. Measurement for bid items involving area units shall be based upon the surface area measured in acres, square yards, square feet, or as indicated in the bid item.

2.4 VOLUME MEASUREMENTS

A. Measurement for bid items involving volume units shall be based upon the volume measured in cubic yards, tons, or as indicated in the bid item.

2.5 UNIT MEASUREMENTS

A. Measurement for bid items involving units of the item shall be based upon the number of units counted as indicated in the bid item.

2.6 LUMP SUM MEASUREMENT

A. Lump sum items shall include all labor, delivery, materials, equipment and testing services as required by these Specifications for the complete installation of the bid items described in this Section. No separate payment shall be made for items not included by the CONTRACTOR in the total contract Bid Price as described in Part 3 herein.

PART 3 –- EXECUTION

3.1 GENERAL

A. This Section covers methods of measurement and payment for items of WORK under this Contract. The total Bid Price shall cover all WORK required by the Contract Documents. All

costs in connection with the proper and successful completion of the WORK, including furnishing all materials, equipment, tools and incidentals; and performing all necessary labor and supervision to fully complete the WORK, shall be included in the unit (linear, area, volume) and lump sum prices bid. All WORK not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of CONTRACTOR and all costs in connection therewith shall be included in the prices bid.

3.2 ESTIMATED QUANTITIES

A. All estimated quantities stipulated in the Bid Form or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the WORK and (b) for the purpose of comparing the bids submitted for the WORK. The actual amount of WORK done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for WORK and materials will be the actual amount of WORK done and materials furnished. CONTRACTOR agrees that he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of WORK actually performed and materials actually furnished and the estimated amounts therefor.

3.3 BID ITEMS

A. MOBILIZATION/DEMOBILIZATION - Lump Sum Bid Item shall include full compensation for mobilization and demobilization including and not limited to furnishing and installing, complete and in place all the necessary site preparatory WORK and operations, including those necessary for movement of personnel, equipment, supplies, and incidentals to the project site for the establishment and upkeep of temporary facilities, sanitary facilities, permits (unless otherwise specified in other Bid Items), traffic control plans (if required), water pollution control plan preparation and implementation of the plan, maintenance of project site including trash and litter pickup, offices, buildings, and other facilities necessary for WORK on the project, final project close-out and cleanup operations, including, but not limited to, those necessary for the removal of equipment, supplies, incidentals and debris from the project site, cleaning the streets and sidewalks of all soils and construction debris, record drawings, correction of deficiencies in the WORK, and for all other WORK required as indicated in the CONTRACT DOCUMENTS.

B. UV DISINFECTION EQUIPMENT – Lump Sum Bid Item shall include full compensation for all equipment supplied by the UV Disinfection System manufacturer as required in CONTRACT DOCUMENTS. This bid item includes the following but are not limited to shop drawing submittals, the UV Lamps and Lamp Banks, Drivers, Sleeves, Cleaning System, Water Level Controllers, Weir Gate, Light Locks, Power Distribution Centers, Hydraulic System Centers, System Control Centers, Water Level Sensors and related controls, UV Intensity Sensors and Transmission Monitor, Dose Pacing System, Ultrasonic Water Level Sensors, UV Bank Lifting Devices, Spare Parts as specified and all ancillary items including cables, hoses, switches, boxes etc. for a complete functional UV Disinfection System. The intent of this bid item is to pay for the equipment supplied and work performed by the UV Disinfection System manufacturer. The cost of installation of the UV disinfection system and other required equipment shall be included in other bid items.

C. CIVIL - SITE IMPROVEMENTS - Lump Sum Bid Item shall include full compensation for all equipment, materials, and labor to install the Civil – Site improvements complete and in place as indicated on plans and as required in CONTRACT DOCUMENTS. The Price for this Bid Item shall include all WORK related to Demolition of all equipment and structures as shown on the plans. It shall also include the cost for new Guardrails, new Access Ladders and

Stairs, new Hatches, new Covers and Gates, new Valves, Site Preparation, Storage & Staging, and Clearing and Grubbing. Civil Site WORK shall also include demolition, Excavation and Shoring, Hauling soil offsite, Aggregate Base, crushed stone base, Finish Grading, Fine Grading for Over Excavation Subgrade, Reinforced Portland Cement Concrete sidewalks, driveways and incidental paving, AC Paving, and Site Drainage Improvements.

D. STRUCTURAL - Lump Sum Bid Item shall include full compensation for all equipment, materials, and labor to install the Structural Walls, Beams, Columns and other structural items complete and in place as indicated on plans and as required in CONTRACT DOCUMENTS.

E. MECHANICAL - Lump Sum Bid Item shall include full compensation for all ancillary mechanical equipment, materials, and labor to install all MECHANICAL systems complete and in place as indicated on plans and as required in CONTRACT DOCUMENTS. The Price for this Bid Item shall include all WORK related to the installation and testing of the UV Disinfection System including all accessories for a complete working system in place. The cost for the Bioassay testing, report preparation and related WORK shall also be included in this item. The cost for the mechanical equipment supplied by the UV Disinfection system manufacturer shall be included in the bid item for the UV Disinfection System.

F. INSTRUMENTATION & CONTROL - Lump Sum Bid Item shall include full compensation for all equipment, materials, and labor to install the Instrumentation & Control System complete and in place as indicated on plans and as required in CONTRACT DOCUMENTS. The Price for this Bid Item shall include all WORK related to DCS Equipment Panels Installation and Modifications, Commissioning, Field Instruments and Modifications to existing control equipment. The cost for the instrumentation and control equipment supplied by the UV Disinfection system manufacturer shall be included in the bid item for the UV Disinfection System.

G. ELECTRICAL - Lump Sum Bid Item shall include full compensation for all equipment, materials, and labor to install the Electrical System complete and in place as indicated on plans and as required in CONTRACT DOCUMENTS. The Price for this Bid Item shall include all WORK related to Electrical Demolition, Modifications to MCCs, Cable & Conduit, Miscellaneous Electrical. The cost for the electrical equipment supplied by the UV Disinfection system manufacturer shall be included in the bid item for the UV Disinfection System.

H. TRAINING AND OPERATIONS & MAINTENANCE (O&M) MANUALS - Lump Sum Bid Item shall include full compensation for all equipment, materials, and labor to complete all trainings of the City's operations and maintenance staff by the various manufacturers' representatives, and preparation and submittal of approved O&M Manuals as required in CONTRACT DOCUMENTS.

**** END OF SECTION ****

SECTION 01640 - SEISMIC DESIGN OF EQUIPMENT AND ANCHORAGE

PART 1--GENERAL

1.1 REFERENCES

A. General

1. The publications listed below form a part of this Section to the extent referenced.

2. Where a date is given for referenced standards, the edition of that date shall be used. Where no date is given for referenced standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

B. California Building Standards Commission

1. California Building Code (CBC)

1.2 SUBMITTALS

A. The CONTRACTOR shall submit calculations and shop drawings of equipment design and equipment anchorage layout and details.

1.3 DEFINITIONS

A. Equipment—Equipment shall include, but not be limited to, electrical, mechanical, and plumbing equipment machinery, tanks and vessels (including contents).

1.4 EQUIPMENT LOCATIONS AND DETAILS

A. Equipment layout, dimensions, details, and anchorage shown on the drawings shall be verified by the CONTRACTOR for agreement with manufacturer's information and shop drawings.

1. If required by the specifications or if the CONTRACTOR desires to revise the layout or anchorage details shown on the design drawings, the CONTRACTOR shall prepare detailed submittal drawings of the desired revision to be approved by the Engineer. The CONTRACTOR’s submittal shall include the necessary detailed drawings and design calculations prepared and stamped by a civil or structural engineer currently registered in the State of California.

2. Where anchorage details are not shown on the design drawings, the CONTRACTOR shall submit structural calculations and details of the proposed anchorage including that required for the UV disinfection system prepared and stamped by a civil or structural engineer currently registered in the State of California. The structural calculations and details of the proposed anchorage shall be included in the submittal for the associated equipment.

3. The installation of the equipment shall not be performed and supporting concrete shall not be placed until details of the anchorage have been approved by the Engineer.

4. Floor mounted electrical equipment shall be installed on an equipment pad at least 4 inches higher than adjacent grade or floor unless otherwise noted on the plans.

1.5 DESIGN CRITERIA

A. All equipment, including UV disinfection units, furnished by the CONTRACTOR shall be designed to adequately resist static loading as well as loading due to system operations and vertical and lateral dynamic forces imposed by wind or seismic events.

B. Unless otherwise specified, all equipment shall be designed and installed to resist seismic and wind forces which are determined in accordance with the CBC.

C. The following coefficients shall be used in determining the lateral seismic forces for the CBC formulas:

1. Seismic Design Category: **D**

2. Site Class: **D**

3. CBC Seismic Design Spectral Acceleration Parameters:
Based on site latitude and longitude as generated by
https://earthquake.usgs.gov/designmaps/us/application.php

D. Unless otherwise specified, the Occupancy Category shall be **IV** and the WORK shall be considered as an "Essential Facility" and the appropriate importance factors (I, I_p or I_w) specified on drawing or as defined by the CBC, the more restrictive requirements shall be used.

E. Anchorage design shall consider vertical seismic force per CBC. Horizontal and vertical seismic forces shall be considered to act concurrently.

F. Wind loading shall be determined using minimum basic wind speed (V) of **115 mph** and CBC Exposure **C**.

G. Friction shall not be used to resist sliding due to seismic forces.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

****END OF SECTION****

SECTION 02050 - DEMOLITION

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes furnishing materials, equipment and labor necessary to perform and complete demolition per Contract Documents.

B. In areas indicated to be remodeled, cut back flush and seal any pipe stub-outs remaining, and remove exposed piping, conduits, fixtures, junction boxes, light fixtures, water fixtures, and supports. Switches, receptacles, and boxes shall also be removed. Concealed piping and conduits shall be removed or capped and abandoned as necessary to facilitate the remodeling WORK. All other items shall be removed as shown.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 02200 Earthwork
2. Section 13300 Instrumentation and Control

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Building Code

1.5 SUBMITTALS

A. The following shall be submitted:

1. Demolition Schedule: The CONTRACTOR shall submit a complete coordination schedule for demolition work including shut-off and continuation of utility services prior to start of the WORK. The schedule shall indicate proposed methods and operations of facility demolition, and provide a detailed sequence of demolition and removal work to ensure uninterrupted operation of occupied areas.

1.6 ASBESTOS REMOVAL

NOT USED.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 GENERAL

A. Structures shall be demolished and removed in compliance with SSPWC Section 401 and the requirements indicated herein.

3.2 POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used for dust suppression.

B. Water shall not be used when it creates hazardous or objectionable conditions such as flooding, erosion, sedimentation, or pollution.

3.3 PROTECTION

A. Safe passage of persons around the area of demolition shall be provided. Operations shall be conducted to prevent injury to people and damage to adjacent buildings, structures, and other facilities.

B. Interior and exterior shoring, bracing, or supports shall be provided to prevent movement, settlement or collapse of structures to be demolished.

C. Existing landscaping materials, structures, and appurtenances which are not to be demolished shall be protected and maintained as necessary.

D. Unless otherwise indicated, the CONTRACTOR shall protect and maintain all utilities in the proximity of the facilities to be demolished.

E. The CONTRACTOR shall protect the nearby existing equipment such as control panels and others from dust caused by demolition activities by covering, drop-curtains and other similar methods.

3.4 STRUCTURE DEMOLITION

A. Building structures and appurtenances shall be demolished, as shown and required to complete WORK, in compliance with governing regulations.

B. Small structures may be removed intact when approved by authorities having jurisdiction.

C. Demolition shall proceed in a systematic manner, from top of structure to ground.

D. Concrete and masonry shall be demolished in small sections. Use bracing and shoring to prevent collapse.

E. Demolition equipment shall be dispersed throughout structure and demolished materials removed to prevent excessive loads on supporting walls, floors or framing.

F. Existing concrete structures, walls, floors, anchors, rebars, bolts etc. that are to be demolished to match to adjacent finished grades shall be saw cut flush with the finished grade. Chisel 2" off existing concrete below the grade, cut off steel rebar/anchor/bolt, coat surface with epoxy and fill chiseled 2" section with grout to match adjacent finished surface.

3.5 BELOW-GRADE DEMOLITION

A. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth which will not interfere with new construction, but not less than 12 inches below existing ground surface or future ground surface, whichever is lower. All floors of basements, vaults, and other underground structures shall be broken up.

B. Below-grade areas and voids resulting from demolition of structures shall be completely filled to a minimum compaction of 95%.

C. All fill and compaction shall be in accordance with Section 02200.

D. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from demolition operations shall be removed and disposed of in compliance with all laws and regulations. Burning of removed materials from demolished structures shall not be permitted.

3.7 PATCHING AND REPAIRING

A. The CONTRACTOR shall provide patching, replacing, repairing, and refinishing of damaged areas involved in demolition as necessary to match the existing adjacent surfaces.

B. The CONTRACTOR shall repair all damages caused to adjacent facilities by demolition at no additional cost to the OWNER.

C. After patching and repairing has been completed, the CONTRACTOR shall carefully remove splatterings of mortar from adjoining work (plumbing fixtures, trim, tile, and finished metal surfaces) and repair any damage caused by such cleaning operations.

3.8 CLEANING

A. During and upon completion of WORK, the CONTRACTOR shall promptly remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work in a clean condition.

B. Clean adjacent structures and facilities of dust, dirt, and debris caused by demolition and return adjacent areas to condition existing prior to start of WORK.

C. The CONTRACTOR shall clean and sweep the affected portions of roads, streets, sidewalks and passageways daily.

**** END OF SECTION ****

SECTION 02100 - SITE PREPARATION

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes site preparation, clearing and grubbing.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 02050 Demolition
2. Section 02200 Earthwork

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 GENERAL

A. **Existing Conditions:** The site shall be examined and the CONSTRUCTION MANAGER notified of any conditions which affect the WORK of this Section.

B. **Utility Interference:** Where existing utilities interfere with the WORK of this Section, the CONSTRUCTION MANAGER shall be notified of interferences.

3.2 CLEARING AND GRUBBING

A. Clearing and grubbing shall comply with SSPWC Subsection 300-1 and the following:

1. The site shall be cleared of grass and weeds to a depth of at least 6 inches and debris and obstructions including brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement.

2. The site shall be grubbed to a depth necessary to remove objectionable material including stumps and roots.

3.3 SALVAGE AND DISPOSAL

A. **Salvage:** Topsoil shall be salvaged and stored at a location which will not interfere with the WORK.

B. **Disposal:** Waste material shall be disposed of in accordance with SSPWC Section 401.

**** END OF SECTION ****

SECTION 02200 - EARTHWORK

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes all earthwork required for construction of the WORK. Such earthwork shall include the loosening, removing, loading, transporting, depositing, and compacting in its final location of all materials wet and dry, as required for the purposes of completing the WORK.

B. Fill material is defined as material used to raise the level of a portion of the site to the line and grade indicated. Backfill material is defined as material used to refill an excavation.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 02100 Site Preparation

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 REGULATORY REQUIREMENTS

A. The WORK of this Section shall comply with current versions, with revisions, of the following:

1. Construction Safety Orders, Division of Industrial Safety, State of California.
2. California Department of Transportation Traffic Manual.

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. The CONTRACTOR shall comply with the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the OWNER and shall be in possession of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system established in the Construction Safety Orders of the State of California, such alternative system plans shall be prepared by a civil or structural engineer licensed in the State of California.

2. Copy of the excavation permit issued by the California Department of Industrial Safety.

3. Samples of imported material. Samples shall be submitted in accordance with SSPWC, Subsection 217-2.2.

4. Such other samples of materials as the CONSTRUCTION MANAGER may require.

1.6 SOIL TESTING

A. **General:** All soils testing shall be done in accordance with SSPWC, Section 211, and by a testing laboratory of the OWNER's choice at the OWNER's expense.

B. **Compaction Tests:** Where soil material is required to be compacted to a percentage of maximum density, the maximum density shall be determined in accordance with the requirements of SSPWC, Subsection 211-1. In case the tests of the fill or backfill show non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and shall be at the CONTRACTOR's expense.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIALS

A. **General:** Fill and backfill material shall consist of select material obtained from the excavation, imported material, granular bedding material, or unclassified material. The CONTRACTOR shall import at his expense materials in excess of the approved material obtained from excavation as required to complete the fill, backfill, and grading WORK as indicated.

B. **Select Material:** Select material shall consist of primarily granular material encountered in the excavation which is free of vegetation, organic matter, debris, rocks larger than 4 inches in diameter and other unsuitable material, and shall have an expansion index less than 30 (less than 20 for footings and floor slabs) as determined by UBC Standard No. 29-2, plasticity index of 10 or less, a liquid limit of 30 or less and shall be approved as select material by the CONSTRUCTION MANAGER.

C. Imported Material: Imported material shall conform to the same specifications as select material defined above. In addition, the imported materials shall have a minimum sand equivalent of 15 as determined by California Test Method No. 217. Imported material placed in areas to be planted shall be able to support normal plant growth. Obtain approval by the CONSTRUCTION MANAGER prior to transporting imported material.

D. Bedding Material: Bedding material, defined as that material supporting, surrounding and extending to 1 foot above the top of a pipe, shall be in accordance with SSPWC, Subsection 306-6.

E. Unclassified Material: Unclassified material shall conform to SSPWC, Subsection 300-4.

2.2 ROCK PRODUCTS

A. Rock products, consisting of crushed rock, rock dust, gravel, sand, and stone for riprap shall be clean, hard, sound, durable, uniform in quality and free of disintegrated material, organic matter, oil alkali, or other deleterious substance, and shall, unless otherwise specified, conform with the requirements of SSPWC, Subsection 200-1.

2.3 UNTREATED BASE MATERIALS

A. Untreated base materials shall conform with the requirements of SSPWC, Subsection 200-2.

2.4 TOPSOIL

A. Topsoil shall be designated as Class A (imported), Class B (selected), or Class C (unclassified), and shall conform with the requirements of SSPWC, Subsection 212-1.1. The CONSTRUCTION MANAGER shall determine the suitability of topsoil prior to use.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall perform earthwork as necessary to complete the WORK as shown on the Contract Drawings and specified herein. The CONTRACTOR shall take the necessary precautionary measures to prevent dust or other nuisances which might be created by reason of his activities. The necessary precautionary measures shall conform to the requirements of SSPWC, Subsection 3-12. The requirements specified in Subsection 3-12 shall be extended to include paved surfaces.

B. All types of earthwork, including trench, structural and general excavation, fill, backfill and compaction, shall conform to applicable requirements of the SSPWC. Section 300, and to the requirements specified herein.

3.2 SITE PREPARATION

A. Areas to be excavated, filled, graded, and to be occupied by permanent construction or embankments shall be prepared by clearing and grubbing. Clearing and grubbing shall conform to the applicable requirements of SSPWC, Subsection 300-1.

3.3 EXCAVATION

A. **General:** Except when specifically provided to the contrary, 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. Unless otherwise directed, the removal of said materials shall conform to the lines and grades shown. Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The CONTRACTOR shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations, and all pumping, ditching, or other measures for the removal or exclusion of water as required. Excavations shall be sloped or otherwise supported in a safe manner in accordance with the rules, orders, and regulations of the Division of Industrial Safety of the State of California.

B. **Unclassified Excavation:** Unclassified excavation shall consist of all excavation, including roadways, unless separately designated.

1. Unsuitable material shall be excavated and disposed of in accordance with the requirements of SSPWC, Subsection 300-2.2.

2. Wet material, if unsatisfactory for the specified use on the project solely because of high moisture content, may be processed to reduce the moisture content, or may be required to be removed and replaced with suitable material in accordance with the requirements of SSPWC, Subsection 300-2.2.2.

3. The removal and disposal of slide and slipout material shall be in accordance with SSPWC, Subsection 300-2.4.

4. Excavation slopes shall be finished in conformance with the lines and grades shown, and in accordance with SSPWC, Subsection 300-2.5.

5. Surplus material shall be disposed of off-site, and in accordance with SSPWC, Subsection 300-2.6.

C. **Structure Excavation:** Structure excavation shall consist of the removal of material for the construction of foundations for bridges, retaining walls, headwalls, culverts, buildings, or other structures, and shall be in accordance with SSPWC, Subsection 300-3.

1. Cofferdams for foundation construction shall be constructed in accordance with SSPWC, Subsection 300-3.2.

2. The treatment of foundation material shall be in accordance with SSPWC, Subsection 300-3.3**.**

D. **Underground Conduit Excavation:**

1. General: Excavation for underground conduits shall be in accordance with SSPWC, Subsection 306-3 and the requirements contained herein. Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. Trench widths shall be kept as narrow as is practical for the method of pipe zone densification selected by the CONTRACTOR, but shall have a minimum width at the bottom of the trench equal to the outside diameter of the pipe plus 24 inches for mechanical compaction methods and 18 inches for water consolidation methods. The maximum width at the top of the pipe shall be equal to the outside diameter of the pipe plus 36 inches for pipe diameters 18 inches and larger and to the outside diameter of the pipe plus 24 inches for pipe diameters less than 18 inches.

2. Bracing Excavations: The manner of bracing excavations shall be as set forth in the rules, orders and regulations of the Division of Industrial Safety of the State of California, and in accordance with the requirements of SSPWC, Subsection 306-1.1.6.

3. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe. The trench bottom shall be given a final trim, using a string line for establishing grade, such that each pipe

section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Rounding out the trench to form a cradle for the pipe will not be required.

4. Open Trench: The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure. In such cases, however, barricades and warning lights conforming to requirements set forth in the California Department of Transportation Traffic Manual shall be provided and maintained.

5. Trench Over-Excavation: Where the Drawings indicate that trenches shall be over-excavated, they shall be excavated to the depth required, and then backfilled to the grade of the bottom of the pipe.

6. Where pipelines are to be installed in embankment fills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

E. **Over-Excavation Ordered by CONSTRUCTION MANAGER:**

1. Trenches shall be over-excavated beyond the depth shown when required by the CONSTRUCTION MANAGER. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade of the bottom of the pipe. All WORK specified in this Section shall be performed by the CONTRACTOR at no additional cost to the OWNER when the over-excavation ordered by the CONSTRUCTION MANAGER is less than 6 inches below the limits shown. When the over-excavation ordered by the CONSTRUCTION MANAGER is 6 inches or greater below the limits shown, additional payment will be made to the CONTRACTOR for that portion of the WORK which is located below said 6-inch distance.

F. **Over-Excavation not Ordered or Indicated:**

1. Any over-excavation carried below the grade ordered or indicated shall be backfilled to the required grade with the specified material and compacted. Such WORK shall be performed by the CONTRACTOR at no additional cost to OWNER.

G. **Rock Excavation:**

1. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they possess the characteristics of solid rock and which cannot be removed without systematic drilling and blasting.

2. Said rock excavation shall be performed by the CONTRACTOR; provided that should

the quantity of rock excavation be affected by any change in the scope of the WORK, an appropriate adjustment of the contract price will be made.

3.4 FILL AND BACKFILL

A. **General:**

1. Fill and Backfill shall be placed in accordance with the applicable provisions of SSPWC, Section 300, and the requirements stated herein.

2. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has been properly cured in accordance with the requirements of Section 03300 and has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

3. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall not be placed until all water is removed from the excavation.

B. **Placing and Spreading of Materials:**

1. Materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment the layers shall be evenly spread so that when compacted, each layer shall not exceed 8 inches in thickness. When compaction is achieved using flooding and jetting methods, each layer shall not exceed 3 feet in thickness after compaction.

2. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Bedding materials shall be brought up evenly around the pipe so that when compacted, the material will provide uniform bearing and side support.

3. Where the material moisture content is below the optimum moisture content water shall be added before or during spreading until the proper moisture content is achieved.

4. Where the material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

C. **Compaction Requirements**

1. Compaction tests shall be performed in accordance with SSPWC, Subsection 211-1.

2. The relative compaction of fill, backfill, and base material shall be in accordance with SSPWC, Section 300, with the following exceptions:

a.	Subgrade where trench has been overexcavated:	95%
b.	One foot layer of crushed aggregate backfill in overexcavated trench. Where trench is overexcavated more than 2 feet, minimum of 2 layers shall be compacted.	95%
c.	Pipe zone for flexible and rigid pipe :	95%
d.	Fill beneath structures, including water containing structures:	95%
e.	Backfill on underground structure roof:	90%

D. **Unclassified Fill:**

1. All fill shall be of unclassified material unless separately designated. Construction of unclassified fill, including preparing the area on which fill is to be placed, and the depositing, conditioning, and compacting of fill material shall be in accordance with SSPWC, Subsection 300-4.

E. **Structure Backfill:**

1. Backfill at structure shall be placed in accordance with SSPWC, Subsections 300-3.5 and 300-4.5.

F. **Underground Conduit Backfill:**

1. Bedding around pipe shall be bedding material placed in accordance with the requirements of SSPWC, Subsection 306-1.2.

2. Backfill above shall be considered as starting 1 foot above the pipe or conduit, or at the subgrade for cast-in-place structures such as manholes, transition structures, junction structures, vaults, and valve boxes.

3. Backfill at underground conduits shall be placed and densified according to SSPWC, Subsection 306-1.3.

3.5 PREPARATION OF SUBGRADE UNDER IMPROVEMENT

A. The preparation of subgrade for pavement, curbs and gutters, driveways, sidewalks and other roadway structures shall be in accordance with SSPWC, Subsection 301-1.

3.6 UNTREATED BASE

A. **Spreading and Compacting:**

1. Aggregate base material shall be spread and compacted in accordance with SSPWC, Subsection 301-2.

**** END OF SECTION ****

SECTION 03100 - CONCRETE FORMWORK

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing concrete formwork, bracing, shoring, and supports.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of the WORK.

1. Section 03200 Reinforcement Steel
2. Section 03300 Cast-in-Place Structural Concrete
3. Section 03310 Cast-in-Place Sitework Concrete
4. Section 03315 Grout

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

PS 1	U.S. Product Standard for Concrete Forms, Class I.
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 347	Recommended Practice for Concrete Formwork

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

B. **Falsework Calculations and Drawings:** The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, as revised November 1973, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.

C. Detailed plans of the falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions.

D. **Catalog information on:**

1. Form ties and all related accessories, including taper tie plugs, if taper ties are used.
2. Form gaskets.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Materials for concrete forms and falsework shall conform to SSPWC Subsection 303-1.3 and the requirements herein.

B. Except as otherwise expressly accepted, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:

Walls	-	Steel or plywood panel
Columns	-	Steel, plywood, or fiber glass
Roof and floor	-	Plywood
All other WORK	-	Steel panels, plywood or tongue and groove lumber

C. Form materials which may remain or leave residues on or in the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.2 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 30 psf (minimum).

2.3 FORM TIES

A. Form ties with integral waterstops shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when approved. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

2.4 MANUFACTURERS

A. Products of the type indicated shall be manufactured by one of the following (or equal):

1. **Form Ties:**
   Burke Penta - Tie System by the Burke Company
   Snap Ties by Dayton Superior

2. **Form ties with Integral Waterstops:**
   Burke Taper - Tie System by the Burke Company
   Taper Ties by Dayton Superior

PART 3 -- EXECUTION

3.1 GENERAL

A. Forms and falsework shall be designed and constructed in accordance with ACI 347 and SSPWC Subsections 303-1.3, 303-1.6, and 303-5.2, and the requirements herein, except that the submittal of detailed falsework will not be required.

B. **Tolerances:** The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117.

C. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced at the CONTRACTOR's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by

CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

D. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.2 FORM DESIGN

A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the CONSTRUCTION MANAGER. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03300. The size, number, and location of such form windows shall be acceptable to the CONSTRUCTION MANAGER.

3.3 CONSTRUCTION

A. **Vertical Surfaces:** All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the CONSTRUCTION MANAGER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. **Form Ties:**

1. **Embedded Ties:** Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as indicated in Section 03300. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. **Removable Ties:** Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the CONSTRUCTION MANAGER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the CONSTRUCTION MANAGER.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section 03300; provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the CONSTRUCTION MANAGER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 2 days after the concrete has been placed. Forms for all parts of the WORK not specifically mentioned herein shall remain in place for periods of time as determined by the CONSTRUCTION MANAGER.

3.6 MAINTENANCE OF FORMS

A. Forms shall be cleaned, treated with a releasing agent, and maintained in accordance with SSPWC Subsection 303-1.3 and the following. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant compatible with the waterproofing membrane material and acceptable to the CONSTRUCTION MANAGER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. Falsework, including staging, walkways, forms, ladders, and similar appurtenances, shall be designed, engineered, constructed, and maintained according to the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements of the Construction Safety Orders of the California Division of Industrial Safety.

**** END OF SECTION ****

SECTION 03200 - REINFORCEMENT STEEL

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing all concrete reinforcement steel, welded wire fabric, couplers, and concrete inserts for use in reinforced concrete and masonry construction, including all the wires, clips, supports, chairs, spacers, and other accessories.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03300 Cast-in-Place Structural Concrete

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code, the latest edition

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section.

ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318	Building Code Requirements for Structural Concrete.
ACI 350	Code Requirements for Environmental Engineering Concrete Structures.
CRSI MSP-1	Concrete Reinforcing Steel Institute Manual of Standard Practice.
WRI	Manual of Standard Practice for Welded Wire Fabric.
AWS D1.4	Structural Welding Code - Reinforcing Steel.
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement.
ASTM A 185	Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM A 775	Specification for Epoxy-Coated Reinforcing Steel Bars.

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Shop bending diagrams, placing lists, and drawings of all reinforcement steel prior to fabrication.

B. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the CONTRACTOR at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements indicated. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.

C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, manufacturer's literature shall be submitted which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which show the location of each coupler with details of how they are to be installed in the formwork.

D. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

E. Mill certificates shall be delivered with each shipment of reinforcing bars.

1.6 FACTORY TESTING

A. If requested by the CONSTRUCTION MANAGER, the CONTRACTOR shall provide samples from each heat of reinforcement steel delivered in a quantity adequate for testing. Costs of initial tests and sample materials will be paid by the OWNER. Costs of additional tests due to material failing initial tests shall be paid by the CONTRACTOR.

B. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the WORK. Such qualifications shall be as specified in AWS D1.4.

1.7 FIELD TESTING

A. Products shall be field tested for compliance with the indicated requirements. If requested by the CONSTRUCTION MANAGER, the CONTRACTOR shall provide samples of each type of welded splice used in the WORK in a quantity and of dimensions adequate for testing. At the discretion of the CONSTRUCTION MANAGER, radiographic testing of direct butt welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld which fails to meet the

requirements of AWS D1.4. The costs of testing will be paid by the OWNER; except, the costs of all tests which fail to meet specified requirements shall be paid by the CONTRACTOR at no additional cost to the OWNER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Materials specified in this Section which may remain or leave residues on or within the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.2 REINFORCEMENT STEEL

A. Reinforcement Steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, or as otherwise indicated.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and as indicated; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches; and provided further, that welded wire fabric with longitudinal wires larger than W4 size shall be furnished in flat sheets only.

3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

B. Accessories**:**

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. All bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

2. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Wire ties shall be embedded in concrete block bar supports.

3. Tie wire shall be a minimum 14 gauge annealed steel wire.

C. Epoxy coating for reinforcing and accessories, where specified or shown, shall conform to ASTM A 775, but its usage shall be subject to City approval.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where shown and where approved by the CONSTRUCTION MANAGER. The couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.

C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

2.4 WELDED SPLICES

A. Welded splices shall be provided where shown and where approved by the CONSTRUCTION MANAGER. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

B. Welded splices shall conform to the requirements of AWS D1.4.

2.5 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements found in Section 03315.

2.6 MANUFACTURERS

A. Products of the type indicated, shall be manufactured by one of the following (or equal):

1. Couplers:

Lenton Form Saver by Erico Products
Dowel Bar Splicer System by Dayton Superior.

PART 3 -- EXECUTION

3.1 GENERAL

A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

3.2 FABRICATION

A. General:

1. Reinforcement steel shall be accurately formed to the dimensions and shapes shown, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as indicated. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2-inch for No. 3 bars, 2-inch for No. 4 bars, and 2-1/2-inch for No. 5 bars. Bends for other bars shall be made around a pin having a diameter not less than 6 times the bar diameter, except for bars larger than 1 inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.

2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings.

B. **Fabricating Tolerances: Bars** used for concrete reinforcement shall meet the following requirements for fabricating tolerances:

1. Sheared length: $\pm$ 1 inch
2. Depth of truss bars: + 0, - 1/2 inch
3. Stirrups, ties, and spirals: $\pm$ 1/2 inch
4. All other bends: $\pm$ 1 inch

3.3 PLACING

A. Reinforcement steel shall be accurately positioned and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. Limitations on the use of bar support materials shall be as follows.

1. **Concrete Dobies:** Permitted at all locations except where architectural finish is required.

2. **Wire Bar Supports:** Permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. **Plastic Bar Supports:** Permitted at all locations except on grade.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Bars additional to those shown which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at no additional cost to the OWNER.

E. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the CBC.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to the approval of the CONSTRUCTION MANAGER.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

I. Epoxy coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating. Non-abrasive slings made of nylon and similar materials shall be used. Specially coated bar supports shall be used. All chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

J. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.4 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5 SPLICING

A. General:

1. Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the CONSTRUCTION MANAGER.

B. Splices of Reinforcement:

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318.

2. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the CONSTRUCTION MANAGER. No bars partially embedded in concrete shall be field-bent except as shown or specifically permitted by the CONSTRUCTION MANAGER.

D. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged.

E. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing shown for the adjacent section.

F. Tack welding of reinforcing bars is prohibited.

3.6 CLEANING AND PROTECTION

A. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary recleaned.

3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation:

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 0.25 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless noted otherwise.

3. The hole shall be drilled by methods which do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove all dust and loose particles.

6. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that insures that excess material will be expelled from the hole during dowel placement.

7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

**** END OF SECTION ****

SECTION 03280 - JOINTS IN SITEWORK CONCRETE

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing expansion joints, contact joints, and weakened plane joints in concrete pavement, sidewalk, curb and gutter.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03100 Concrete Formwork
2. Section 03310 Cast-in-Place Sitework Concrete

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	ASTM D 1751	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
2.	ASTM D 994	Preformed Expansion Joint Filler for Concrete (Bituminous Type)

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Placement shop drawings showing the location and type of all joints.
2. Catalog cuts and samples of the preformed expansion joint filler material including complete product data.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's certification indicating that the preformed expansion joint material meets or exceeds the requirements of these Specifications.

PART 2 -- PRODUCTS

2.1 PREMOLDED JOINT FILLER

A. Premolded joint filler shall be in conformance with SSPWC subsection 201-3.2 and shall be either Preformed Expansion Joint Filler (ASTM D994) or Nonextruding and Resilient Filler (ASTM D 1751) as indicated.

2.2 STEEL BARS AND DOWELS

A. Steel bars used in construction joints or contact joints shall conform to SSPWC subsection 201-2.2.

2.3 CONCRETE CURING COMPOUND

A. Curing compound shall comply with SSPWC subsection 201-4.

PART 3 -- EXECUTION

3.1 EXPANSION JOINTS

A. Expansion joints in sitework concrete shall be constructed in accordance with SSPWC subsection 302-6.5.3 except that the configuration of the joint shall be as indicated on the drawings.

B. Expansion joints in concrete curbs, sidewalk and gutter shall comply with SSPWC subsection 303-5.4.2 except that the joint configuration shall be as indicated on the drawings.

3.2 CONSTRUCTION JOINTS

A. Construction joints in sitework concrete shall comply with SSPWC subsection 302-6.5.2.

3.3 WEAKENED PLANE JOINTS

A. Weakened plane joints in sitework concrete shall comply with SSPWC subsection 302-6.5.4 except that the configuration of the joint shall be as indicated on the drawings.

B. Weakened plane joints in concrete curbs, sidewalks and gutters shall comply with SSPWC subsection 303-5.4.3 except that the joint configuration shall be as indicated on the drawings.

3.4 CONTACT JOINTS

A. Contact joints in concrete pavement shall be made by placing fresh concrete against hardened concrete. A moisture barrier consisting of curing compound conforming to SSPWC subsection 201-4 shall be applied to the face of any contact joint and allowed to dry prior to placing fresh concrete against that joint face. This provision is also applicable to existing portland cement concrete pavement not constructed as part of the WORK performed under the contract. Application rate shall be as specified in SSPWC subsection 302-6.6 for the compound used.

** END OF SECTION **

SECTION 03290 - JOINTS IN CONCRETE STRUCTURES

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing the construction joints, contraction joints, expansion joints, and control joints in structural concrete, including waterstops, joint fillers, and joint sealants.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03100 Concrete Formwork
2. Section 03200 Reinforcement Steel
3. Section 03300 Cast-in-Place Structural Concrete
4. Section 03310 Cast-in-Place Sitework Concrete
5. Section 07905 Joint Sealers
6. Section 07920 Sealants and Caulking

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section.

ASTM C 920	Specification for Elastomeric Joint Sealants.
ASTM D 412	Test Methods for Rubber Properties in Tension.
ASTM D 624	Test Method for Rubber Property -- Tear Resistance.
ASTM D 638	Test Method for Tensile Properties of Plastics.
ASTM D 746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
ASTM D 747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
ASTM D 1056	Specification for Flexible Cellular Materials -- Sponge or Expanded Rubber.
ASTM D 1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
ASTM D 2240	Test Method for Rubber Property -- Durometer Hardness.
CRD-C572	PVC Waterstop.
TT-S-00227E(3)	Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

1.4 TYPES OF JOINTS

A. **Construction Joints:** When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint. Unless otherwise specified, all joints in water bearing members shall be provided with a waterstop and/or sealant groove of the shape specified and shown. The surface of the first pour may also be required to receive a coating of bond breaker as shown.

B. **Contraction Joints:** Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the first pour, which shall be coated with a bond breaker. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, to allow shrinkage of the concrete of the second pour. Waterstop and/or sealant groove shall also be provided when specified or shown.

C. **Expansion Joints:** To allow the concrete to expand freely, a space is provided between the two pours, the joint shall be formed as shown. This space is obtained by placing a filler joint material against the first pour, which acts as a form for the second pour. Unless otherwise specified, all expansion joints in water bearing members shall be provided with a center-bulb type waterstop as shown.

D. Premolded expansion joint material shall be installed with the edge at the indicated distance below or back from finished concrete surface, and shall have a slightly tapered, dressed, and oiled wood strip secured to or placed at the edge thereof during concrete placement, which shall later be removed to form space for sealing material.

E. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the two walls or slab elements in line the joint shall also be provided with a sleeve-type dowel as shown.

F. **Control Joints:** The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions shown, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material.

1.5 SHOP DRAWINGS AND SAMPLES

The following shall be submitted:

A. **Waterstops:** Prior to production of the material required under this contract, qualification samples shall be submitted. Such samples shall consist of extruded or molded sections of each size or shape to be used, and shall be accomplished so that the material and workmanship represents in all respects the material to be furnished under this contract. The balance of the material to be used under this contract shall not be produced until after the CONSTRUCTION MANAGER has reviewed the qualification samples.

B. **Waterstop Samples:** Prior to use of the waterstop material in the field, a sample of a fabricated mitered cross and a tee constructed of each size or shape of material to be used shall be submitted. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be furnished under this contract.

C. Field samples of fabricated fittings (crosses, tees, etc.) will be selected at random by the CONSTRUCTION MANAGER for testing by a laboratory at the OWNER's expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

D. **Joint Sealant:** Prior to ordering the sealant material, the CONTRACTOR shall submit sufficient data to show general compliance with the requirements of the Contract Documents. Submit sample of colored joint sealant(s) to match approved color of integrally colored cast-in-place architectural concrete.

E. **Joint Location:** The CONTRACTOR shall submit placement shop drawings showing the location and type of all joints for each structure.

F. Certified test reports from the sealant manufacturer on the actual batch of material being supplied indicating compliance with the above requirements shall be furnished before the sealant is used on the job.

1.6 OWNER'S MANUAL

A. **Shipping Certification:** The CONTRACTOR shall provide written certification from the manufacturer as an integral part of the shipping form, to show that all of the material shipped to this project meets or exceeds the physical property requirements of the Contract Documents. Supplier certificates are not acceptable.

1.7 SERVICES OF MANUFACTURER

A. Before WORK is commenced, the CONTRACTOR shall arrange for a representative of the sealant manufacturer to instruct the crew doing the WORK on the proper methods of mixing and applying the sealant.

B. When requested by the CONSTRUCTION MANAGER, the CONTRACTOR shall arrange for field technical assistance from the bentonite manufacturer.

1.8 INSPECTION AND TESTING

A. **Waterstop Inspection:** It is required that all waterstop field joints shall be subject to rigid inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the CONSTRUCTION MANAGER to provide for the required inspections. Not less than 24 hours' notice shall be provided to the CONSTRUCTION MANAGER for scheduling such inspections.

B. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which shall pass said inspection, and all faulty material shall be removed from the site and disposed of by the CONTRACTOR at its own expense.

C. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. Offsets at joints greater than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

2. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

3. Any combination of offset or exterior crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16-inch or 15 percent of material thickness at any point, whichever is less.

4. Misalignment of joint which result in misalignment of the waterstop in excess of 1/2-inch in 10 feet.

5. Porosity in the welded joint as evidenced by visual inspection.

6. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a pen knife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

D. **Construction Joint Sealant:** The CONTRACTOR shall prepare adhesion and cohesion test specimens as specified herein, at intervals of 5 working days while sealants are being installed.

E. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

1. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1-inch. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to insure sealant cross-sections of 1/2-inch by 2 inches with a width of 1-inch.

2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall not exceed 24 hours.

3. Following curing period, the gap between blocks shall be widened to 1-1/2-inch. Spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.9 GUARANTEE

A. The CONTRACTOR shall provide a 5-year written guarantee of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the OWNER, at no additional cost to the OWNER, any such defective areas which become evident within said 5-year guarantee period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All joint materials specified herein shall be classified as acceptable for potable water use, by the Environmental Protection Agency, within 30 days of application.

2.2 PVC WATERSTOPS

A. **General:** Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the

requirements of these Specifications. No reclaimed or scrap material shall be used. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the CONSTRUCTION MANAGER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the job meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572 and those listed herein.

B. **Flatstrip and Center-Bulb Waterstops:** Flatstrip and center-bulb waterstops shall be as indicated; provided, that at no place shall the thickness of flat strip waterstops, including the center bulb type, be less than 3/8-inch.

C. **Multi-Rib Waterstops:** Multi-rib waterstops, where required, shall be as indicated. Prefabricated joint fittings shall be used at all intersections of the ribbed-type waterstops.

D. **Other Types of Waterstops:** When other types of waterstops, not listed above, are required, they shall be subjected to the same requirements as those listed herein.

E. **Waterstop Testing Requirements:** When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std.
Tensile Strength-min (psi)	1750	D 638, Type IV
Ultimate Elongation-min (percent)	350	D 638, Type IV
Low Temp Brittleness-max (degrees F)	-35	D 746
Stiffness in Flexure-min (psi)	400	D 747
Accelerated Extraction (CRD-C572)		
Tensile Strength-min (psi)	1500	D 638, Type IV
Ultimate Elongation-min (percent)	300	D 638, Type IV
Effect of Alkalies (CRD-C572)		
Change in Weight (percent)	+0.25/-0.10	------
Change in Durometer, Shore A	+5	D 2240
Finish Waterstop		
Tensile Strength-min (psi)	1400	D 638, Type IV
Ultimate Elongation-min (percent)	280	D 638, Type IV

2.3 JOINT SEALANT

A. Joint sealant shall be polyurethane polymer designed for bonding to concrete which is continuously submerged in water. No material will be acceptable which has an unsatisfactory history as to bond or durability when used in the joints of water retaining structures.

B. Joint sealant material shall meet the following requirements (73 degrees F and 50 percent R.H.):

Work Life	45 - 180 minutes
Time to Reach 20 Shore "A" Hardness (at 77 degrees F, 200 gr quantity)	24 hours, maximum
Ultimate Hardness (ASTM D 2240)	20 - 45 Shore "A"
Tensile Strength (ASTM D 412)	200 psi, minimum
Ultimate Elongation (ASTM D 412)	400 percent, minimum
Tear Resistance (Die C ASTM D 624)	75 pounds per inch of thickness, minimum
Color	Light Gray except color of sealant to match color of integrally-colored concrete at cast-in-place architectural concrete.

C. All polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ANSI/ASTM C 920 Type M or Federal Specification TT-S-00227E(3) for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 25, Grade NS, or Federal Specification TT-S-00227 E(3), Type II, Class A.

3. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-00227E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 35 to 45, shall be used.

4. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.

D. Sealants for non-waterstop joints in concrete shall conform to the requirements of Section 07920.

2.4 JOINT MATERIALS

A. **Bearing Pad:** Bearing pad to be neoprene conforming to ASTM D 1752 Type I, 40 durometer hardness unless otherwise noted.

B. **Neoprene Sponge:** Sponge to be neoprene, closed-cell, expanded, conforming to ASTM D 1056, type RE-45-E1, with a compression deflection, 25 percent deflection (limits), 119 to 168 kPa (17 to 24 psi) minimum.

C. **Preformed Joint Filler:** Preformed joint filler material for water retaining applications shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

2.5 BACKING ROD

A. Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 BOND BREAKER

A. Bond breaker shall contain a fugitive dye so that areas of application will be readily distinguishable.

2.7 BENTONITE WATERSTOP

A. Where called for, bentonite type waterstop, which shall expand in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast, shall be provided.

B. The bentonite waterstop shall be composed of 75 percent bentonite. The balance of the material shall be butyl rubber-hydrocarbon with less than 1.0 percent volatile matter. The waterstop shall contain no asbestos fibers or asphaltics.

C. The manufacturer's rated application temperature range shall be from 5 to 125 degrees F. The service temperature range shall be from -40 to 212 degrees F.

D. The cross sectional dimensions of the unexpanded waterstop shall be one inch by 3/4-inch.

E. The waterstop shall be provided with an adhesive backing which will provide excellent adhesion to concrete surfaces.

2.8 SLIP DOWELS

A. Slip dowels in joints shall be A36 smooth epoxy-coated bars, conforming to ASTM A 775.

2.9 PVC TUBING

A. PVC tubing in joints shall be Sch. SDR 13.5, conforming to ASTM D 2241.

2.10 MANUFACTURERS

A. Products shall be manufactured by one of the following (or equal):

1. **Flatstrip and Center-Bulb Waterstops:**
   Kirkhill Rubber Company
   Progress Unlimited, Incorporated
   Greenstreak Plastic Products Company

2. **Multi-Rib Waterstops:**
   Progress Unlimited, Incorporated
   Greenstreak Plastic Products Company

3. **Sealants:**
   Permapol RC-270 by Products Research
   Elastothane 227R by Pacific Polymers
   Sikaflex 2C by Sika Corporation

4. **Bond Breaker:**
   Super-Lift J-6 WB by Dayton Superior

PART 3 -- EXECUTION

3.1 WATERSTOPS - GENERAL

A. Waterstops of the type specified herein shall be embedded in the concrete across joints as shown. All waterstops shall be fully continuous for the extent of the joint. Splices necessary to provide such continuity shall be accomplished in conformance to printed instructions of manufacturer of the waterstops. The CONTRACTOR shall take suitable precautions and means to support and protect the waterstops during the progress of the WORK and shall repair or replace at its own expense any waterstops damaged during the progress of the WORK. All waterstops shall be stored so as to permit free circulation of air around the waterstop material.

B. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

3.2 SPLICES IN WATERSTOPS

A. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that:

1. The material not be damaged by heat sealing.
2. The splices have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
3. The continuity of the waterstop ribs and of its tubular center axis be maintained.

B. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

C. All joints with waterstops involving more than 2 ends to be jointed together, and all joints which involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections

shall be prefabricated by the CONTRACTOR prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.

D. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. **Setting Waterstops:** In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken of the correct positioning of the waterstops during installation. Adequate provisions must be made to support and anchor the waterstops during the progress of the WORK and to insure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be insured by thoroughly working it in the vicinity of all joints.

B. In placing flat-strip waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed. Unless otherwise shown, all waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through the edge of the waterstop and tied to the curtain of reinforcing steel. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be worked under the waterstops by hand so as to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material. Waterstop in vertical wall joints shall stop 6 inches from the top of the wall where such waterstop does not connect with any other waterstop and is not to be connected to for a future concrete placement.

D. **Joint Location:** Construction joints, and other types of joints, shall be provided where shown. When not shown, construction joints shall be provided at 25-foot maximum spacing for all concrete construction, unless noted otherwise. The location of all joints, of any type, shall be submitted to the CONSTRUCTION MANAGER for acceptance.

E. **Joint Preparation:** Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required. Unless otherwise shown, such bonding will be required at all horizontal joints in walls. Surfaces shall be prepared in accordance with the requirements of Section 03300. Except on horizontal wall construction joints, wall to slab joints or where otherwise shown or specified, at all joints where waterstops are required, the joint face of the first pour shall be coated with a bond breaker as specified herein.

F. **Construction Joint Sealant:** Construction joints in water-bearing floor slabs, and elsewhere as shown, shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used for forming the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sand-blasted. The

grooves shall be allowed to become thoroughly dry, after which they shall be blown out; immediately thereafter, they shall be primed, bond breaker tape placed in the bottom of the groove, and filled with the construction joint sealant. The primer used shall be supplied by the same manufacturer supplying the sealant. No sealant will be permitted to be used without a primer. Care shall be used to completely fill the sealant grooves. Areas designated to receive a sealant fillet shall be thoroughly cleaned, as outlined for the tapered grooves, prior to application of the sealant.

G. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. All sealant shall achieve final cure at least 7 days before the structure is filled with water.

H. All sealant shall be installed by a competent waterproofing specialty CONTRACTOR who has a successful record of performance in similar installations.

I. Thorough, uniform mixing of 2-part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application.

J. Any joint sealant which, after the manufacturer's recommended curing time for the job conditions of the WORK hereunder, fails to fully and properly cure shall be completely removed; the groove shall be thoroughly sandblasted to remove all traces of the uncured or partially cured sealant and primer, and shall be re-sealed with the specified joint sealant. All costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be at the expense of the CONTRACTOR.

K. **Bentonite Waterstop:**

1. Where a bentonite waterstop is called for, it shall be installed with the manufacturer's instructions and recommendations; except, as modified herein.

2. Bentonite waterstop shall only be used where complete confinement by concrete is provided. Bentonite waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of any intersecting joint.

3. The bentonite waterstop shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

4. Where the thickness of the concrete member to be placed on the bentonite waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2.5 inches.

5. Where a bentonite waterstop is used in combination with PVC waterstop, the bentonite waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be placed in contact with the PVC waterstop.

6. The bentonite waterstop shall not be placed when the temperature of the waterstop material is below 40 degrees F. The waterstop material may be warmed so that it shall remain above 40 degrees F during placement; however, means used to warm the material shall in no way harm the material or its properties. The waterstop shall not be installed where the air temperature falls outside the manufacturer's recommended range.

7. The concrete surface under the bentonite waterstop shall be smooth and uniform. The concrete shall be ground smooth if needed. Alternately, the bentonite waterstop shall be bonded to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

8. The bentonite waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing. This shall be in addition to the adhesive backing provided with the waterstop.

**** END OF SECTION ****

SECTION 03300 - CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing finished cast-in-place structural concrete including forming, mixing, placing, curing, repairing, and finishing.

B. The following types of concrete shall be covered in this Section:

1. **Structural Concrete:** Concrete to be used in all cases except where indicated otherwise.

2. **Lean Concrete:** Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles, where the preceding items are indicated as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connection.

C. The term "hydraulic structure" used in these specifications shall refer to environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, or other fluids.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03200 Reinforcement Steel
2. Section 03315 Grout

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section.

B. **Federal Specifications:**

UU-B-790A (Int.Amd. 1)	Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

C. **Commercial Standards:**

ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 214	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304.2R	Guide to Placing Concrete by Pumping Methods
ACI 309	Consolidation of Concrete

ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ASTM C 31	Practices for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94	Specification for Ready-Mixed Concrete
ASTM C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 156	Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 157	Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C 172	Standard Method of Sampling Freshly Mixed Concrete
ASTM C 192	Method of Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 289	Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C 309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	Specification for Chemical Admixtures for Concrete
ASTM C 535	Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction & Criteria for Laboratory Evaluation
ASTM D 1751	Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E 119	Test Methods for Fire Tests of Building Construction and Materials

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. **Mix Designs:** Prior to beginning the WORK and within 14 days of the notice to proceed, preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete. The mix designs shall be checked by an independent testing laboratory acceptable to the CONSTRUCTION MANAGER. All costs related to such checking shall be borne by the CONTRACTOR.

2. Provide the following submittals in accordance with ACI-301:

   a. Mill tests for cement.
   b. Admixture certification. Chloride ion content must be included.
   c. Aggregate gradation and certification.
   d. Materials and methods for curing.

3. **Certified Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. CONTRACTOR'S certificate with each delivery ticket shall show the public weighmaster's signature, and the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

1.5 TESTING

A. **General**

1. Tests on component materials and for compressive strength and shrinkage of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

2. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the OWNER. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on WORK performed which does not meet the specifications. The laboratory must meet or exceed the requirements of ASTM C 1077.

3. Concrete for testing shall be supplied by the CONTRACTOR at no cost to the OWNER, and the CONTRACTOR shall provide assistance to the CONSTRUCTION MANAGER in obtaining samples, and disposal and cleanup of excess material.

B. **Field Compression Tests:**

1. Compression test specimens will be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the

CONSTRUCTION MANAGER to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 4 cylinders.

2. Compression test specimens for concrete will be made and cured in accordance with ASTM C 31. Specimens will be 6-inch diameter by 12-inch high cylinders.

3. Compression tests will be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 at 28 days. The remaining cylinder will be held to verify test results, if needed.

C. **Evaluation and Acceptance of Concrete:**

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 5 "Concrete Quality," and as specified herein.

2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi.

3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.

5. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at no additional cost to the OWNER.

D. **Shrinkage Tests:**

1. Drying shrinkage tests will be made for the trial batch indicated below, the first placement of each class of concrete, and during construction to insure continued compliance with these Specifications.

2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70 degrees F ±3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F ±3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F ±3 degrees F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of

base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as indicated below.

E. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed WORK is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 117.

1. The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the level or from the grades shown.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the plumb	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. **General:**

1. All materials specified herein shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application.

2. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials furnished for the WORK shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand Portland cement conforming to ASTM C 150 for Type II or Type V, including Table 1A optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be acceptable to the CONSTRUCTION MANAGER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the CONSTRUCTION MANAGER if requested regarding compliance with these Specifications.

2. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

3. Aggregates shall be obtained from pits acceptable to the CONSTRUCTION MANAGER, shall be non-reactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as specified herein. Lightweight sand for fine aggregate will not be permitted.

    a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete the two size groups shall be combined. See the requirements below for the use of the size groups.

    b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 75 percent for an average of three samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33, with 15 to 30 percent passing the number 50 screen and 5 to 10 percent passing the number 100 screen. The fineness modulus of sand used shall not be over 3.00.

    c. Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. When tested in accordance with ASTM C 289, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e. When tested in accordance with ASTM C 40, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 131 or ASTM C 535, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 88, the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94.

5. **Admixtures:** All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

   a. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent received on the job by the CONTRACTOR. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement.

   b. Set controlling and water reducing admixtures: Admixtures may be added at the CONTRACTOR's option to control the set, effect water reduction, and increase workability. The addition of an admixture shall be at the CONTRACTOR's expense. The use of an admixture shall be subject to acceptance by the CONSTRUCTION MANAGER. Concrete containing an admixture shall be first placed at a location determined by the CONSTRUCTION MANAGER. Admixtures specified herein shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

      (1) Concrete shall not contain more than one water reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the CONSTRUCTION MANAGER.

      (2) Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture shall be used.

(3) Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the Manufacturer's instructions and recommendations.

(4) High range water reducer shall conform to ASTM C 494, Type F or G. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating water cement ratio.

(5) If the high range water reducer is added to the concrete at the job site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches ± 1/2-inch prior to adding the high range water reducing admixture at the job site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.

(6) Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

(7) Flyash shall not be used.

2.2 CURING MATERIALS

A. Materials for curing concrete as specified herein shall conform to the following requirements and ASTM C 309:

1. All curing compounds shall be white pigmented, resin based; Sodium silicate compounds shall not be allowed. Only water based resin curing compounds shall be used.

2. Polyethylene sheet for use as concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.

3. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (Int. Amd. 1). The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when

determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

5. Curing mats for use in Curing Method 6 as specified herein, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

2.3 NON-WATERSTOP JOINT MATERIALS (NOT USED)

2.4 MISCELLANEOUS MATERIALS

A. Dampproofing agent shall be an asphalt emulsion.

B. Bonding agents shall be epoxy adhesives.

2.5 CONCRETE DESIGN REQUIREMENTS

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the WORK will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. In mix designs, the percentage of sand of the total weight of fine and coarse aggregate shall not exceed 41 for hydraulic structures or 50 for all other structures, unless noted otherwise. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER. All changes shall be subject to review by the CONSTRUCTION MANAGER.

Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation.

Type of Work	Min 28-Day Compr. Strength (psi)	Max Size Aggregate (in)	Minimum Cement per cu yd (lbs)	Max W/C Ratio (by weight)
Structural Concrete:				
Roof, floor slabs, columns, walls and all other concrete items not specified elsewhere	4,000	1	611	0.45
12" and thicker walls, slabs on grade and footings. (optional)	4,000	1-1/2	611	0.45
Pea Gravel Mix. Thin sections and areas with congested reinforcing, at the CONTRACTOR'S option and with the written approval of the CONSTRUCTION MANAGER for the specific location. Maximum fine	4,000	3/8	752	0.40

Type of Work	Min 28-Day Compr. Strength (psi)	Max Size Aggregate (in)	Minimum Cement per cu yd (lbs)	Max W/C Ratio (by weight)
aggregate 50% by weight of aggregate.				
Lean concrete	2,000	1	376	0.60
Note: The CONTRACTOR is cautioned that the limiting parameters specified above are not a mix design. Additional cement or water reducing agent may be required to achieve workability demanded by the CONTRACTOR'S construction methods and aggregates. The CONTRACTOR is responsible for any costs associated with furnishing concrete with the required workability.				

B. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

C. Quick Set Concrete Mix: Due to the limitation of pumping the ready mix concrete, quick set concrete mix package can be replaced with ready mix concrete. The products shall be the following, or approved equal: Quikrete 5000 Concrete Mix by Quikrete, Rapidset Concrete Mix by RapidSet. The mixing, curing, and finishing shall be in accordance with manufacturer's installation instructions.

2.6 CONSISTENCY

A. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless noted otherwise	3 inches +- 1 inch
With high range water reducer added	7 inches +- 2 inches
Pea gravel mix	7 inches +- 2 inches
Ductbanks	5 inches +- 1 inch

2.7 TRIAL BATCH AND LABORATORY TESTS

A. Before placing any concrete, a testing laboratory designated by the CONSTRUCTION MANAGER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the CONTRACTOR. All concrete shall conform to the requirements of this Section, whether the

aggregate proportions are from the CONTRACTOR's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch. The cost of not more than 3 laboratory trial batch tests for each specified concrete strength will be borne by the OWNER but the CONTRACTOR shall furnish and deliver the materials in steel drums at no cost. Any additional trial batch testing required shall be performed at the expense of the CONTRACTOR at no increase in cost to the OWNER.

B. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7 days and 3 at 28 days. The average compressive strength for the 3 cylinders tested at 28 days for any given trial batch shall not be less than 125 percent of the specified compressive strength.

C. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

2.8 SHRINKAGE LIMITATION

A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the OWNER, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.9 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the CONSTRUCTION MANAGER.

B. **Weighing tolerances:**

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.10 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the CONSTRUCTION MANAGER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

2.11 READY-MIXED CONCRETE

A. At the CONTRACTOR'S option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94, including the following supplementary requirements.

B. Ready-mixed concrete shall be delivered to the site of the work, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.

C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

F. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a delivery ticket furnished to the CONSTRUCTION MANAGER.

G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the CONSTRUCTION MANAGER.

2.12 MANUFACTURERS

A. Products shall be manufactured by one of the following (or equal):

1. **Air Entraining Agent:**
   Micro-Air by Master Builders
   Daravair by W.R. Grace
   Sika AEA-15 by Sika Corporation

2. **Set Retarding Admixture:**
   Plastocrete by Sika Corporation
   Pozzolith 300R by Master Builders
   Daratard by W.R. Grace

3. **Set Accelerating Admixture:**
   Plastocrete 161FL by Sika Corporation
   Pozzutec 20 by Master Builders
   Daraset by W.R. Grace

4. **Normal Range Water Reducer:**
   WRDA 79 by W.R. Grace
   Pozzolith 322-N by Master Builders
   Plastocrete 161 by Sika Corporation

5. **High Range Water Reducer:**
   Daracem 100 or WRDA 19 by W.R. Grace
   Sikament FF or Sikament 86 by Sika Corporation
   Rheobuild 1000 or Rheobuild 716 by Master Builders

6. **Curing Compound:**
   Aqua Resincure by Burke
   Aqua-cure by Euclid Chemical Company
   Masterkure-W by Master Builders

7. **Evaporation Retardant:**
   Confilm by Master Builders
   Eucobar by Euclid Chemical Company

8. **Dampproofing Agent:**
   Hydrocide 600 by Sonneform
   Sealmastic by W.R. Meadows
   Damp proofing Asphalt Coating by Euclid Chemical Company

9. **Agents for Bonding Freshly-Mixed Plastic Concrete to Hardened Concrete:**
   Sikadur 32 Hi-Mod Epoxy Adhesive by Sika Corporation
   Concresive liquid (LPL) by Master Builders
   BurkEpoxy MV by Burke

10. **Agents for Bonding Hardened Concrete to Steel:**
    Sikadur 31 Hi-Mod Gel by Sika Corporation

BurkEpoxy NS by Burke
Concresive Paste (LPL) by Master Builders

11. **White Portland Cement:**
Atlas White

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. **Proportioning:** Proportioning of the concrete mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.

B. **Mixing:** Mixing of concrete shall conform to the requirements of Chapter 7 of ACI 301.

C. **Slump:** Maximum slumps shall be as indicated.

D. **Retempering:** Retempering of concrete or mortar which has partially hardened shall not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. **Joints in Concrete up to 60 Days Old:** Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the CONSTRUCTION MANAGER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. After the surfaces have been prepared all approximately horizontal construction joints shall be covered with a 6-inch lift of the pea gravel mix indicated above. The mix shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

D. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the CONSTRUCTION MANAGER.

E. **Embedded Items:** No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the CONSTRUCTION MANAGER at least 4 hours before

placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

F. All inserts or other embedded items shall conform to the requirements herein.

G. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the CONSTRUCTION MANAGER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

H. **Casting New Concrete Against Concrete over 60 Days Old:** Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydro-blasting or sandblasting (exposing aggregate). The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the CONSTRUCTION MANAGER.

I. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the CONSTRUCTION MANAGER.

J. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

K. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.

L. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.

M. **Cleaning:** The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. **Non-Conforming Work or Materials:** Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these Specifications, or

which is of inferior quality, shall be removed and replaced by the CONTRACTOR at no additional cost to the OWNER.

C. **Unauthorized Placement:** No concrete shall be placed except in the presence of duly authorized representative of the CONSTRUCTION MANAGER. The CONTRACTOR shall notify the CONSTRUCTION MANAGER in writing at least 24 hours in advance of placement of any concrete.

D. **Placement in Wall Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4 feet below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in forms shall not exceed 5 feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.

E. **Conveyor Belts and Chutes:** All ends of chutes, hopper gates, and all other points of concrete discharge throughout the CONTRACTOR'S conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of an acceptable type. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the specified consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered.

F. **Placement in Slabs:** Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

G. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 55 degrees F for sections less than 12 inches thick nor less than 50 degrees for all other Sections. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. When the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.

H. **Cold Weather Placement**: Remove all snow, ice and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches. All reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3.4 PUMPING OF CONCRETE

A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. **Pumping Equipment:** The pumping equipment must have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the site during pumping.

C. The minimum diameter of the hose (conduits) shall be in accordance with ACI 304.2R.

D. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.

E. Aluminum conduits for conveying the concrete shall not be permitted.

F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement (discharge) end of the line.

3.5 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the work shall be acceptable to the CONSTRUCTION MANAGER. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 7 days for hydraulic structures and 3 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 14 days for hydraulic structures and 7 days for all other structures.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be Group 3 (per ACI 309) high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with (at least

one) standby units as required. Group 2 vibrators may be used only at specific locations when accepted by the CONSTRUCTION MANAGER.

B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.

C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and were indicated above. Tolerances are to be distinguished from irregularities in finish as described below. Aluminum finishing tools shall not be used.

B. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects.

1. Surface holes larger than ½ inch in diameter or deeper than ¼ inch are defined as surface defects in basins and exposed walls.

C. **Unformed Surfaces**: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. **Finish U1** - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.

2. **Finish U2** - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints

and edges shall be tooled where shown or as determined by the CONSTRUCTION MANAGER.

3. **Finish U3 -** After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

4. **Finish U4 -** Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

D. **Unformed surfaces shall be finished according to the following schedule:**

UNFORMED SURFACE FINISH SCHEDULE

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs not water bearing	U4

E. **Floor Sealer/Hardener (Surface Applied): (Not Used)**

F. **Sandblasted Concrete Finish (Not Used)**

3.8 ARCHITECTURAL FINISH (NOT USED)

3.9 CURING AND DAMPPROOFING

A. **General:** All concrete shall be cured for not less than 14 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following paragraphs:

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	4 or 6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Floor slabs on grade in hydraulic structures	5
Slabs not on grade	6

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed

within 14 days of placing the concrete, curing shall be continued in accordance with Method 6, herein.

C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. **Method 3**: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. **Method 4:** The surface shall be sprayed with a liquid curing compound.

1. Curing compound shall not be used on concrete surfaces to be coated, waterproofed, moistureproofed, or where any coverings are to be bonded.

2. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.

3. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

4. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

5. Where curing compound is specified, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as specified herein.

6. At all locations where concrete is placed adjacent to a panel which has been coated with curing compound, the previously coated panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

7. Prior to final acceptance of the WORK, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage surface finish.

F. **Method 5:**

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is

not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4, herein. Not less than one hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 14-day curing period and shall not be removed until after concrete for adjacent work has been placed. Should the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

G. **Method 6:**

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 14 consecutive days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes and to be substantially in contact with the concrete surface. All edges shall be continuously held in place.

4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4, herein.

6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the work.

H. **Dampproofing (not used)**

3.10 PROTECTION

A. The CONTRACTOR shall protect all concrete against injury until final acceptance by the OWNER.

B. Fresh concrete shall be protected from damage due to rain. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring.

3.11 CURING AND THERMAL PROTECTION IN COLD WEATHER (NOT USED)

3.12 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the CONSTRUCTION MANAGER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the CONTRACTOR at its own expense.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

3.13 PATCHING HOLES IN CONCRETE

A. **Patching Small Holes:**

1. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.

2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the Paragraph above.

3. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

B. Patching Large Holes:

1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.

2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless indicated otherwise.

3.14 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the OWNER. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the CONTRACTOR'S expense.

**** END OF SECTION ****

SECTION 03310 - CAST-IN-PLACE SITEWORK CONCRETE

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing finished cast-in-place lean concrete, site WORK concrete, minor non-hydraulic concrete structures, air placed concrete, including formwork, steel reinforcement, mixing, placing curing, and repairing, all in conformance with SSPWC.

B. Site WORK concrete includes curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground duct bank encasement, and all concrete WORK indicated to be site work concrete.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03280 Joints in Sitework Concrete

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 SHOP DRAWINGS AND SAMPLES

A. Submittals shall be made in accordance with the requirements of SSPWC, Section 201.

1.5 TESTS

A. Tests on component materials, for the compressive strength of concrete, and for construction tolerances shall be performed in accordance with the requirements of SSPWC, Section 201.

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. Concrete component materials, including curing materials and joint materials shall be in accordance with SSPWC, Subsections 201-1, 201-4, and 201-5.

2.2 FORMWORK

A. Concrete formwork shall comply with SSPWC Subsection 204-1.

2.3 STEEL REINFORCEMENT

A. Reinforcing steel shall conform to SSPWC Subsection 201-2.

PART 3 -- EXECUTION

3.1 GENERAL

A. Proportioning and mixing, preparation of surfaces for concreting, handling, transporting and placing concrete, finishing and curing concrete surfaces and related procedures shall be performed in accordance with SSPWC, Subsections 303-1 and 303-5.

3.2 AIR-PLACED CONCRETE

A. Air-placed concrete construction (Gunite and Shotcrete) shall be in accordance with SSPWC, Subsection 303-2 and the applicable provisions of Subsection 303-1.

****END OF SECTION****

SECTION 03315 – GROUT

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing grout other than that required for masonry WORK, complete.

B. The following types of grout are included in the WORK of this Section:

1. Non-Shrink Grout: This type of grout shall be used wherever grout is required, unless another type is specifically indicated.
2. Cement Grout
3. Epoxy Grout
4. Topping Grout and Concrete Fill

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03300 Cast-in-Place Structural Concrete

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current versions of the following apply to the WORK of this Section:

CRD-C 621	Corps of Engineers Specification for Non-shrink Grout
ASTM C 109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens)
ASTM C 531	Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C 579	Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C 827	Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM D 696	Test Method for Coefficient of Linear Expansion of Plastics Between -30^{o}C and 30^{o}C with a Vitreous Silica Dilatometer

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of non-shrink and epoxy grouts proposed for use in the WORK.

2. Certified test results verifying the compressive strength, shrinkage, and expansion properties for proposed non-shrink and epoxy grouts.

1.5 TESTING DURING CONSTRUCTION

A. **Field Tests:**

1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the CONSTRUCTION MANAGER to insure continued compliance with these specifications. The specimens will be made by the CONSTRUCTION MANAGER or its representative.

2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the CONSTRUCTION MANAGER. A set of three specimens will be made for testing at 7 days, 28 days, and each additional time period as appropriate.

3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the CONSTRUCTION MANAGER. A set of three specimens will be made for testing at 7 days, and each additional time period as appropriate.

4. All grout, already placed, which fails to meet the requirements of these specifications, is subject to removal and replacement at the cost of the CONTRACTOR.

5. The cost of all laboratory tests on grout will be borne by the OWNER, but the CONTRACTOR shall assist the CONSTRUCTION MANAGER in obtaining specimens for testing. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on WORK performed which does not meet the specifications. The CONTRACTOR shall supply all materials necessary for fabricating the test specimens.

PART 2 -- PRODUCTS

2.1 CEMENT GROUT

A. **Cement Grout:** Cement grout shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4000 psi.

B. Cement grout materials shall be as indicated in Section 03300.

2.2 PREPACKAGED GROUTS

A. **Non-Shrink Grout:**

1. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged.

The specific formulation for each class of non-shrink grout indicated herein shall be that recommended by the manufacturer for the particular application.

2. Class A non-shrink grouts shall have a minimum 28 day compressive strength of 5000 psi; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRD-C 621.

3. Class B non-shrink grouts shall have a minimum 28 day compressive strength of 5000 psi and shall meet the requirements of CRD-C 621.

4. **Application:**

   a. Class A non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where grout is specified in the contract documents; except, for those applications for Class B non-shrink grout and epoxy grout indicated herein. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications.

   b. Class B non-shrink grout shall be used for the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

B. **Epoxy Grout:**

1. Epoxy grout shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

2. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

3. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 F.

4. The epoxy grout shall develop a compressive strength of 5000 psi in 24 hours and 14,000 psi in seven days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.

5. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by a test consisting of filling a 2-inch diameter by 4-inch high metal cylinder mold covered with a glass plate coated with a release agent. A weight shall be

placed on the glass plate. At 24 hours after casting, the weight and plate shall be removed and the area in plan of all voids measured. The surface of the grout shall be probed with a sharp instrument to locate all voids.

6. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30 x 10^{-6} inches/inch/degree F when tested according to ASTM C 531 or ASTM D 696.

7. **Application:** Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout, and for all other applications required in the Contract Documents.

2.3 TOPPING GROUT AND CONCRETE FILL

A. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated herein. All materials and procedures specified for concrete in Section 03300 shall apply except as indicated otherwise herein.

B. Topping grout and concrete fill shall contain a minimum of 611 pound of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 3 inches, structural concrete as indicated in Section 03300 may be used when accepted by the CONSTRUCTION MANAGER.

C. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2"	100
3/8"	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

D. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.

E. **Strength:** Minimum compressive strength of topping grout and concrete fill at the end of 28 days shall be 3000 psi.

2.4 CURING MATERIALS

A. Curing materials shall be as indicated in Section 03300 for cement grout and as recommended by the manufacturer of prepackaged grouts.

2.5 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as required for the particular application.

B. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

2.6 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

2.7 MANUFACTURERS

A. Products shall be of the following manufacture (or equal):

1. **Epoxy Grout:** Epoxy Grout J55 by Dayton Superior
Sika Grout 328
Sikadur 42 Grout-Pak by Sika Corporation

PART 3 -- EXECUTION

3.1 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as specified in Section 03300. The finish of the grout surface shall match that of the adjacent concrete.

B. The manufacturer of Class A non-shrink grout and epoxy grout shall provide on-site technical assistance upon request.

C. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the CONSTRUCTION MANAGER.

3.2 GROUTING PROCEDURES

A. **Prepackage Grouts:** All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. **Base Plate Grouting:**

1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for an one-inch thickness of grout or a thickness as indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by the CONSTRUCTION MANAGER, alternate grouting methods shall be submitted for acceptance.

C. **Topping Grout:**

1. All mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.

2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2-inches deep.

3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement grout shall be broomed into the surface of the slab just before topping or fill placement. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.

4 Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

3.3 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

**** END OF SECTION ****

SECTION 03930 – EPOXY-INJECTED CONCRETE CRACK REPAIR

PART 1 – GENERAL

1.1 SUMMARY

A. This specification describes the pressure injection of cracks in concrete with an epoxy resin adhesive.

1.2 QUALITY ASSURANCE

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001/9002 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. CONTRACTOR shall maintain qualified personnel who have received product training by a manufacturer's representative.

C. Install materials in accordance with all safety and weather conditions required by the manufacturer, or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Safety Data Sheets for complete handling recommendations.

1.3 DELIVERY, STORAGE, AND HANDLING

A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing or excessive heat until ready for use.

C. Condition the specified product as recommended by the manufacturer.

1.4 JOB CONDITIONS

A. Environmental Conditions: Do not apply material if it is raining or snowing or if such conditions appear to be imminent. Minimum application temperature 40ºF (5ºC) and rising.

B. Protection: Precautions should be taken to avoid damage to any surface near the WORK zone due to mixing and handling of the specified product.

1.5 SUBMITTALS

A. Submit two copies of manufacturer's literature, to include: Product Data Sheets, and appropriate Safety Data Sheets (SDS).

1.6 WARRANTY

A. Provide a written warranty from the manufacturer against defects of materials for a period of one (1) year, beginning with date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Sikadur 52, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 or approved equal.

B. Sikadur 31 Hi-Mod Gel, as manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302 or approved equal.

2.2 MATERIALS

A. Epoxy resin adhesive for pressure injection of cracks shall be Sikadur 52:

1. Component “A” shall be a modified epoxy resin of the diglycidiether bisphenol A Type containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2. Component “B” shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A Type containing suitable viscosity control agents, pigments, and accelerators.

3. The ratio of component A: component B shall be 2:1 by volume.

4. The material shall not contain asbestos.

B. Epoxy resin adhesive for sealing of cracks & porting devices shall be Sikadur 31 Hi-Mod Gel

1. Component “A” shall be a modified epoxy resin of the diglycidiether bisphenol A Type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2. Component “B” shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidiether bisphenol A Type containing suitable viscosity control agents, pigments, and accelerators.

3. The ratio of component A: component B shall be 1:1 by volume

4. The material shall not contain asbestos.

C. Porting devices as required for either manual or automated application. Porting devices for automated application shall be supplied from manufacturer of the pressure injection equipment.

2.3 PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin adhesive used for the pressure injection grouting:

1. Pot Life: Approx. 30 minutes (60 gram mass) @ 73° F
2. Tack-FreeTime: 90^{O}F (32^{O}C) 1.5 to 2 hours
   75^{O}F (24^{O}C) 3 to 3.5 hours
   40^{O}F (5^{O}C) 14-16 hours
3. Viscosity: Approx. 200 cps. (mixed)
4. Color: Clear, pale yellow

B. Properties of the cured epoxy resin adhesive used for pressure injection of grout:

1. Compressive Strength (ASTM D-695)
   a. 3 day: 10,000 psi (68.9 MPa)
   b. 7 day: 11,300 psi (77.9 MPa)
   c. 28 day: 12,000 psi (82.7 MPa)
2. Compressive Modulus, psi
   a. 7 day: 350,000 psi (2400 MPa)
3. Shear Strength (ASTM D-732)
   a. 14 day: 4,300 psi (29.6 MPa)
4. Flexural Strength (ASTM D-790)
   a. 14 day: 5,400 psi (37.2 MPa)
5. Tangent Modulus of Elasticity in Bending
   a. 14 days: 380,000 psi (2,600 MPa)
6. Bond Strength (ASTM C-882) ,14 days (moist cure)
   a. Hardened Concrete to Hardened Concrete: 2,200 psi (15 MPa)
7. Water Absorption (ASTM D-570), 7 day 1.50% (2-hour boil)
8. Tensile properties (ASTM D-638) min.
   a. 7 day Tensile Strength 7,900 psi (54 MPa)
      Elongation at Break 3.1%
   b. 14 day Modulus of Elasticity 200,000 psi (1,400 MPa)

C. Properties of the mixed epoxy resin adhesive used for sealing of cracks & porting devices:

1. Pot Life: Approx. 60 minutes (500 gram mass) @ 73° F
2. Tack-Free Time: 75^{O}F (24^{O}C) 1.5 – 2.5 hours
   40^{O}F (5^{O}C) 14-16 hours
3. Consistency: Non-Sag paste

4. Color: Concrete Gray

D. Properties of the cured epoxy resin adhesive used for sealing of cracks & porting devices:

1. Compressive Strength (ASTM D-695) @ 73F
   a 1 day: 13,000 psi (89.6 MPa)
   b. 3 day: 14,000 psi (96.5 MPa)
   c. 28 day: 16,000 psi (110.3 MPa)

2. Compressive Modulus, psi: min.
   a. 7 day: 795,000 psi (MPa)

3. Shear Strength (ASTM D-732)
   a. 7 day: 4,600 psi (31.7 MPa)

4. Flexural Strength (ASTM D-790) min.
   a. 7 day: 6.100 psi (42 MPa)

   Tangent Modulus of Elasticity in Bending: min.
   b. 7 day: 167,000 psi (11,520 MPa)

5. Bond Strength (ASTM C-882), 14 day (moist cure) min.
   a. Hardened Concrete to Hardened Concrete: 2,900 psi (20 MPa)

6. Water Absorption (ASTM D-570)
   a. 24 hour: 0.07%

6. Tensile properties (ASTM D-638) min.
   a. 7 day Tensile Strength 3,300 psi (22.7 MPa)
   Elongation at Break 0.9%

PART 3 - EXECUTION

3.1 MIXING AND APPLICATION

A. Mixing the epoxy resin adhesive for sealing the cracks & porting devices: Pre mix each component. Proportion equal (A:B = 1:1) parts by volume of Component "A" and Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (60 minutes,500gram mass@ 73F).

B. Mixing of the epoxy resin adhesive used for the pressure injection grouting:

1. Manual: Proportion two parts by volume of Component "A" to one part Component "B" into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its potlife (20-30 minutes 73F).

C. Placement procedure:

1. The epoxy resin adhesive for sealing the cracks & porting device: Set the porting devices as required by the equipment manufacturer. Spacing of the porting devices shall be accomplished as required to achieve the travel of the epoxy resin for the pressure injection grouting between ports and fill the cracks to the maximum. On structures open on both sides, provide porting devices on opposite sides at staggered elevations. Apply the mixed epoxy resin adhesive for sealing over cracks and around each porting device to provide an adequate seal to prevent the escape of the epoxy resin adhesive for the injection grouting. Where required by the Engineer, apply the epoxy resin adhesive for sealing in such a manner that minimal defacing or discoloration of the substrate shall result.

2. The epoxy resin adhesive for the pressure injection grouting:

   Manual: Load the mixed epoxy resin adhesive for grouting into a disposable caulking cartridge or bulk- loading caulking gun. Inject the prepared cracks with a constant pressure in order to achieve maximum filling & penetration without the inclusion of air pockets or voids in the epoxy resin adhesive. Begin the pressure injection at the widest part of the crack being injected and continue until there is the appearance of epoxy resin adhesive at an adjacent port, thus indicating travel. When travel is indicated, to discontinue or continue the pressure injection from that port should be made by the CONTRACTOR based on his experience, with the approval of the Engineer. Continue procedure until pressure injectable cracks has been filled.

   Automated: Dispense the epoxy resin adhesive for grouting under constant pressure in accordance with procedures recommended by the equipment manufacturer as required to achieve maximum filling and penetration of the prepared cracks without the inclusion of air pockets or voids in the epoxy resin adhesive. The pressure injection of single or multiple ports, by use of a manifold system, is possible. This decision should be made by the CONTRACTOR, with the approval of the Engineer. Continue the approved procedure until all pressure injectable cracks have been filled.

D. If penetration of any cracks is impossible, consult the Engineer before discontinuing the injection procedure. If modification of the proposed procedure is required to fill the cracks, submit said modification in writing to the Engineer for acceptance prior to proceeding.

E. Adhere to all limitations and cautions for the epoxy resin adhesive in the manufacturers current printed literature.

3.2 CLEANING

A. After the epoxy resin adhesive for grouting has cured, the epoxy resin adhesive for sealing cracks and porting devices shall be removed as required by the Engineer. Clean the substrate in a manner to produce a finish appearance acceptable to the Owner.

B. The uncured epoxy resin adhesive can be cleaned from tools with approved solvent. The cured epoxy resin adhesive can only be removed mechanically.

C. Leave finished WORK and WORK area in a neat, clean condition without evidence of spillovers onto adjacent areas.

**** END OF SECTION ****

SECTION 05301 – ALUMINUM EXTRUDED FLAT COVERS

PART 1--GENERAL

1.1 WORK OF THIS SECTION

A. This Section specifies minimum requirements for the aluminum extruded flat covers as described in the contract drawings and documents.

B. The intent of this Section is to provide aluminum flat covers over the entire UV Disinfection Basin as shown in the contract drawings, also referred to as plans. The covers over the UV disinfection equipment will be sized by the CONTRACTOR so that only one section needs to be removed to allow for the one bank to be raised and/or worked on. The size of the cover needs to be less than 50 pounds to allow for removal by a single person. The number of sizes of the covers shall not be more than the number shown on the plans to avoid issues during removal and reinstallation by the City's O&M personnel.

1.2 SPECIFICATIONS AND STANDARDS

A. This Section contains references to the following documents. It is a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

B. The following codes and standards form a part of this Section to the extent specified herein:

1. ASTM C-864-90 Standard Specifications for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

2. Aluminum Association Specifications for Aluminum Structures

3. Aluminum Association Aluminum Design Manual; Specifications and Guidelines for Aluminum Structures

4. ASCE 8-02 Specification for the Design of Cold-Formed Stainless Steel Structural Members

5. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

6. Federal Specification TT - S - 00230C

1.3 SHOP DRAWINGS AND SAMPLES

A. Before executing any of the WORK in this Section, prints or drawings shall be submitted to the engineer showing dimensions, sizes, thickness, gauges, materials, finishes, joint attachment and erection procedure. The size of each section of cover shall be determined by the CONTRACTOR to ensure that the cover meets the project intents.

B. A complete set of design calculations for the cover(s) shall also be submitted. These calculations shall be prepared, sealed and signed by a California registered professional engineer. All WORK shall be fabricated and erected in accordance with the approved drawings.

C. Certification that the specified material alloys, sizes and quantities have been furnished shall be submitted upon completion of the project.

PART 2--PRODUCTS

2.1 GENERAL

A. The extruded flat covers shall be clear-span and self-supporting from the peripheral structure. The cover system shall consist of removable panels each weighing no more than 50 pounds. The required lifting force per panel shall not exceed the dead weight of the panel. The extruded panels utilize specially extruded panel structural members, slip- resistant top planks with stiffeners, and integral perimeter flashing/endcaps. Both male and female panels must independently be designed to meet both the design loading and the deflection limits specified herein. Elastomeric weatherseal gasket shall form a continuous substantially watertight seal along all panel edges. The gaskets shall be fully enclosed to prevent ultraviolet exposure.

B. Each panel must be able to be removed without needing to remove more than the two adjacent panels. The need for removing separate flashing or "hold-down" extrusions longer than the width of the panel is prohibited. Primary panel support members shall be integral to the panels. Upon removal of the panels, the entire area beneath the panels shall be exposed and no substructure in the form of beams or box-beams shall remain in the basin(s) to be covered. To facilitate removal, panels shall incorporate integral lifting handles. Handles shall be located at both ends of the cover panels and shall not penetrate the cover panels or pond water.

C. The extruded flat cover shall have an integral bi-directional slip resistant surface which extends a minimum of 0.1-inch above the panel surface. Raised surfaces without the use of texturing to achieve slip resistance are not acceptable. The use of checkered plate, paint, tape, sandblasting, or other applied systems to achieve the slip resistant surface is expressly prohibited.

D. The extruded flat cover system shall be Flush or Top Mount depending on what is called out in the plans. For Top Mounts, the covers slip resistant walking surface will be 6-8 inches above the top of the basin or tank wall. Lifting handles shall be integral with the panel endcaps.

E. All metal components of the flat cover structure shall be aluminum or Grade 316 stainless steel. No galvanized, painted, or plated steel shall be used. The use of structural plastic is expressly prohibited. Dissimilar materials in the supporting structure shall be isolated from the aluminum flat cover by means of a compatible elastomeric gaskets and sleeves.

F. The use of structural members in contact with the contents of the tank is expressly prohibited.

G. The design shall prevent water pooling which may result in over-stressing the flat cover.

H. The extruded flat cover will have a mill finish surface.

I. Fasteners shall be designed with a factor of safety of 2.34 on ultimate strength and 1.65 on yield strength.

J. The removable extruded flat cover system shall be designed to be substantially air and water tight under the specified design loading conditions.

2.2 EXPERIENCE AND QUALIFICATIONS

A. No equipment shall be supplied by any manufacturer not regularly engaged in the manufacturing and production of extruded flat cover(s) in the size and character herein specified.

B. The cover manufacturer must be ISO 9001 certified.

2.3 MATERIALS

A. The following is a summary of approved materials and/or material specifications. All aluminum alloys shall be as defined by the Aluminum Association and published in the ALUMINUM STANDARDS AND DATA.

1. **Bolts and Fasteners** - Bolts shall be Grade 316 stainless steel per ASTM F593, Alloy Group 1. Lockbolts shall be 7075-T73 aluminum or 316 stainless steel. Screws shall be aluminum or 316 series stainless steel.

2. **Structural Shapes** - Aluminum structural shapes shall be alloy 6061-T6 or 6063-T6. Load supporting surfaces shall be 0.1-inch minimum thickness.

3. **Miscellaneous Shapes** - Miscellaneous aluminum shapes shall be alloy 6061-T6 or 6063-T6.

4. **Gaskets** - All gaskets shall be Neoprene conforming to ASTM C-864-90, resistant to ozone and shielded from exposure to ultraviolet light. The gaskets must have a ¼" minimum thickness.

5. **Sealant** - All sealants shall be silicone, GE Silpruf SCS 9000.09 and resistant to ozone and ultraviolet light and conform to Federal Specification TT-S-00230C.

6. **Miscellaneous Penetration Seals**- All other penetration seals shall be weatherproof rubber seals.

7. **Support Bearings** – Bearings at the supports (if required) shall conform to AASHTO Division 2 Section 25. Acceptable bearing surfaces for sliding bearings are Teflon to stainless steel only. In order to avoid damage to the Teflon and to reduce the coefficient of bearing friction, Teflon shall not bear on aluminum surfaces.

2.4 DESIGN LOADS

A. The entire extruded flat cover structure shall be designed to sustain the loads specified herein, within the stress limitations of the Aluminum Association Aluminum Design Manual. In no case shall the formed panel flat cover be designed for any loads less than those specified by the local building code and/or local amendments.

B. As a minimum, the load cases to be considered shall be those described below.

1. **Dead Load** – The dead load shall be defined as the weight of the structure and all permanently attached to and supported by the structure.

2. **Live Load** – As required per ASCE 7 Section 4.9.1.

3. **Snow Load** – As required per ASCE 7-05 but not less than required by local building codes and/or local amendments.

4. **Wind Load** – As required per ASCE 7-05 but not less than required by local building codes and/or local amendments. Importance Factor (I) = 1.0 or greater per ASCE 7-05 Table 6-1. Exposure Factor = C minimum or D where required.

5. **Load Combinations** – As required per ASCE 7-05 Section 2.4.1.

6. **Temperature** - The load combinations listed above shall be considered for a temperature change of 100 degrees F below the installation temperature and 100 degrees F above the installation temperature and for a material temperature range of 40 degrees F below 0 to 160 degrees F above zero.

7. **Panel Design Load** - In addition to the above mentioned loads and load combinations, the aluminum panels shall be designed for a 400 pound load distributed over one square foot at any location. This load is to be taken as acting separately and not simultaneously with other design loads.

8. **Deflection** - For the above loads and load combinations, the deflection of all components (structural and cladding) shall not exceed L/240 with L equal to the span of the component. This deflection limit applies not only to the flat cover as a whole, but also to the decking of the cover spanning between the supporting edges of each panel or module. Calculations stamped by a California registered Professional Engineer shall be provided at the time of submittal to ensure that this requirement has been met.

2.5 MANUFACTURERS

A. The aluminum extruded flat cover shall be as manufactured by CST Covers - Gardena, California (310) 353-5100 or approved equal.

PART 3--EXECUTION

3.1 INSTALLATION

A. All WORK shall be executed by skilled mechanics with a supervisor experienced in the erection of extruded flat covers. The flat cover shall be erected plumb and level and in proper alignment. The installation shall be in strict accordance with the manufacturer's recommendations.

3.2 WARRANTY

A. The extruded flat cover manufacturer shall warrant that the WORK described herein shall be free from defects, workmanship and material. The flat cover manufacturer shall replace or repair only

faulty workmanship or defective material furnished by it that is reported to it within one (1) year from the date of completion of the project.

****END OF SECTION****

SECTION 05500 - MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing miscellaneous metalwork and appurtenances not covered elsewhere in the contract documents.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03300 Cast-in-Place Structural Concrete
2. Section 03315 Grout
3. Section 09800 Protective Coating.

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code

1.4 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.5 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. **Federal Specifications:**

QQ-F-461 C (1)	Floor Plate, Steel, Rolled
MIL-6-18015	(Ships) Aluminum Planks, (6063-T6)

2. **Commercial Standards:**

AISC MO11	Manual of Steel Constructions
AASHTO HS-20	Truck Loading
ASTM A36 / A992	Specification for Structural Steel
ASTM A 48	Specification for Gray Iron Castings
ASTM A 53	Specification for Pipe, Steel, Black and Hot- Dipped, Zinc-Coated Welded and Seamless

ASTM A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 125	Specification for Steel Springs, Helical, Heat Treated
ASTM A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 240	Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A 276	Specification for Stainless Steel Bars and Shapes
ASTM A 283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
ASTM A 320	Specification for Alloy-Steel Bolting Materials for Low-Temperature Service
ASTM A 325	Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength
ASTM A 489	Carbon Steel Eyebolts
ASTM A 569	Specification for Steel, Carbon, (0.15 Maximum Percent) Hot Rolled, Sheet and Strip, Commercial Quality
ASTM A 575	Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 666	Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar
ASTM B 98	Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
ASTM B 210	Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B 221	Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes
ASTM B 438	Specification for Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	Standard Specification for Iron-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)
ASTM B 695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM F436	Standard Specification for Hardened Steel Washers.
ASTM F594	Standard Specification for Stainless Steel Nuts.
ASTM F1267	Standard Specification for Metal, Expanded, Steel
ANSI/AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum.
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D10.18	Guide for Welding Ferritic/Austenitic Duplex Stainless Steel Piping and Tubing
AWS A2.4	Standard Symbols for Welding, Brazing, and Nondestructive Examination
NFPA 101	Life Safety Code
NAAMM AMP 510	Metal Stairs Manual

1.6 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in addition to General Requirements:

1. Shop drawings showing connection details and locations proposed for power driven pins.

2. Shop drawings of miscellaneous metalwork including seat angles, supports and guides.

3. Shop drawings showing proposed use of adhesive anchors.

4. Data indicating load capacities, chemical resistance and temperature limitations of power driven pins.

5. Manufacturer's catalog data for manhole frame, covers, and each type of anchor.

6. Welding procedures and welder qualifications.

7. Submit samples of material or fabricated items if requested by the Engineer.

1.7 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's installation instructions.

PART 2 -- PRODUCTS

2.1 MISCELLANEOUS METALWORK

A. **Materials:** Except as otherwise indicated, products fabricated of structural steel shapes, plates and bars shall comply with the requirements of ASTM A 36 Grade 36 & A992 Grade 50.

B. **Corrosion Protection:** Miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment or will be submerged shall be stainless steel. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication and coated per Specification Section 09800 except as otherwise indicated.

C. **Stainless Steel:** Stainless steel metalwork shall be of Type 316 L stainless steel. Stainless steel shall not be torch heated for welding. The CONTRACTOR shall submit welding methods and procedures. All welded stainless steel shall be passivated after welding by immersing in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid. Temperature and detention time for passivation shall be sufficient for removal of oxidation and ferrous contamination without etching of surface. The passivated steel shall undergo a complete neutralization by immersion in a detergent rinse followed by clean water wash, or shall be buffed with Scotch Brite EXL (or equal) for removal of weld discoloration and heat tint.

D. **Welding:** Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" and supplemented by other standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall comply with the

AWS Code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. **Galvanizing:** Where galvanizing is indicated, structural steel plates shapes, bars and fabricated assemblies shall be thoroughly cleaned of rust and scale and shall be galvanized in accordance with the requirements of ASTM A 123. Any galvanized part that becomes warped during the galvanizing operation shall be straightened. Bolts (except ASTM A325), anchor bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

2.2 ANCHOR BOLTS

A **General:** Anchor bolts shall comply with the following:

1. Anchor bolts shall be fabricated of materials complying with SSPWC Subsections 206-1.4.1 and 209-3.2 and as follows:

Steel bolts	ASTM A325
Fabricated steel bolts	ASTM A36
Stainless steel bolts, nuts, washers	ASTM A320, Type 316

2. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a maximum oversizing of 1/4 inch. Unless otherwise indicated, minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment shall be 316 stainless steel and shall be provided with leveling nuts which shall be tightened against flat surfaces to not less than 10 percent of the bolt's safe tensile stress.

3. Tapered washers shall be provided where mating surface is not square with the nut.

4. Expansion, wedge, or adhesive anchors set in holes drilled in the concrete after the concrete is placed is not permitted as substitution for anchor bolts except where otherwise indicated. Upset threads shall not be acceptable.

5. ASTM A307 anchor bolts are prohibited.

B. **Adhesive Anchors:** Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors. Substitutions will not be considered unless accompanied with ICC report verifying strength and material equivalency and approved by the Engineer. Except as otherwise indicated, adhesive anchors shall comply with the following:

1. Epoxy adhesive anchors may be provided for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars. Threaded rod shall be stainless steel Type 316.

2. Glass capsule, polyester resin adhesive anchors may be permitted in other locations.

C. **Expanding-Type Anchors:** Expanding-type anchors, where indicated, shall be Type 316 stainless steel. Size shall be as shown. Expanding-type anchors are prohibited from use in corrosive areas and in deteriorating concrete.

2.3 POWER DRIVEN PINS

A. **Materials:** Power-driven pins for installation in concrete or steel in interior locations of nonprocess areas shall be heat-treated steel alloy complying with AISI 1062 or 4063 and shall be zinc-plated. Pins shall have capped or threaded heads capable of transmitting the shank loads. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.4 BOLTS

A. **Bolt Requirements:** Bolts shall comply with the following:

1. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

2. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

B. **Standard Service Bolts (Not Buried or Inside Tanks or Channels)**: Except where otherwise indicated, bolts and nuts shall be steel and shall be galvanized after fabrication. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated herein, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A 325, or threaded parts of ASTM A 36. ASTM A 325 bolts and nuts shall not be galvanized.

C. **Bolts Buried or Inside Tanks or Channels:** Unless otherwise indicated, bolts, anchor bolts, nuts and washers which are buried, submerged, or below the top of the wall inside any hydraulic structure shall be of Type 316 stainless steel.

D. Unless otherwise indicated, eyebolts shall conform to ASTM A 489.

2.5 SEAT ANGLES, SUPPORTS AND BRACKETS

A. Seat angles and brackets shall be Type 316 L stainless steel.

B. Seat angles for grating shall be aluminum or steel as indicated, except that Type 316 L stainless steel shall be used over tanks and channels. Seat angles and supports for grating shall be Type 316L stainless steel unless otherwise indicated. Guides for slide gates shall be Type 316 L stainless steel.

2.6 IRON CASTINGS

A. Castings shall conform to the requirements of ASTM A 48 unless otherwise indicated. Castings weighing less than 100 pounds shall be hot-dip galvanized after machining. Castings weighing greater than 100 pounds shall be galvanized where indicated.

2.7 GRATINGS

A. **General:** Both bearing bars and cross bars shall be continuous. Openings shall be banded with bars having the same dimensions as the bearing bars. Perimeter edges shall be banded with bars flush at the top surface of the grating and 1/4 inch clear of the bottom surface. Bars terminating against edge bars shall be welded to the edge bars when welded construction is used. When crimped or swaged construction is used, bars at edges shall protrude a maximum of 1/16 inch and shall be peened or ground to a smooth surface. No single piece of grating shall weigh more than 80 pounds unless otherwise indicated.

Rough weld beads and sharp metal edges on gratings and plates shall be ground smooth. Welds exposed to view shall be uniform and neat. Welds to be galvanized shall be sandblasted prior to galvanizing.

Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise indicated. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled. Cutting, drilling, punching, threading and tapping shall be performed prior to hot-dip galvanizing.

1. **Aluminum:** Aluminum grating bearing bars and aluminum floor plates and cover plates shall be of alloy 6061-T6 conforming to ASTM B221. Aluminum grating cross bars shall be of an alloy conforming to either ASTM B221 (extrusions) or B210 (drawn). Unless otherwise indicated, grating shall be fabricated of aluminum. Bearing bars shall be punched to receive the cross bars. After insertion in the bearing bars, cross bars shall be deformed by a hydraulic press or similar means to permanently lock the bars into the bearing bar openings. Fabrication methods employing bending or notching of bearing or cross bars will not be permitted.

2. **Steel:** Steel grating bearing bars and cross bars shall be of welding quality mild carbon steel conforming to ASTM A569. Steel floor plates and cover plates shall be of structural quality steel conforming to ASTM A36. Steel grating shall be used only where indicated. Steel grating shall be hot-dip galvanized. Notching, slotting, or cutting the top or bottom edges of bearing bars to receive cross bars will not be permitted unless each intersection of bars is fully welded to restore each bearing bar to its full cross-sectional strength.

2.8 FALL PREVENTION SYSTEM

A. The fall prevention system shall include safety belt and other components for a complete and fully operational fall prevention system.

2.9 MANHOLE FRAMES AND COVERS

A. Except as otherwise indicated, manhole frames and covers shall comply with SSPWC Subsection 206-3.3 and shall be fabricated of cast iron complying with ASTM A48, Class 30 and shall be the heavy-duty type designed for H-20 highway loading, shall have a minimum 24-inch clear frame opening or as indicated and a minimum frame height of 4 ½ inches and shall be equipped with a continuous-ring type gasket designed to minimize surface water inflow. Cover pattern shall be checkered pattern design and shall have concealed or closed pick holes with sufficient dimensions to allow for removal without special equipment. Bearing and wedging surfaces shall be machined to ensure a tight fit and to prevent rocking. Frames shall be provided with four 1-inch diameter holes for anchor bolts. The use of salvaged or scrap materials will not be permitted.

B. Covers shall be provided with a continuous, machined groove on either the underside bearing lip or the outer wedging edge of the cover. A groove on the bearing lip shall be fitted with a glued, continuous, low compression, set gasket; a groove on the outside edge shall be fitted with a neoprene O-ring seal.

C. Locking type, nongasketed frames and covers shall be provided where indicated. Locking covers shall have two locking wedges in the frame. Covers shall have two fingers which engage the locking wedges when the cover is positioned in the frame and turned.

2.10 MANUFACTURERS

A. Products of the type or model (if any) indicated shall be manufactured by one of the following (or equal):

1. **Epoxy Adhesive Anchors:**

   Hilti HIT-RE 500 or Hilti HIT-HY 200 Epoxy Anchor System
   Red Head Epcon G5 Epoxy Adhesive

2. **Glass Capsule Polyester Resin Adhesive Anchors:**

   Hilti HIT-HY 150 Or Hilti HFX Injection Adhesive
   Red Head Epcon A7 Acrylic Adhesive

3. **Expanding-Type Anchors:**

   Red Head Trubolt
   Hilti Kwik-Bolt 3

4. **Steel Gratings:**

   Grating Pacific Type 19-4
   McNichols Type GW

5. **Field Repairs to Galvanizing:**

   "Galvinox"
   "Galvo-Weld"

PART 3 -- EXECUTION

3.1 GENERAL

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. **General:** Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Grouting of anchor bolts with nonshrink or epoxy grouts, where indicated, shall be in accordance with Section 03315.

1. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

2. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if indicated, recesses or blockouts shall be formed in the concrete. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned. Recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place. Embedments shall comply with Section 03300.

3. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise indicated. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.

4. Fabrication including cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent WORK shall be performed prior to hot-dip galvanizing.

3.2 INSTALLATION OF ANCHOR BOLTS

A. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

B. Installation of adhesive, capsule and expansion anchors shall comply with the following:

1. All installation recommendations by the anchor system manufacturer shall be followed carefully, including maximum hole diameter.

2. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is not indicated. Overhead applications (such as pipe supports) shall not be allowed.

3. Use shall be limited to locations where exposure to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is not indicated.

4. Concrete temperature (not air temperature) shall be compatible with curing requirements recommended by adhesive manufacturer. Anchors shall not be placed in concrete below 25 degrees F.

5. Anchor diameter and grade of steel shall comply with equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.

6. Adhesive capsules of different diameters may be used to obtain proper volume for the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. Any extension or protrusion of the capsule from the hole is prohibited.

7. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.

8. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.

9. Anchor shall be left undisturbed and unloaded for full adhesive curing period.

3.3 INSTALLATION OF SEAT ANGLES, SUPPORTS AND GUIDES

A. Seat angles shall be set flush with the floor.

3.4 INSTALLATION OF POWER DRIVEN PINS:

A. Power-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space From Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D minimum	14D	20D
Steel	1/4-inch	Steel thickness	4D	7D

3.5 INSTALLATION OF DRILLED ANCHORS

A. Drilled anchors shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dry. Drilled anchors shall not be installed until the concrete has reached the indicated 28-day compressive strength. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.6 INSTALLATION OF MANHOLE FRAMES AND COVERS

A. The installation of manhole frames and covers shall comply with SSPWC Subsection 301-1.6.

**** END OF SECTION ****

SECTION 05515 – ALUMINUM LADDER AND STAIRS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing aluminum ladders with or without cages and stairs.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 05500 Miscellaneous Metalwork

2. Section 16170 Grounding System

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Code of Regulations, Title 24, Part 2, also known as the California Building Code (CBC).

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK

of this Section:

1. Aluminum Association (AA).

2. Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (ASTM B 209).

3. Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (ASTM B 221).

4. Fixed Ladders (OSHA 1910.27).

5. ASCE 7 (Latest Edition) Minimum Design Loads for Buildings and Other Structures.

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's specifications, literature, and published installation instructions for each roof accessory, product, or system.

2. Detail fabrication and erection of each ladder or stair indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.

3. Provide templates for anchors and bolts specified for installation under other Sections.

4. Provide reaction loads for each hanger and bracket.

5. Design calculations and drawings prepared, sealed and signed by a California Registered Civil Engineer.

B. Qualification Data:

1. Refer to Quality Assurance provisions for submittal requirements evidencing knowledge, certifications and resources.

C. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors.

D. Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, represent actual product color.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm knowledgeable in producing aluminum metal ladders and stairs similar to those indicated for this Project.

1. Record of successful in-service performance.

2. Sufficient production capacity to produce required units.

3. Professional engineer competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.

B. Installer Qualifications: Competent and knowledgeable firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.

C. Product Qualification: Product design shall comply with CALOSHA standards.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Manufactured materials shall be delivered in original, unbroken, packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored on wood blocking in an area that is protected from all deleterious elements. Storage shall be in a manner that will prevent damage or marring of the products and their finishes.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before fabrication.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, indicate established dimensions on shop drawing submittal and proceed with fabrication.

1.9 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for WORK of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from OWNER, manufacturer shall promptly and without inconvenience and cost to OWNER correct said deficiencies.

1. Defects in materials and workmanship.

2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.

3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective ladder.

B. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

1.10 EXTRA MATERIALS

A. Furnish touchup kit for each type and color of paint finish provided.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Roof Ladders and their installation shall be in accordance with the manufacturer's literature and published specifications for the products indicated.

2.2 MANUFACTURERS

A. Acceptable Manufacturer for Ladder: O'Keeffe's, Inc. or Approved Equal.

B. Acceptable Manufacturer for Stairs: Miro Industries, Inc. or Approved Equal.

2.3 APPLICATION AND SCOPE

A. Fixed and Cage Ladder Design:

1. Safety cages are required on ladders over 20 feet (6096 mm)

2. Safety cages are required on all ladders in high or hazardous areas.

3. Landing platforms are required at 30 feet (9144 mm) above the bottom of the ladder.

4. Rail and harness fall arrest system as alternate to safety cage and landing platforms shall be a permissible manufacturer's option.

a. Fixed Ladder Bottom Bracket.

b. Bottom floor supported bracket.

c. Bottom wall supported bracket.

d. Bracket as drawn.

B. Ladder with Platform:

1. Model 503 as manufactured by O'Keeffe's Inc or Approved Equal.

C. Stair with Platform:

1. Bridge Crossover manufactured by Miro Industries, Inc. or Approved Equal.

2.4 FINISHES

A. Clear Anodic Finish: AA-M10C22A41 Mechanical finish as fabricated. Architectural Class I, clear coating 0.7 mil.

2.5 MATERIALS

A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.

B. Aluminum Extrusions: Alloy 6063-T1 and 6063-T6 to comply with ASTM B221.

C. Brackets and Hardware including threaded rods, bolts, nuts, washers, anchor bolts etc. shall be Grade 316 Stainless Steel.

D. Bases for Staircase shall be polycarbonate with UV inhibitors. Supports for stairs shall be provided with anti-slip pads.

E. Grade 316 Stainless Steel posts and bases will be used where required.

F. All metal struts, pipe supports, hanger etc. shall be Grade 316 Stainless Steel.

2.6 FABRICATION

A. Rungs: Not less than 1-1/4 inches (32 mm) in section and 18–3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.

1. Rungs shall withstand a 1,500 pound (454 kg) load without deformation or failure.

B. Channel Side Rails: Not less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide.

C. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr-free surfaces.

D. Ship Ladders: Not less than 1-1/4 inches (32mm) high, 4-1/8 inch (105 mm) deep and 2 feet (610 mm) wide; tread spacing shall be 1 foot (305 mm) on center. Handrails shall be aluminum pipe, not less than 1-1/2 inches (38 mm) in diameter with hemispheric end caps.

E. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.

F. Landing Platform: 1-1/2 inches (38 mm) or greater diameter, tubular aluminum guardrails and decks of serrated aluminum treads.

G. Stanchion Bases for stairs: Provide Stanchion Bases for stairs to allow for anchorage to concrete and/or metal supports. The maximum working load of each support shall not induce more than 2 psi to any part of the cover material.

H. Security Doors: Formed 1/8 inch (3 mm) thick aluminum sheet. Security panels shall extend on both sides, perpendicular to the door face, to within 2 inches (51 mm) of the wall. Security door shall be furnished with continuous aluminum piano hinge and heavy duty forged steel locking hasps.

I. Ship Ladder Seismic Bottom Support: Manufacturer’s standard; two isolation bearings per stringer.

J. Ladder Safety Post: Retractable hand hold and tie off.

K. Rail and Harness Fall Arrest System: Supplied where specified as alternate to safety cage and landing platforms, in accordance with OSHA regulation 1910.27; permanently mounted to ladder rungs and complete with necessary components.

L. Safety Cages:

1. Fabricate ladder safety cages to comply with authority having jurisdiction. Assemble by welding. Spacing of primary hoops, secondary hoops and vertical bars shall not exceed that required by code.

2. Safety cage hoops and vertical bars: 3/16 inch (5 mm) by 2 inches (51 mm) aluminum bar.

PART 3 -- EXECUTION

3.1 GENERAL

A. The installation shall conform to applicable codes and the manufacturer's published or written recommendations, specifications, and installation instructions for the type of WORK being performed.

B. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.

C. Do not begin installation until supporting structure is complete and ladder or stair installation will not interfere with supporting structure WORK.

If supporting structure is the responsibility of another installer, notify Engineer/Architect of unsatisfactory supporting WORK before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

**** END OF SECTION ****

SECTION 05520 – HANDRAILS AND RAILINGS

PART 1--GENERAL

1.1 WORK OF THIS SECTION

A. This Section specifies minimum requirements for the handrails, guardrails and railings as described in the contract drawings and documents.

1.2 SPECIFICATIONS AND STANDARDS

A. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the specifications, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

1.3 SHOP DRAWINGS AND SAMPLES

A. Before executing any of the WORK in this Section, prints or drawings shall be submitted to the engineer showing dimensions, sizes, thickness, gauges, materials, finishes, joint attachment and erection procedure. Design and calculations for guard rails and related anchorage shall be prepared, signed and sealed by a California registered Civil/Structural Engineer and submitted to the City.

PART 2--PRODUCTS

2.1 GENERAL

A. Guardrails and Handrails shall be the product of a company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 16 feet for field erection and not to exceed 6 feet for removable sections to allow it to be removed easily when maintenance staff needs unimpeded access to remove equipment.

B. The handrail shall be made of pipes joined together with component fittings. Samples of all components, bases, toeboard and pipe must be submitted for approval at the request of the engineer. Components that are pop-riveted or glued at the joints will not be acceptable. All components must be mechanically fastened with Grade 316 stainless steel hardware.

2.2 MATERIALS AND SIZES

A. Guardrails and Handrails shall be 1 1/2" Schedule 40 aluminum pipe alloy 6105-T5, ASTM-B-429 or ASTM-B-221. Post shall be 1 1/2" Schedule 40 aluminum pipe of the same alloy. Post spacing shall be a maximum of 6'-0” unless noted otherwise on the contract drawings.

B. Finish shall be Aluminum Association M10-C22-A41 (215-R1). The pipe shall be plastic-wrapped. The plastic wrap is to be removed after erection.

C. Guardrails and Handrails shall be designed to withstand a 200lb concentrated load applied in any direction and at any point on the top rail.

D. Intermediate railings shall be provided such that a 21-inch diameter sphere cannot pass through any opening.

E. The guardrails shall be removable type at locations shown on the plans to allow for maintenance personnel to remove it to gain access when they need to remove certain equipment and then reinstall the guardrails back after the maintenance activity is complete.

2.3 MISCELLANEOUS

A. The Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations (OSHA 1910.23). The top surface of the top railing shall be smooth and shall not be interrupted by projected fittings.

B. The mid-rail at a corner return shall be able to withstand a 200lb load without loosening.

C. Concrete anchors shall be stainless steel type 316 wedge anchors and shall be furnished by the handrail manufacturer. The anchor design shall include the appropriate reduction factors for spacing and edge distances in accordance with the manufacturers published data.

D. Toeboard shall conform to OSHA standards. Toeboard shall be a minimum of 4" high and shall be an extrusion that attaches to the posts with clamps which will allow for expansion and contraction between posts. Toeboard shall be set 1/4" above the walking surface. Toeboard shall be provided on handrails as required by OSHA and/or as shown on drawings. Toeboard shall be shipped in stock lengths for field installation.

E. Aluminum surfaces in contact with concrete, grout or dissimilar metals will be protected with a coat of bituminous paint, Mylar isolators or other approved material.

2.4 MANUFACTURERS

A. Handrail and components shall be manufactured by Thompson Fabricating, LLC or approved equal.

PART 3--EXECUTION

3.1 INSTALLATION

A. All WORK shall be executed by skilled workmen with a supervisor experienced in the erection of railings, handrails and guardrails. The installation shall be in strict accordance with the manufacturer’s recommendations.

****END OF SECTION****

SECTION 07905 - JOINT SEALERS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing joint sealers and appurtenant WORK, complete in place for a fully functioning system.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 07920 Sealants and Caulking
2. Section 03280 Joints in Sitework Concrete
3. Section 03290 Joints in Concrete Structures

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code

1.4 SPECIFICATIONS AND STANDARDS

Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ASTM C 719	Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement
ASTM C 790	Recommended Practices for Use of Latex Sealing Compounds
ASTM C 804	Recommended Practices for Use of Solvent-Release Type Sealants
ASTM C 834	Specification for Latex Sealant Compounds
ASTM C 919	Practice for Use of Sealants in Acoustical Applications
ASTM C 920	Specification for Elastomeric Joint Sealants
ASTM C 962	Guide for Use of Elastomeric Joint Sealants
ASTM D 412	Test Methods for Rubber Properties in Tension
ASTM D 1056	Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 2628	Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete
ASTM D 3405	Specification for Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements
ASTM D 3406	Specification for Joint Sealant, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavement

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Product Data: Manufacturer's recommended applications and technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.

2. Samples for Initial Selection Purposes: Submit manufacturer's standard bead samples consisting of strips of actual products showing the full range of colors available, for each product exposed to view.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Delivery of Materials**: Manufactured materials shall be delivered in original, unbroken packages or containers bearing the manufacturer's label. Packages or containers shall be delivered to the site with seals unbroken.

B. Manufacturer's labels shall bear name of manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

1. **Storage**: All materials shall be carefully stored in an area that is protected from deleterious elements and in a manner recommended by the product manufacturer. Storage and handling of materials shall be in such a manner as to prevent deterioration or damage due to moisture, temperature changes, contaminants or other causes.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Manufacturer's Recommendations**: Only products recommended for the specific application indicated shall be used.

B. **Single Source Responsibility**: All joint sealer materials for a specific application shall be obtained from a single manufacturer.

C. **Compatibility**: Joint sealers, joint fillers, and other related materials shall be provided which are compatible with one another and with joint substrates under the indicated conditions of service and application, as demonstrated by manufacturer's testing and field knowledge.

D. **Colors**: Colors of exposed joint sealers shall be provided as indicated or, if not otherwise indicated, as selected by the CONSTRUCTION MANAGER from manufacturer's standard colors. See Section 03290 “Joints in Concrete Structures” for color of sealant to match color of integrally colored concrete at cast-in-place architectural concrete.

2.2 ELASTOMERIC JOINT SEALANTS

A. **Elastomeric Sealant Standards**: Manufacturer's standard chemically curing elastomeric sealant shall be of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class and Uses.

1. **Two-Part Nonsag Polysulfide Sealant:** Type M; Grade NS; Class 12 1/2; Uses NT, M, G, A, and as applicable to the joint substrate indicated, Use O.

2. **Two-Part Pourable Polysulfide Sealant:** Type M; Grade P; Class 12 1/2; Uses T, M, G, A, and, as applicable to the joint substrates indicated, Use O.

3. **Two-Part Water Immersion Polysulfide Sealant:** Type M; Grade NS; Class 12 1/2; Uses T, M. G, A, and, as applicable to the joint substrates indicated, Use O; with a history of successful field knowledge in sealing joints immersed intermittently or continuously in water.

4. **One-Part Polysulfide Sealant:** Type S; Grade NS; Class 12 1/2; Uses T, M, G, A, and, as applicable to joint substrates indicated, Use O.

5. **One-Part Non-Acid-Curing Silicone Sealant:** Type S; Grade NS; Class 25; and complying with the following requirements for Uses NT, M, G, A, and, as applicable to joint substrates indicated, Use O. Modulus and additional joint movement capabilities as follows:

    a. Low Modulus: Tensile strength of 45 psi or less at 100 percent elongation when tested after 14 days at 77 degrees F and 50 percent relative humidity per ASTM D 412.

    b. Medium Modulus: Tensile strength of not less than 45 nor more than 75 psi or less at 100 percent elongation when tested after 14 days at 77 degrees F and 50 percent relative humidity per ASTM D 412.

    c. Additional capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, withstand 50 percent increase and decrease of joint width as measured at time of application and remain in compliance with other requirements of ASTM C 920.

6. **One-Part Acid-Curing Silicone Sealant:** Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to joint substrates indicated, Use O.

7. **One-Part Mildew-Resistant Silicone Sealant:** Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, Use O; formulated with fungicide for sealing interior joints with nonporous substrates around ceramic tile, showers, sinks and plumbing fixtures.

8. **Two-Part Non-Acid Curing Silicone Sealant for Use T:** Type M; Grade NS; Class 25; Uses T, M, and, as applicable to joint substrates indicated, Use O; and complying with the following requirement for additional joint movement capability:

    a. Additional capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand an increase and decrease of 50 percent of joint width as measured at time of application and remain in compliance with other requirements of ASTM C 920.

9. **Multi-Part Nonsag Urethane Sealant:** Type M; Grade NS; Class 25; Uses NT, M, G, A, and, as applicable to joint substrates indicated, Use O.

10. **Two-Part Nonsag Low-Modulus Urethane Sealant:** Type M; Grade NS; Class 25; Uses NT, M, A, and as applicable to joint substrates indicated, Use O; with additional capability to withstand an increase and decrease of 50 percent of joint width as measured at time of

application and remain in compliance with other requirements of ASTM C 920, based on manufacturer's recommendations and testing.

11. **Two-Part Pourable Urethane Sealant:** Type M; Grade NS; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, Use O.

12. **Two-Part Nonsag Urethane Sealant for Use T:** Type M, Grade NS: Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, Use O.

13. **One-Part Nonsag Urethane Sealant:** Type S; Grade NS; Class 25; Uses NT, M, A, and, as applicable to joint substrates indicated, Use O.

14. **One-Part Nonsag Low-Modulus Urethane Sealant:** Type S; Grade NS; Class 25; Uses NT, M, A, and, as applicable to joint substrates indicated, Use; with additional capability to withstand an increase and decrease of 50 percent of joint width as measured at time of application and remain in compliance with other requirements of ASTM C 920, based on manufacturer's recommendations and testing.

15. **One-Part Pourable Urethane Sealant:** Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, Use O.

2.3 SOLVENT RELEASE CURING JOINT SEALANTS

A. **Acrylic Sealant**: Manufacturer's standard one-part, nonsag, solvent release curing, acrylic terpolymer sealant complying with ASTM C 920 for Type S; Grade NS: Uses NT, M, G, A, and, as applicable to joint substrates indicated, Use O; except for selected test properties which are revised as follows:

1.	Heat aged hardness	-	40 to 50
2.	Weight loss	-	15 percent
3.	Maximum cyclic movement capability (Class)	-	plus or minus 7-1/2 percent

B. **Butyl Sealant**: Manufacturer's standard one-part, nonsag, solvent release curing, polymerized butyl sealant complying with FS TT-S-001657 for Type I and formulated with minimum of 75 percent solids to be nonstaining, paintable, and have a tack-free time of 24 hours or less.

C. **Pigmented Small Joints Sealant**: Manufacturer's standard, solvent release curing, pigmented, synthetic rubber sealant formulated for sealing joints 3/16-inch or smaller in width.

2.4 LATEX JOINT SEALANTS

A. **Acrylic-Emulsion Sealant**: Manufacturer's standard, one- part, nonsag, acrylic, mildew resistant, acrylic-emulsion sealant complying with ASTM C 834, formulated to be paintable and recommended for exposed applications on interior and on protected exterior exposures involving joint movement of not more than plus or minus 7.5 percent.

2.5 MISCELLANEOUS JOINT SEALANTS

A. **Acoustical Sealant for Concealed Joints**: Manufacturer's standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmissions of airborne sound.

B. **Butyl-Polyisobutylene Sealant**: Manufacturer's standard solvent release curing, butyl-polyisobutylene sealant recommended for concealed joints.

C. **Butyl-Polyisobutylene Tape Sealant**: Manufacturer's standard, solvent-free, butyl-polyisobutylene tape sealants with a solids content of 100 percent; formulated to be nonstaining, paintable, and non-migrating in contact with nonporous surfaces; packaged on rolls with release paper on one side; with or without reinforcement thread to prevent stretching.

2.6 COMPRESSION SEALS

A. **Preformed Foam Sealant**: Manufacturer's standard preformed, precompressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellant agent; factory-produced in precompressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by the manufacturer. Provide products which are permanently elastic, mildew-resistant, non-migratory, nonstaining, compatible with joint substrates and other joint sealers, and comply with the following requirements:

1. **Impregnating agent:** Manufacturer's standard

2. **Density:** Manufacturer's standard

3. **Backing:** Pressure sensitive adhesive, factory applied to one side, with protective wrapping or coated on one face with release agent serving as bond breaker for primary joint sealant.

B. **Preformed Hollow Neoprene Gasket**: Manufacturer's standard preformed polychloroprene elastomeric joint seal of the open-cell compression type complying with ASTM D 2628 and with requirements indicated for size, profile and cross-section design.

2.7 JOINT SEALANT BACKING

A. **General**: Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers.

B. **Plastic Foam Joint-Fillers**: Preformed, compressible, resilient, non-waxing, non-extruding strips of either flexible, open cell polyurethane foam or non-gassing, closed-cell polyethylene foam, subject to sealant manufacturer's approval; and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. **Bond-Breaker Tape**: Polyethylene tape or other plastic tape as recommended by the sealant manufacturer for preventing bond between sealant and joint filler or other materials at the back or third surface of the joint. Provide self-adhesive tape where applicable.

D. **Elastomeric Tubing Joint Fillers**: Neoprene, butyl or EPDM tubing complying with ASTM D 1056, non-absorbent to water and gas, capable of remaining resilient at temperatures down to minus 26 degrees F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.

2.8 MISCELLANEOUS MATERIALS

A. **Primer**: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated.

B. **Cleaners for Nonporous Surfaces**: Provide non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. **Masking Tape**: Provide non-staining, non-absorbent type compatible with joint sealants and with surfaces adjacent to joints.

2.9 MANUFACTURERS

A. Products of the type indicated shall be manufactured by one of the following (or equal):

1. **Two-Part Nonsag Polysulfide Sealant:**
   Bostik Construction Products Division, [Chem-Calk 200]
   W.R. Meadows, Inc., [CM-60]

2. **Two-Part Pourable Polysulfide Sealant:**
   Bostik Construction Products Division, [Chem-Calk 250]

3. **Two-Part Water Immersion Polysulfide Sealant:**
   Bostik Construction Products Division, [Chem-Calk 400]

4. **One-Part Polysulfide Sealant:**
   Bostik Construction Products Division, [Chem-Calk 100]
   Pecora Corp., [Synthacalk GC-9]

5. **One-Part Non-Acid Curing Low-Modulus Silicone Sealant:**
   Bostik Construction Products Division, [Chem-Calk 1000]
   Dow Corning Corp., [Dow Corning 790]

6. **One-Part Non-Acid Curing Medium-Modulus Silicone Sealant:**
   Dow Corning Corp., [Dow Corning 795]
   General Electric Co., [Silpruf]

7. **One-Part Acid-Curing Silicone Sealant:**
   Bostik Construction Products Division, [Chem-Calk 1200]
   Dow Corning Corp., [Dow Corning 999]

8. **One-Part Mildew-Resistant Silicone Sealant:**
   Dow Corning Corp., [Dow Corning 786]
   General Electric Co., [SCS 1702]

9. **Two-Part Non-Acid Curing Silicone Sealant for Use T:**
   Dow Corning Corp., [Dow Corning 888]

10. **Multi-Part Nonsag Urethane Sealant for Uses NT, M, G, A, and O:**
    Bostik Construction Products Division, [Chem-Calk 500]
    Pecora Corp., [Dynatrol II]

11. **Two-Part, Nonsag Low-Modulus Urethane Sealant:**
    Mameco International, Inc., [Vulkem 922]

12. **Two-Part, Pourable, Urethane Sealant:**
    Bostik Construction Products Division, [Chem-Calk 550]
    Mameco International, Inc., [Vulkem 245]

13. **Two-Part Nonsag Urethane Sealant for Use T:**
    Pecora Corp., [Dynatred]

14. **One-Part Nonsag Urethane Sealant:**
    Pecora Corp., [Dynatrol II]

15. **One-Part Nonsag Low-Modulus Urethane Sealant:**
    Mameco International, Inc., [Vulkem 921]
    Sika Corp., [Sikaflex-15LM]

16. **One-Part, Pourable, Urethane Sealant:**
    Mameco International, Inc., [Vulkem 45]
    Pecora Corp., [NR-201 Urexpan]

17. **Acrylic Sealant:**
    Bostik Construction Products Division, [Chem-Calk 800]
    Pecora Corp., [60+Unicrylic]

18. **Butyl Sealant:**
    Bostik Construction Products Division, [Chem-Calk 600]
    Pecora Corp., [BC-158]

19. **Pigmented Small Joint Sealant:**
    Protective Treatments, Inc., [PTI 200]
    Tremco, Inc., [Tremco Seam Sealer]

20. **Latex Joint Sealers:**
    Bostik Construction Products Division, [Chem-Calk 600]
    Pecora Corp., [AC-20]

21. **Acoustical Sealants for Concealed Joints:**
    Pecora Corp., [BA-98]
    Tremco, Inc., [Tremco Acoustical Sealant]

22 **Butyl-Polyisobutylene Sealant:**
    Protective Treatments, Inc., [PTI 404]

23. **Butyl-Polyisobutylene Tape Sealant:**
    Pecora Corp., [Extru-Seal Tape]
    Protective Treatments, Inc., [PTI 606]

24. **Compression Seals:**
    Emseal Corp., [Emseal Greyflex]
    Illbruck, [Will-Seal Tape Type 250]
    Sandell Manufacturing Co., Inc., [Polytite Standard]

25. **Preformed Hollow-Neoprene Gasket:**
Acme Highway Products Corp.
Watson Bowman Associates, Inc.

PART 3 -- EXECUTION

3.1 PROJECT CONDITIONS

A. **Environmental Conditions**: CONTRACTOR shall not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by the joint sealer manufacturers.

2. When joint substrates are wet due to rain, frost, condensation, or other causes.

B. **Joint Width Conditions**: Installation of joint sealers shall not proceed when joint widths are less than, or more than, allowed by the joint sealer manufacturer for the application indicated.

3.2 PREPARATION

A. **Surface Cleaning of Joints**: All joints shall be cleaned out immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. All foreign material shall be removed from joint substrates which could interfere with adhesion of joint sealer, including dust; paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer) oil; grease; waterproofing; water repellents; water, and surface dirt.

2. Concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces shall be cleaned by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Loose particles remaining from the above cleaning operations shall be removed by vacuuming or blowing out joints with oil-free compressed air.

3. Laitance and form release agents shall be thoroughly removed from all concrete surfaces.

4. Metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other non-porous surfaces shall be cleaned with chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. **Joint Priming**: Joint substrates shall be primed where indicated or where recommended by joint sealer manufacturer. Primer shall be applied so as to comply with joint sealer manufacturer's recommendations. Primers shall be confined to areas of joint sealer bond. Spillage or migration onto adjoining surfaces shall not be allowed.

C. **Masking Tape**: Masking tape shall be used where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Tape shall be removed immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

A. **General**: Unless otherwise indicated, comply with joint sealer manufacturers' printed installation instructions.

B. **Elastomeric Sealant Installation Standard**: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. **Solvent-Release-Curing Sealant Installation Standard**: Comply with requirements of ASTM C 804 for use of solvent-release-curing sealants.

D. **Latex Sealant Installation Standard**: Comply with requirements of ASTM C 790 for use of latex sealants.

E. **Acoustical Sealant Application Standard**: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications and conditions indicated.

F. **Installation of Sealant Backings**: Install sealant backings to comply with the following requirements:

1. Install joint-fillers of the types indicated to produce support of sealants during application and at position necessary to product the required cross-sectional shapes and depths.

    a. Do not leave gaps between ends of joint-fillers.

    b. Do not stretch, twist, puncture or tear joint-fillers.

    c. Remove absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants and joint-fillers, compression seals or back of joints, where required to prevent third-side adhesion of sealant to back of joint.

3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint-fillers.

G. **Installation of Sealants**: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

H. **Tooling of Nonsag Sealants**: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by the sealant manufacturer.

1. Concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated.

2. Flush joint configuration per Figure 6B in ASTM C 962, where indicated.

3. Recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated.

    a. Where necessary, use masking tape to protect adjacent surfaces of tooled joints.

I. **Installation of Preformed Foam Sealants**: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, and complying with sealant manufacturer's directions for installation methods, materials and tools which produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.

J. **Installation of Preformed Hollow Neoprene Gaskets**: Install gaskets, with minimum number of end joints, in joint recesses with edges free of spalls and sides straight and parallel, both within tolerances specified by gasket manufacturer. Apply manufacturer's recommended adhesive to joint substrates immediately prior to installing gaskets. For straight sections provide gaskets in continuous lengths; where changes in direction occur, adhesively splice gasket together to provide watertight joints. Recess gaskets below adjoining surfaces by 1/8 inch to 1/4 inch.

3.4 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers and reseal joints with new materials to produce installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as WORK progresses, by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

**** END OF SECTION ****

SECTION 07920 - SEALANTS AND CAULKING

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing sealants, caulking, and accessories.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03280 Joints in Sitework Concrete
2. Section 03290 Joints in Concrete Structures
3. Section 07905 Joint Sealers

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ASTM C 920	Elastomeric Joint Sealants
Fed. Spec. TT-S-001543A	Sealing Compound, Silicone Rubber Base, (For Caulking, Sealing and Glazing in Buildings and Other Structures).
Fed. Spec. TT-S-00230C(2)	Sealing Compound, Elastomeric Type, (For Caulking, Sealing, and Glazing in Buildings and Other Structures).

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's product data including catalogue cuts.
2. Manufacturer's installation instructions.
3. Certification that products comply with indicated requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from deleterious elements.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.

2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

PART 2 - PRODUCTS

2.1 GENERAL

A. **General:** Only products certified as complying with the indicated requirements shall be provided.

B. **Products:** Products shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. **Manufacturer's Recommendations:** Products shall be recommended by the manufacturer for the application indicated.

D. Colors: See Section 03290 “Joints in Concrete Structures” and Section 07905 “Joint Sealers”.

2.2 SEALANTS AND CAULKING MATERIALS

A. Caulking and sealing materials shall conform to the following requirements:

1. Sealant for exterior and interior use shall be 2-part polyurethane, gun grade.

2. Sealant for interior use shall be 1-part acrylic trypolymer sealant.

3. Sealants used with aluminum doors, windows, storefronts, and frames shall be silicone sealant conforming to Federal Specifications TT-S-001543A (Class A) and TT-S-00230C(2) (Type II, Class A).

4. Acoustic caulking compound shall be nonskinning synthetic polymer.

5. Acoustic sheet caulking shall be resilient synthetic polymer, self-adhesive, 1/8-inch thick sheet acoustic sealer.

6. Fire-resistant penetration sealants shall be a medium density fire-resistant foam that retains form and stability at high temperature and meets UL test requirements for fire rating required at location used.

7. Caulking tapes shall be of the butyl-base, vulcanized type.

8. Filler material shall be resilient, closed-cell polyethylene foam and/or bond breakers of proper size for joint widths and shall be compatible with sealant manufacturer's product.

9. Primers shall be as recommended by the manufacturer for caulking and sealants.

10. Cleaning and cleanup solvents shall be as recommended by the manufacturer for caulking and sealants.

2.3 MANUFACTURERS

A. Products shall be of the type and manufacture as indicated below (or equal):

1. **Sealant for Exterior and Interior Use:**
Sika 15LM
Vulkem 931

2. **Sealant for Interior Use:**
Tremco's "Mono"
Sonneborn Sonolac
Dap "One-Part Acrylic"

3. **Acoustic Caulking Compound:**
Presstite "579.64"
Lowry "Acoustical Sealer"

4. **Acoustic Sheet Caulking:**
Lowry "Electrical Box Pad"
Presstite "579.6"

5. **Fire-resistant Penetration Sealant:**
Dow-Corning Corporation's "3-6548 Silicone RTV" foam
3M Corporation's "Fire Barrier Caulk CP 25"
Putty Corporation's "303"

6. Silicone Sealant:
General Electric 2000 Silpruf
Dow Corning 795

PART 3 - EXECUTION

3.1 GENERAL

A. **General:** Products shall be installed in accordance with the manufacturer's installation instructions.

B. **Authorized Installers:** Caulking and sealants shall be complete systems, and shall be installed only by installers authorized and approved by the manufacturer.

C. **Acoustic Partition Joints:** Acoustic partition joints shall be made air and sound-tight with acoustic caulking material.

3.2 SEALANT FILLED JOINTS

A. **Manufacturer's Representative:** The WORK includes the services of the sealant manufacturer's representative (prior to sealant work) for inspection of the joints and for instructing the installer in the proper use of the materials.

B. **Surface Preparation:** Joints and spaces to be sealed shall be clean, dry, and free of dust, loose mortar, and other foreign materials. Ferrous metal surfaces shall be cleaned of rust, mill scale, and other coatings by wire brush, grinding, or sandblasting. Oil and grease shall be removed by cleaning in accordance with sealant manufacturer's recommendations. Protective coatings shall be removed from aluminum surfaces against which caulking or sealing compound is to be placed. Bituminous or resinous materials shall be removed from surfaces to receive caulking or sealants.

C. **Sealant Depth:** Sealant depth in joints shall be 1/2 the width of joint, but not less than 1/8-inch deep and 1/4-inch wide nor more than 1/2-inch deep and 1-inch wide. Joints shall have a rigid filler material installed to proper depth prior to application of sealant.

A. **Joints in Porous Materials:** Where required by the manufacturer, sides of joints of porous materials shall be primed immediately prior to caulking or sealing.

D. **Applications:** A full bead of sealant shall be applied to the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint to ensure forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with caulking tool or soft bristled brush moistened with solvent. The finished sealant filled joint shall be slightly concave unless otherwise indicated.

E. **Cleaning:** After application of sealant and caulking materials, adjacent materials which have been soiled shall be cleaned and left in a neat, clean, undamaged or unstained condition. On porous surfaces, excess sealant shall be removed in accordance with the sealant or caulking manufacturer's printed instructions.

3.3 ACOUSTIC CAULKING

A. **Preparation:** Joints and surfaces shall be clean, dry, and free of loose materials.

B. **Concealed Joints:** Concealed joints in acoustic partitions including perimeters, intersections of walls and penetrations through finish WORK, and at conduit ends with boxes shall be sealed with acoustic caulking compound. Backs of electrical boxes shall be sealed with acoustic sheet caulking installed over holes and knock-outs.

**** END OF SECTION ****

SECTION 09800 - PROTECTIVE COATING

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes the protective coating of all indicated surfaces including surface preparation, pretreatment, coating application, touch-up, protection of surfaces not to be coated, cleanup, and all appurtenant WORK.

B. Definitions

1. The term “paint”, “coatings”, or “finishes” as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, except galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term “DFT” shall mean minimum dry film thickness, without any negative tolerance.

C. The following surfaces shall not be protective coated hereunder unless indicated.

1. Concrete except in chemical(s) containment areas
2. Stainless steel
3. Machined surfaces
4. Grease fittings
5. Glass
6. Equipment nameplates
7. Platform gratings, stair treads, door thresholds, and other walk surfaces

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the drawings are used to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11000 – Equipment General Provisions

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. References herein to "SSPC Specifications" or "SSPC" shall mean the published standards of the Steel Structures Painting Council, 40 24th Street, 6th Floor, Pittsburgh, PA 15222.

2. References herein to "NACE" shall mean the published standards of the National Association of Corrosion Engineers, P.O. Box 281340, Houston, TX 77218-8340.

3. **Commercial Standards:**

ANSI A13.1	Scheme for Identification of Piping Systems
ANSI/AWWA C105	Polyethylene Encasement for Ductile Iron Piping
ANSI/AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape-Hot-Applied
ANSI/AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
ANSI/AWWA D102	Painting Steel Water-Storage Tanks

4. **Federal Specifications:**

TT-P-28	Paint, Aluminum, Heat Resisting ($1200^{O}F$)
DOD-P-23236	Military Specification, Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast

1.5 SHOP DRAWINGS AND SAMPLES

A. Submittals shall include the following information and be submitted at least 30 days prior to protective coating WORK.

1. **Coating Materials List:** The CONTRACTOR shall provide a coating materials list which indicates the manufacturer and the coating number, keyed to the coating systems herein, prior to or at the time of submittal of samples.

2. **Paint Manufacturer's Catalogue:** For each paint system to be used the CONTRACTOR shall submit manufacturer's catalogue containing the following data

a. Paint Manufacturer’s data sheet for each product used, including statements on the suitability of the material for the intended use.

b. Technical and performance information that demonstrates compliance with the system performance and material requirements.

c. Manufacturer’s Instructions and recommendations on surface preparation, thinning, mixing, handling, applying and proper storage.

d. Colors available for each product (where applicable).

e. Compatibility of shop and field applied coatings (where applicable).

f. Material safety data sheet for each product used.

B. **Samples:**

1. Samples of all paint, finishes, and other coating materials shall be submitted on 8.5-inch by 11-inch sheet metal. Each sample shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the CONSTRUCTION MANAGER from the Manufacturer’s standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the CONSTRUCTION MANAGER. The color formula shall be shown on the back of each color sample.

3. Qualifications of Painting Subcontractor

a. Copy of a valid State of California license as required for the application of coatings.

b. Provide the name, address and telephone number of the OWNER of each installation. The CONTRACTOR shall obtain the references from the subcontractor and submit them to the CONSTRUCTION MANAGER.

1.6 SERVICES OF MANUFACTURER

A. For submerged and severe service coating systems, the CONTRACTOR shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall furnish at least 6 hours of on-site instruction in the proper surface preparation, use, mixing, application and curing of the coating systems.

2. The manufacturer's representative shall personally observe the start of surface preparation, mixing, and application of the coating materials.

3. The manufacturer's representative shall provide technical support to resolve field problems associated with manufacturer's products furnished under this Contract or the application thereof.

4. The manufacturer shall certify that these services have been furnished, and the CONTRACTOR shall submit the certification within 7 days of completion of each paint system.

1.7 INSPECTION AND TESTING

A. **General:** The CONTRACTOR shall give the CONSTRUCTION MANAGER a minimum of 3 days' advance notice of the start of any field surface preparation WORK or coating application

WORK, and a minimum of 7 days' advance notice of the start of any shop surface preparation WORK.

B. All such WORK shall be performed only in the presence of the CONSTRUCTION MANAGER, unless the CONSTRUCTION MANAGER has granted prior approval to perform such WORK in its absence.

C. Inspection by the CONSTRUCTION MANAGER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the WORK in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the CONSTRUCTION MANAGER to facilitate inspection. Additional illumination shall be furnished to cover all areas to be inspected.

E. **Inspection Devices:** The CONTRACTOR shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gauges shall be made available for the CONSTRUCTION MANAGER'S use at all times while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the CONSTRUCTION MANAGER.

F. **Holiday Testing:** The CONTRACTOR shall holiday test all coated ferrous surfaces inside a steel reservoir, or other surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Areas which contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested. In addition to the above the CONSTRUCTION MANAGER may test any surfaces for any number of times at no additional cost to CONTRACTOR. All defects so found shall be corrected by the CONTRACTOR at no additional cost to the OWNER.

1. Coatings With Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the indicated coating thickness.

2. Coatings With Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo, or equal, shall be added to the water prior to wetting the detector sponge.

G. **Film Thickness Testing:** On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gauge such as Mikrotest model FM, Elcometer model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. **Surface Preparation:** Evaluation of blast cleaned surface preparation WORK will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standard TM-01-70 and TM-01-75.

1.8 WARRANTY INSPECTION

A. A warranty inspection may be conducted during the eleventh month following completion of all coating and painting WORK. The CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. All defective WORK shall be repaired in accordance with these specifications and to the satisfaction of the OWNER. The OWNER may, by written notice to the CONTRACTOR, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the CONTRACTOR shall not be relieved of its responsibilities under the CONTRACT DOCUMENTS.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer, all of which shall be plainly legible at the time of use.

B. Paint materials shall be carefully stored in a manner that will prevent damage and in an area that is protected from deleterious elements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Suitability:** The CONTRACTOR shall use suitable coating materials as recommended by Manufacturer for the intended service.

B. **Compatibility:** In any coating system only compatible materials from a single manufacturer shall be used in the WORK. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

C. **Colors:** All colors and shades of colors of all coats of paint shall be as indicated or selected by the CONSTRUCTION MANAGER. Each coat shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the CONSTRUCTION MANAGER.

D. **Substitute or “Or Equal” Products:**

1. The CONTRACTOR shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or-equal" material that said material meets the requirements and is equivalent or better than the listed materials in the following properties:
    a. Quality
    b. Durability
    c. Resistance to abrasion and physical damage

d. Life expectancy

e. Ability to recoat in future

f. Solids content by volume

g. Dry film thickness per coat

h. Compatibility with other coatings

i. Suitability for the intended service

j. Resistance to chemical attack

k. Temperature limitations in service and during application

l. Type and quality of recommended undercoats and topcoats

m. Ease of application

n. Ease of repairing damaged areas

o. Stability of colors

E. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the CONTRACTOR shall provide the name of least one successfully performing application of the proposed manufacturer's products in a project of comparable size and complexity constructed in the recent past.

F. The cost of all testing and analyzing proposed substitute materials that may be required by the CONSTRUCTION MANAGER shall be paid by the CONTRACTOR at no additional cost to the OWNER. If the proposed substitution requires changes in the contract WORK, the CONTRACTOR shall bear all such costs involved and the costs of allied trades affected by the substitution at no additional cost to the OWNER.

2.2 INDUSTRIAL COATING SYSTEMS

A. **Material Sources**: Each of the following manufacturers is capable of supplying many of the industrial coating materials indicated herein. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials shall be considered as indicated above. All industrial coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, water, and wastewater treatment plants.

1. Ameron
2. Carboline Coatings Company
3. Inorganic Coatings, Inc.
4. International (Courtaulds)
5. Tnemec Company

B. **System 1 - Alkyd Enamel:** High quality, gloss or semi-gloss, medium long oil alkyd finish shall have a minimum solids content of 49 percent by volume. Primer shall be as recommended by manufacturer.

1. Prime coat (DFT = 3 mils) Amercoat 5105, Tnemec 4-55, or equal.

2. Finish coats (two or more, DFT = 3 mils), Amercoat 5401 HSA, or 5405, Tnemec 2H, or equal.

3. Total system DFT = 6 mils.

C. **System 2 - Not Used**

D. **System 3 - Aluminum Silicone Resin:** Aluminum silicone resin material shall be suitable for a service temperature of up to 1,000 degrees F, and shall comply with Federal Specification TT-P-28.

1. Prime coat and finish coat (2 or more, DFT = 3 mils), Tnemec Series 39-1061, Amercoat 878, or equal.

2. Total system DFT = 3 mils.

E. **System 4 - Aliphatic Polyurethane:** Two component aliphatic acrylic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58 percent by volume. Primer shall be a rust inhibitive two component epoxy coating with a minimum solids content of 68 percent by volume.

1. Prime coat (DFT = 4 mils), Amercoat 385, Carboline 893, Tnemec 69, or equal.

2. Finish coat (one or more, DFT = 3 mils), Amershield, Carboline 134 HS, Tnemec 74, or equal.

3. Total system DFT = 7 mils.

4. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

F. **System 5 - Inorganic Zinc/Polyurethane:** The inorganic zinc primer shall be a water or solvent based, self-curing, zinc silicate 2-component inorganic coating which contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. The intermediate coat shall be a high-build two component epoxy with a solids content of at least 70 percent by volume. Finish coats shall be a 2-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58 percent by volume.

1. Prime coat (DFT = 2 mil), Ameron Dimetcote 21-5 or 21-9, Inorganic Coatings 531, or equal.

2. Intermediate coat (DFT = 4 mils), Ameron 385, Inorganic Coatings P24, or equal.

3. Finish coats (one or more, DFT = 3 mils), Ameron Amershield, Inorganic Coatings 64, or equal.

4. Total system DFT = 10 mils.

5. Intermediate coat shall be applied in excess of 4 mils DFT or in more than one coat as necessary to completely cover the inorganic zinc primer and prevent application bubbling of the polyurethane finish coat.

6. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

7. If the inorganic zinc primer is used as a pre-construction or shop applied primer, all damaged and uncoated areas shall be spot abrasive blasted and coated after construction using the indicate material.

G. **System 6 - Inorganic Zinc, Water Based:** Water based, self curing, ethyl silicate shall be a two component inorganic coating material that contains at least 85 percent of metallic zinc by weight in the dried film.

1. Prime coat and finish coat (One, DFT = 3 mils), Ameron Dimetcote 21-5, Inorganic Coatings 531, or equal.

2. Total system DFT = 3 mils.

H. **System 7 - Acrylic Latex:** Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35 percent by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.

1. Prime coat (DFT = 2 mils), as recommended by manufacturer.

2. Finish coats (2 or more, DFT = 6 mils), Ameron Amercoat 220, Carboline 3359, Tnemec 6, or equal.

3. Total system DFT = 8 mils.

I. **System 8 - Epoxy Equipment:** Two component, rust inhibitive polyamide cured epoxy coating material shall provide a recoatable finish that is available in a wide selection of colors. The coating material shall have a minimum solids content of 66 percent by volume and be resistant to service conditions of condensing moisture, splash and spillage of lubricating oils, and frequent washdown and cleaning.

1. Prime coat DFT = 3 mils, Ameron 385, Tnemec 69, or equal.

2. Prime coat, where shop applied. (DFT = 3 mils), universal primer, Ameron 185 HS, Tnemec 50-330 or 161, or equal.

3. Finish coat (2 or more, DFT =6 mils), Ameron 385, Tnemec 69, or equal.

4. Total system DFT = 6 mils.

J. **System 9 - Inorganic Zinc/Epoxy, Equipment:** The inorganic zinc primer shall be a water or solvent based, self curing, zinc silicate, two-component inorganic coating that contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacture as a primer for this system. The finish coats shall be a polyamide cured epoxy

material with a minimum solids content of at least 80 percent by volume, and available in a large selection of colors.

1. Prime coat DFT =3 mils Ameron Dimetcote 21-5 or 21-9, Carboline carbozinc 7 WB, or equal.

2. Finish coats (2 or more, DFT = 9 mils) Ameron 400, Carboline 890, or equal.

3. Total system DFT = 12 mils.

K. **System 10 - Acrylic, Concrete:** The acrylic coating material shall be a single component, industrial grade, high molecular weight acrylic coating material shall have a minimum solids content of 35 percent by volume. The filler-sealer shall be a two component epoxy masonry sealer for wet and exterior exposure, with a solids content of at least 64 percent by volume. A 100 percent solids epoxy surface shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Prime coat (Filler-sealer), applied in two coats to the entire surface and worked into the surface with a squeegee to achieve a smooth, void-free surface, Tnemec 54-660, Ameron Nu-Klad 105A followed by Nu-Klad 114A (2 coats), or equal.

2. Finish coats (2 or more, DFT = 6 mils), Tnemec 6, Ameron Amercoat 220, or equal.

L. **System 11 - Aliphatic Polyurethane, Concrete:** Two component aliphatic polyester polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, and resistance to chemical fumes and severe weathering, and with a minimum solids content of 65 percent by volume. Filler-sealer compound shall be a two component epoxy material used to provide a smooth surface for the epoxy intermediate coat. The filler-sealer shall be applied to the entire concrete surface and worked into the concrete surface with a wide blade putty knife or squeegee. The intermediate coat shall be a high-build epoxy coating with a minimum solids content of 70 percent by volume.

1. Prime coat (Filler-sealer), Ameron Nu-Klad 105A followed by, Nu-Klad 114 Tnemec 54-660, or equal.

2. Intermediate coat (DFT = 4 mils), Ameron Amerlock 400, Tnemec 104 HS, or equal.

3. Finish coats (2 or more, DFT = 3 mils), Ameron Amershield, Tnemec 74, or equal.

M. **System 12 - Aliphatic Polyurethane, Fiber Glass:** Two-component aliphatic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, and resistance to chemical fumes and severe weathering. A primer, tie coat, or mist coat shall be used as recommended by the manufacturer.

1. Prime coat (Tie coat), Ameron Amercoat 385, Tnemec 66, or equal.

2. Finish coats (2 or more, DFT = 3 mils), Ameron Amershield, Tnemec 74, or equal.

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. **Materials Sources:** The manufacturers' products listed in this paragraph are materials which satisfy the material descriptions of this paragraph and have a documented successful record for long term submerged or severe service conditions. Proposed substitute products shall be considered as indicated above.

B. **System 100 - Amine Cured Epoxy:** High build, amine cured, straight epoxy resin shall have a solids content of at least 80 percent by volume, and shall be suitable for long-term immersion service in potable water and wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61B Drinking Water System Components - Health Effects.

1. Prime coat and finish coats (3 or more, DFT = 16 mils), Amercoat 395, Tnemec 139, or equal.

2. For coating of valves and non-submerged equipment, DFT = 12 mils.

C. **System 101 - Cold-Applied Tape:** Tape coating materials and procedures shall be in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II. The system shall consist of a primer layer, inner layer tape (35 mils), and an outer layer tape (35 mils). Total system DFT = 70 mils.

D. **System 102 - Polyamide Cured Epoxy:** High build, polyamide epoxy resin shall have a solids content of at least 56 percent by volume, and shall be suitable for long-term immersion in potable water and municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61.

1. Prime coat and finish coats (3 or more, DFT = 12 mils), Tnemec 20, or equal.

E. **System 103 - Coal Tar Epoxy:** High build, 2-component amine or polyamide cured coal tar epoxy shall have a solids content of at least 68 percent by volume, suitable for long term immersion in wastewater and for coating of buried surfaces, and conforming to DOD-P-23236, Class 2, or to SSPC Paint 16. Prime coats are for use as a shop primer only. Prime coat shall be omitted when both surface preparation and coating are to be performed in the field.

1. Finish coats (2 or more, DFT = 16 mils), Amercoat 78 HB, Tnemec 46 H-413, or equal.

2. Total system DFT = 16 mils.

F. **System 104 –** (Not Used)

G. **System 105 - Epoxy, Reservoirs:**

1. **Primer:** Solids content of 100 percent, NSF listed, compatible with finish coating, 3 mils.

2 Polyamide Cured Epoxy: High build polyamide cured epoxy coating shall have a solids content of at least 70 percent by volume and a finish coat color of white.

3. **Amine Cured Epoxy:** High build amine cured epoxy coating shall have a solids content of at least 78 percent by volume and with a finish coat color of white or ivory.

4. The epoxy coating material shall be either a polyamide-cured epoxy or an amine-cured epoxy suitable for long-term immersion service in reclaimed and potable water. The material shall be listed by NSF International as in compliance with NSF Standard 61 and shall conform with State and local health regulations and policies for service in potable water reservoirs. The CONTRACTOR shall submit a written certification that the proposed materials meet the above regulatory agency standards and policies. The material shall be applied with a primer if recommended by the coating manufacturer.

5. **Part A:** Products shall be as listed, or equal:

a.	Pre-coating, prior to erection. See Note (1) under Paragraph f.	(DFT = 3 mils)	Ameron Dimetcote 21-5, International Interline 982
b.	Finish coating, prior to erection. Top of roof rafters, girders, and other areas not accessible after erection.	(DFT = 9 mils)	Ameron Amercoat 395, International Interline 925
c.	Touch up, following erection. See Note (2) under Paragraph f.	(DFT = 3 mils)	
d.	Difficult-to-coat areas, following erection. See Note (3) under Paragraph f.	(DFT = 9 mils)	Ameron Amercoat 395, International Interline 925
e.	Finish Coats (2 or more)	(DFT = 9 mils)	Ameron 395, International Interline 925
f.	Notes:		
	(1) All lap roof plate edges, both sides, are to be pre-coated. If necessary, zinc primer exposed on exterior of roof may be removed prior to welding. Pre-coating shall extend at least 6 inches from plate edges.		
	(2) Touch-up coating shall be done for areas damaged during erection, or areas not pre-coated. The CONTRACTOR shall spot sandblast to SSPC-SP-5 - white metal blast cleaning, before application of coating. Material used for touch-up shall be the specified material, or a compatible primer recommended by the manufacturer.		
	(3) All edges, nuts, bolts, lap joints, weld seams and the roof rim angle shall receive one brush-applied coat prior to the application of the first complete spray coat.		

6. **Part B:** Products shall be as listed, or equal:

a.	Difficult-to-coat areas. See Note (1) under Paragraph d.		Ameron Amercoat 395, International Interline 925
b.	Finish coats (2 or more). Finish coats to be applied at 4-6 mils	(DFT = 12 mils)	Ameron Amercoat 395, International Interline 925

	DFT per coat. See Note (1) under Paragraph d.		
c.	Total system DFT = 12 mils		
d.	Notes:		
	(1) All edges, nuts, bolts, lap joints, and weld seams shall receive one brush-applied coat prior to the application of the first complete spray coat.		

7. **Curing Period:** Prior to immersion, the completed system shall be subjected to at least 240 hours of curing time with the metal temperature at a minimum of 70 degrees F, or 480 hours at a minimum of 60 degrees F, both conditions at a maximum relative humidity of 50 percent and under the forced ventilation conditions required by the paragraph entitled "Curing of Coatings, herein. More curing time or a higher temperature shall be provided if recommended by the epoxy coating manufacturer. If the environmental conditions do not provide the necessary minimum temperature, use heated air to provide the necessary heat for curing. Other combinations of curing time and temperature may be used if the coating manufacturer presents satisfactory documentation and test results to substantiate that the degree of curing is equal or greater than curing for 240 hours at 70 degrees F.

8. **Volatile Organic Compound Testing:** The completed interior reservoir coating system shall be tested for volatile organic compounds as specified herein.

H. **System 106 - Fusion Bonded Epoxy:** The coating material shall be a 100 percent powder epoxy, certified as compliant with NSF Standard 61, applied in accordance with the ANSI/AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines," except that the surface preparation shall be as specified in the coating system schedule of this Section. The coating shall be applied using the fluidized bed or electrostatic spray process.

1. Coating DFT = 16 mils, Scotchkote 134 (electrostatic) or 206N (fluidized bed), or equal, applied in one coat.

2. For coating of valves, DFT = 12 mils.

3. For field repairs, the use of a liquid epoxy will be permitted, applied in one coat to provide a DFT of 15 mils. The liquid epoxy shall be Scotchkote 312 or as recommended by the powder epoxy manufacturer.

I. **System 107 - Chemical Resistant Sheet Lining:**

1. **Materials:** The CONTRACTOR shall use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining materials as indicated herein. The shop drawing submittal shall contain technical information that confirms the suitability of the lining material system for long-term contact with each chemical to be stored. The service temperatures are expected to be up to 150 degrees F.

2. Neoprene sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 inch. The lining material shall be Polymeric Protective Linings BFG 2011 (59688), or equal.

3. Chlorobutyl sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be Polymeric BFG 1051 (60924), or equal.

4. Natural rubber (soft) sheet lining material shall be soft natural rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 inch. The lining material shall be Polymeric BFG 2004 (83160), or equal.

5. Material rubber (hard) sheet lining material shall be a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. The minimum lining thickness shall be 3/16 inch. The lining material shall be Polymeric BFG 1006 (8631), or equal.

6. EPDM sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution and formulated for autoclave or steam curing under pressure. The lining material shall be Polymeric BFG 1039 (EP 156), or equal.

7. Hypalon sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution. The lining material shall be Polymeric BFG 2045 (8706), or equal.

8. Primers, adhesives, activators, accelerators and other necessary materials shall be as specified by the sheet material manufacturer.

9. Metal Surface Preparation: Prior to abrasive blast cleaning the base metal shall be prepared as specified by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications the higher degree of cleaning and surface preparation shall be provided. Abrasive blast cleaning shall be done in accordance with this Section.

10. Installation of lining materials shall be in accordance with the material manufacturer's written installation instructions. All interior surfaces shall be lined, including all piping, vents, fittings, flange faces, manhole covers and blind flanges.

11. The lining system shall be holiday tested in accordance with this Section before and after curing.

12. The lining system shall be cured by steam using the time and temperature as specified by the material manufacturer.

J. **System 108 - Epoxy, Concrete:** The coating material shall be an amino cured epoxy material suitable for long-term immersion in water and wastewater and for service where subjected to occasional splash and spillage of water and wastewater treatment chemicals. The finish coating material shall have a minimum solids content of 69 percent by volume. If used for potable water service the finish coating material shall be listed by the NSF International as in compliance with NSF Standard 61, and shall conform with state and local health regulations and policies for service in potable water. The filler-sealer shall be a 100 percent solids amine-cured epoxy material with silica and inert fillers.

1. **Filler-sealer:** Plastic 9029 (applied by squeegee); Tnemec 69-1211 (6-8 mils) followed by Tnemec 63-1500; Ameron Nu-Klad 105A followed by Nu-Klad 114A (two coats) or equal.

2. Finish coats (two or more, DFT = 12 mils); Plasite 9133; Tnemec 69; Ameron Amercoat 395, or equal. On walking surfaces use a non-skid additive such as Ameron 886 in the final coat.

K. **System 109 –** (Not Used)

L. **System 110 –** (Not Used)

M. **System 111 - Vinyl Ester:** Vinyl ester resin coating material with an inert flake pigment suitable for immersion service in 30 percent hydrochloric acid and 30 percent sulfuric acid solutions.

1. Two or more coats (DFT = 40 mils), Plasite 4100, or equal. Use a prime coat as recommended by the material manufacturer.

N. **System 112 - Vinyl Ester, Concrete:** Vinyl ester resin coating material with an inert flake pigment suitable for immersion service in hydrochloric acid and sulfuric acid solutions. The filler-sealer shall be a 100 percent solids amine-cured epoxy or vinyl ester material with silica and inert fillers. The filler-sealer is applied to the entire concrete surface. A 100 percent solids epoxy or vinyl ester surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Prime coat (filler-sealer), applied in two coats using a squeegee to achieve a smooth void-free surface, Plasite 9028 MI, or equal.

2. Finish coats (two or more, DFT = 40 mils), Plasite 4100, or equal.

2.4 SPECIAL COATING SYSTEMS

A. **System 200 - PVC Tape:** Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. **System 201 - Rich Portland Cement Mortar:** Rich Portland cement mortar coating shall have a minimum thickness of 1/8-inch, followed by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped and sealed with tape.

C. **System 203 - Epoxy Surfacing:** Two-component epoxy floor surfacing shall be formulated to resist many acids, alkalies, and solvents. Material shall be resistant to liquid alum, sodium hydroxide, and 50 percent sulfuric acid. Products shall be as follows, or equal:

1. Prime coat Nu-Klad 105; finish coat Nu-Klad 110 (1/4-inch thick), or equal.

D. **System 204 - Water-Retardant:** Two coats (or single coat if manufacturer recommends in writing) of a clear, non-staining, silane-modified-siloxane masonry water-retardant material. The water-retardant system after application shall be provided with not less than a five-year warranty on the performance of the product.

1. TAMMS Barricade Series; Rainguard "Blok-Lok"; or equal.

Surfaces shall be cleaned with a chemical cleaner approved by the manufacturer and power wash. Surfaces shall be clean and dry before application of the material. Method and rate of application shall be in accordance with manufacturer's published instructions. A manufacturer's representative shall be present during applications if necessary for warranty.

E. **System 205 - Polyethylene Encasement:** Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

F. **System 206 - Cement Mortar Coating:** A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane-Forming Compounds for Curing Concrete" ASTM C 309-81, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped by at least 6 inches.

G. **System 207 –** (Not Used)

H. **System 208 - Aluminum Metal Isolation**: Two coats of a high build polyamide epoxy paint, such as Tnemec 66, or equal (8 mils). Total thickness of system DFT = 8.0 mils.

I. **System 209 - Alkyd-Wood:** Industrial quality, gloss or semi-gloss, medium long oil alkyd coating material with a minimum solids content of 49 percent by volume. Primer shall be an alkyd primer as recommended by the manufacturer.

1. Prime coat DFT = 3 mils
2. Finish coats (two or more, DFT = 3 mils), Amercoat 5401, Tnemec 2H, or equal.
3. Total system DFT = 6 mils.

J. **System 210 - Acrylic-Wood:** Single component, water-based acrylic latex coating material with a fungicide additive and a minimum solids content of 35 percent by volume. Primer shall be an alkyd primer as recommended by the manufacturer.

1. Prime coat DFT = 2 mils.

2. Finish coats (two or more, DFT = 6 mils), Amerguard 220, Carboline 3300, Tnemec 6, or equal.

3. Total system DFT = 8 mils.

K. **System 211 - Acrylic Drywall:** Single component, water-based acrylic latex coating material with a fungicide additive and a minimum solids content of 35 percent by volume. Primer shall be a PVA sealer as recommended by the manufacturer.

1. Prime coat DFT = 1.5 mils.

2. Finish coats (two or more, DFT = 6 mils), Amerguard 220, Carboline 3300, Tnemec 6, or equal.

3. Total system DFT = 7.5 mils.

L. **System 212 – Anti-Algae Coating for Concrete:** 100% solids, 2-component, No VOC, epoxy lining system designed to minimize growth of algae, chemical resistance to acids, bases and resistance to cathodic disbondment on concrete surface treated with the coating. Material shall completely cure in 100% humidity. Meets regulatory requirements and can be applied to surfaces in contact with potable water, wastewater and saltwater.

1. Surface Preparation = As per manufacturer's recommendations.

2. System DFT = 100 mils in single coat multiple pass, Hydro-Pox 204 UHB or approved equal.

PART 3 -- EXECUTION

3.1 WORKMANSHIP

A. Skilled craftsmen and knowledgeable supervision shall be used on all WORK.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough cleaning and an adequate thickness of coating material. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given to insure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. All damage to surface resulting from the WORK shall be cleaned, repaired, and refinished to original condition.

3.2 STORAGE, MIXING, AND THINNING OF MATERIALS

A. **Manufacturer's Recommendations:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.

B. All protective coating materials shall be used within the manufacturer's recommended shelf life.

C. **Storage and Mixing:** Coating materials shall be stored under the conditions recommended by the Material Safety Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings of different manufacturers shall not be mixed together.

3.3 PREPARATION FOR COATING

A. **General:** All surfaces to receive protective coatings shall be cleaned as indicated prior to application of coatings. The CONTRACTOR shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.

B. **Protection of Surfaces Not to be Coated:** Surfaces which are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. All hardware, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of all mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent WORK during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent WORK or adjoining property occurring from blast cleaning or coating operations.

E. **Protection of Painted Surfaces:** Cleaning and coating shall be scheduled so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.

3.4 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. **Solvent Cleaning (SSPC-SP1):** Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. **Hand Tool Cleaning (SSPC-SP2):** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. **Power Tool Cleaning (SSPC-SP3):** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. **White Metal Blast Cleaning (SSPC-SP5):** Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. **Commercial Blast Cleaning (SSPC-SP6):** Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. **Brush-Off Blast Cleaning (SSPC-SP7):** Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint. Tightly adherent mill scale, rust and paint which cannot be removed by a dull putty knife may remain.

7. **Near-White Blast Cleaning (SSPC-SP10):** Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

3.5 METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as specified in the coating system schedules included at the end of this Section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the more stringent degree of cleaning shall apply.

B. Workmanship for metal surface preparation shall be in conformance with the current SSPC Standards and this Section. Blast cleaned surfaces shall match the standard samples available from the National Association of Corrosion Engineers, NACE Standard TM-01-70 - Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive and TM-01-75 - Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Grits...

C. Oil, grease, welding fluxes and other surface contaminants shall be removed by solvent cleaning per SSPC-SP1 prior to blast cleaning.

D. All sharp edges shall be rounded or chamfered and all burrs, and surface defects and weld splatter shall be ground smooth prior to blast cleaning.

E. The type and size of abrasive shall be selected to produce a surface profile that meets the manufacturer's recommendation for the specific coating and service conditions. Abrasive shall not be used unless approved by the CONSTRUCTION MANAGER.

1. Submerged and Severe Service

    a. Automated blasting systems shall not be used for surfaces that will be in submerged service but are acceptable for severe service.

    b. Abrasives for submerged and severe service coatings shall be clean, hard, sharp cutting crushed: no metallic abrasives shall be used.

2. Other Services

    a. Either automated or manual methods of blasting may be used.

    b. Abrasives shall be clean, oil-free metallic abrasives, composed of at least 50 percent grit.

F. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

G. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil/moisture separators which remove at least 95 percent of the contaminants.

H. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming or another approved method prior to painting.

I. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

J. Damaged or defective coating shall be removed by the specified blast cleaning to meet the clean surface requirements before recoating.

K. If the specified abrasive blast cleaning will damage adjacent WORK, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC-SP2, or SSPC-SP3 may be used.

L. Shop applied coatings of unknown composition shall be completely removed before the specified coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC-SP1 before the abrasive blast cleaning WORK has been started.

M. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

3.6 SURFACE PREPARATION FOR GALVANIZED FERROUS METAL

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system to be used, followed by brush-off blast cleaning per SSPC-SP7.

B. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer.

3.7 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. **General:** All grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. **Abrasive Blast Cleaning:** The CONTRACTOR shall provide the degree of cleaning specified in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not specified in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC-SP6, Commercial Blast Cleaning. Areas of tightly adhering coatings shall be cleaned to SSPC-SP7, Brush-off Blast Cleaning, with the remaining thickness of existing coating not to exceed 3 mils.

C. **Incompatible Coatings:** If coatings to be applied are not compatible with existing coatings the CONTRACTOR shall apply intermediate coatings per the paint manufacturer's recommendation for the specified coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. **Unknown Coatings:** Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. **Water Abrasive or Wet Abrasive Blast Cleaning:** Where indicated or where job site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced

equipment with a successful service record. Wet blasting methods shall not be used for submerged and severe service coating systems unless indicated.

3.8 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.

B. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC-SP1 before abrasive blast cleaning.

C. Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.

D. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, rinse surfaces with water and test the pH. The pH shall be between neutral and 8.

E. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model DB, or equal.

3.9 PLASTIC, FIBER GLASS, AND NONFERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC-SP1 followed by sanding or brush-off blast cleaning SSPC-SP7.

C. All surfaces shall be clean and dry prior to coating application.

3.10 ARCHITECTURAL CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. The mortar surfaces shall be cured at least 14 days before surface preparation WORK is started.

B. Dust, dirt, grease, and other foreign matter shall be removed prior to abrasive blasting.

C. The masonry surfaces shall be prepared in accordance with the material manufacturer's printed instructions.

3.11 SHOP COATING REQUIREMENTS

A. Unless indicated otherwise, items of equipment, or parts of equipment which are not submerged in service, shall be shop primed and then finish coated in the field after installation with the indicated or approved color. The methods, materials, application equipment and all other details of shop painting shall comply with this section. If the shop primer requires topcoating within a

specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.

B. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating WORK performed in the field.

C. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the specified quality in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. The CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the shop drawings for the equipment.

D. For certain small pieces of equipment the manufacturer may have a standard coating system which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

E. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before topcoated, or less time if recommended by the coating manufacturer.

F. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

G. The CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment shop drawings.

3.12 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with "Paint Application Specification No. 1, (SSPC-PA1)," Steel Structures Painting Council.

B. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the CONSTRUCTION MANAGER in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.

F. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner which will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperature exceeding the manufacturer's recommended maximum and minimum allowable.
2. Dust or smoke laden atmosphere.
3. Damp or humid weather.
4. When the substrate or air temperature is less than 5 degrees F above the dewpoint.
5. When air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dewpoint within 8 hours after application of coating.
6. When wind conditions are not calm.

I. Dewpoint shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Steel piping shall be abrasive blast cleaned and primed before installation.

K. The finish coat on all WORK shall be applied after all concrete, masonry, and equipment installation is complete and the WORK areas are clean and dust free.

3.13 CURING OF COATINGS

A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

C. **Forced Air Ventilation of Steel Reservoirs and Enclosed Hydraulic Structures:** Forced air ventilation is required for the application and curing of coatings on the interior surfaces of enclosed hydraulic structures. During application and curing periods continuously exhaust air from the lowest level of the structure using portable ducting. After all interior coating operations have been completed provide a final curing period for a minimum of 10 days, during which the forced ventilation system shall operate continuously.

3.14 TESTING FOR VOLATILE ORGANIC COMPOUNDS IN POTABLE WATER RESERVOIRS

A. **General**: The CONTRACTOR shall provide the following services to ensure that the interior reservoir coatings or linings do not convey volatile organic compounds to the potable water.

B. **Selection of Coating or Lining Material**: The CONTRACTOR shall provide a coating or lining system that has a successful record in meeting the national, regional, and local regulations and policies pertaining to leaching of volatile organic compounds into potable water.

C. Before the coating or lining materials are used, the CONTRACTOR shall by letter notify the regulatory agency having jurisdiction. The letter shall describe the proposed materials, including brand names, catalog numbers, catalog technical data, application and curing instructions, and material safety data sheets.

D. The CONTRACTOR shall provide curing time, temperature and ventilations as required by the manufacturer or this Section, whichever is the more stringent requirement. In some cases, the CONTRACTOR may find it necessary to extend the curing time or ventilation time beyond the requirements in order to comply with the regulatory agency requirements or to reduce the leached organic compounds to the required levels. All costs in connection with any extended curing times required for curing shall be at no additional cost to the OWNER.

E. Following the curing or ventilation period, the CONTRACTOR shall clean, disinfect and fill the reservoir as specified.

F. A 7-day soaking period shall follow initial filling to determine the presence of any leached organics. Before the tank is placed into service, samples of the water in the tank will be taken by the CONSTRUCTION MANAGER and analyzed by a laboratory approved by the State of California or the EPA. Analyses will be for volatile organic compounds by EPA Method 524.1 - Volatile Organic Compounds in Water by Purge and Trap Gas Chromatography/Mass Spectrometry or 524-2 or equivalent (this test includes TCE, PCE, xylenes, toluene, ketones, carbon tetrachloride, and similar compounds).

G. If the test results are above either (1) 0.005 mg/l for TCE, 0.004 mg/l for PCE, 0.62 mg/l for xylenes, 0.10 mg/l for toluene, 0.75 mg/l for methyl-ethyl ketone (to be used as representative for all ketone compounds), 0.005 mg/l for carbon tetrachloride, or (2) the regulatory agency's recommended Action Level Limits, whichever is less, the CONTRACTOR shall drain the water from the tank and flush, refill, and retest at no additional cost to the OWNER. The CONTRACTOR shall provide as many curing, soaking, and flushing cycles as necessary to reduce the leached volatile organic compounds to levels below the requirements.

3.15 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 15030, "Piping Identification Systems."

B. Every valve or connection, where it may be possible for a worker to be exposed to a hazardous substance, shall be labeled per General Industry Safety Orders, Article 112 and 5194.

C. All unburied pipe in structures and in chemical pipe trenches shall be color-code painted. Colors shall be as selected by the CONSTRUCTION MANAGER, or as indicated.

3.16 COATING SYSTEM SCHEDULES - FERROUS METALS

A. **Coating System Schedule, Ferrous Metal - Not Galvanized:**

	Item	Surface Prep.	System No.
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC-SP6	(1) alkyd enamel
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC-SP6	(4) aliphatic polyurethane
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Near white metal blast cleaning SSPC-SP10	(5) inorganic zinc/polyurethane
FM-2	(NOT USED)		
FM-3	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in potable water or utility water, including all surfaces lower than 2 feet above high water level and all surfaces inside enclosed hydraulic structures and vents (excluding shop-coated valves, couplings, pumps).	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-4	Surfaces exposed to high temperature (between 150 and 600 degrees F).	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-5	Surfaces exposed to high temperature (between 600 and 1000 degrees F).	Near white metal blast cleaning SSPC-SP10	(3) aluminum silicone resin
FM-6	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FM-7	Where indicated, ferrous surfaces in water passages of all valves 4-inch size and larger, exterior surfaces of submerged valves.	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-8	Where indicated, ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge	White metal blast cleaning	(100) amine-cured epoxy

	Item	Surface Prep.	System No.
	size of 4 inches or larger.		
FM-9	Ferrous surfaces of sleeve-couplings.	Solvent cleaning SSPC-SP1, followed by near-white metal blast cleaning SSPC-SP5	(106) fusion-bonded epoxy
FM-10	All ferrous surfaces of sluice gates, flap gates, and shear gate, including wall thimbles.	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-11	Buried surfaces that are not indicated to be coated elsewhere.	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-12	(NOT USED)		
FM-13	(NOT USED)		
FM-14	Structural steel, miscellaneous metalwork, and supports for prefabricated metal buildings	Per FM-1	Per FM-1
FM-15	Structural steel, miscellaneous metalwork, and supports for roof and facia support systems for buildings	Per FM-1	Per FM-1
FM-16	Surfaces of indoor equipment, not submerged.	Commercial blast cleaning SSPC-SP6	(8) epoxy, equipment
FM-17	Existing equipment.	Minimum preparation shall be the manufacturer's requirements for service preparation or per SSPC-SP2, hand tool cleaning removal of loose rust, mill scale, and loose paint, by hand chipping, scraping, sanding and wire brushing; not all mill scale, rust and paint may not be removed by this process, but loose mill scale, loose rust, loose paint and other detrimental foreign matter present shall be removed.	Prime and Recoat per FM-1 requirements
FM-18	Buried pipe couplings, valves, fittings, and flanged joints	Removal of dirt, grease, oil	(201) rich Portland cement mortar

	Item	Surface Prep.	System No.
	(where piping is plastic).		
FM-19	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including epoxy-coated surfaces.	As specified by reference specification	As specified by reference specification
FM-20	Buried pipe couplings, valves, and flanged joints (where pipe is mortar-coated steel or reinforced concrete), including epoxy-coated surfaces.	Removal of dirt, grease, oil	(206 cement-mortar coating

B. **Coating System Schedule, Ferrous Metal - Galvanized:** Pretreatment coatings, barrier coatings, or washes shall be applied as recommended by the coating manufacturer. All galvanized surfaces except for the following items shall be coated unless coating is required by other Sections: (1) Floor gratings and frames, (2) Handrails, (3) Stair treads, (4) Chain link fencing and appurtenances.

	Item	Surface Prep.	System No.
FMG-1	All exposed surfaces indoors and outdoors, except those included below.	Solvent cleaning SSPC-SP1	(1) alkyd enamel
FMG-1	All exposed surfaces indoors and outdoors, except those included below.	Solvent cleaning SSPC-SP1	(4) aliphatic polyurethane
FMG-2	(NOT USED)		
FMG-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FMG-4	Buried miscellaneous surfaces, couplings, valves, and flanged joints.	Removal of dirt, grease, oil	(201) rich Portland cement mortar
FMG-5	Indoor sheet metal flashings, exposed ducts.	Solvent cleaning SSPC-SP1	(1) alkyd enamel
FMG-6	Surfaces buried or submerged in water or wastewater, including all	Solvent cleaning SSPC-SP1 followed by brush-off grade blast cleaning SSPC-SP7	(100) amine-cured epoxy

	Item	Surface Prep.	System No.
	surfaces lower than two feet above high water level and all surfaces inside enclosed hydraulic structures and vents.		

C. **Coating System Schedule, Steel Water Reservoir Interior**: (NOT USED)

D. **Coating System Schedule, Steel Digester Floating Covers and Digester Gasholders:** (NOT USED)

E. **Coating System Schedule, Interior Surfaces of Welded Steel Tanks:** As specified by reference specification.

3.17 COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBER GLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, the CONTRACTOR shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	**Surface Prep.**	**System No.**
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPC-SP1	(1) alkyd enamel
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPC-SP1	(4) aliphatic polyurethane
NFM-2	(NOT USED)		

	Item	**Surface Prep.**	**System No.**
	Item	**Surface Prep.**	**System No.**
NFM-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC-SP1	(208) aluminum metal isolation
NFM-4	Polyvinyl chloride plastic piping, indoors and outdoors, or in structures, not submerged.	Solvent cleaned SSPC-SP1	(7) acrylic latex
NFM-5	Fiber glass surfaces.	Per Paragraph 3.9	(12)

			aliphatic polyurethane-fiber glass
NFM-6	Buried non-ferrous metal pipe.	Removal of dirt, grease, oil	(200) PVC tape

3.18 COATING SYSTEM SCHEDULE-CONCRETE

	Item	**Surface Prep.**	**System No.**
C-1	Exposed indoors and outdoors, as shown.	Per Paragraph 3.8	(10) acrylic, concrete
C-1	All surfaces indoors and outdoors, as indicated.	Per paragraph 3.8	(11) aliphatic polyurethane, concrete
C-2	Submerged in water or wastewater including surfaces up to 2 feet above high water line and down to 2 feet below low water line and all surfaces in an enclosed structure, as shown.	Per Paragraph 3.8	(108) epoxy, concrete
C-2	Submerged in wastewater including surfaces up to 2 feet above high water line and down to 2 feet below low water line and all surfaces in an enclosed structure, as shown.	Per Paragraph 3.8	(112) vinyl ester, concrete
C-3	Floor slab, exposure to chemicals, as shown.	Per Paragraph 3.8	(203) epoxy surfacing
C-4	Wall, floors, exposure to chemical splash, washdown, as indicated.	Per paragraph 3.8	(11) aliphatic polyurethane concrete
C-5	Interior surfaces of sewer manholes, including bottom, and metal appurtenances, for manholes indicated.	Per Paragraph 3.8	(12) vinyl ester, concrete

3.19 COATING SYSTEM SCHEDULE-CONCRETE BLOCK MASONRY (Not Used)

SECTION 11000 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing general requirements for the WORK of applicable Sections of these Specifications. Unless there are more restrictive requirements in the individual Sections, the provisions of this Section shall apply.

B. The WORK of this Section applies to the WORK of the following Sections:

1 Equipment in Divisions 11, 13, 15 and 16.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 01640 Seismic Design of Equipment and Equipment Anchorage
2 Section 05500 Miscellaneous Metalwork
3 Section 09800 Protective Coating
4 Section 11002 Equipment Supports, Grouting and Installation
5 Section 13300 Instrumentation and Control
6 Section 13350 Commissioning
7 Section 16030 Electrical Tests
8 Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Mechanical Code (UMC)
2. Uniform Plumbing Code (UPC)
3. Uniform Fire Code (UFC)
4. National Electrical Code (NEC)
5. Uniform Building Code (UBC)

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the applicable standards of the following organizations apply to the WORK of this Section:

1. American Society for Testing and Materials (ASTM)
2. American Public Health Association (APHA)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineers (ASME)
5. American Water Works Association (AWWA)

6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
7. American Welding Society (AWS)
8. National Fire Protection Association (NFPA)
9. National Electrical Manufacturers Association (NEMA)
10. Antifriction Bearing Manufacturers Association (ABMA)
11. American Gear Manufacturers Association (AGMA)

B. The current editions of the following apply to the WORK of this Section:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ANSI A 58.1	Minimum Design Loads for Buildings and Other Structures
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ANSI/NFPA 70	National Electrical Code

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted unless specifically mentioned elsewhere in these specifications:

1. Manufacturer's product data including catalogue cuts.

2. Equipment name, identification number and specification numbers.

3. Shop drawings showing details, dimensions, anchorage details, and installation of equipment with all special fittings, appurtenances and required clearances.

4. Shipping weights.

5. Calculations of equipment anchorage forces and anchorage details.

6. Certification that the single manufacturer accepts the indicated unit responsibilities.

7. Parts list with materials of construction by ASTM reference and grade.

8. List of at least 5 installations and telephone numbers, where identical equipment has been used.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's catalog including installation instructions.

2. Manufacturer's operating and maintenance procedures including lubricating instructions.

3. Manufacturer's certification that products comply with the indicated requirements.
4. Bearing L-10 life calculations.

5. Certification that products have been factory-tested and found to conform with the contract requirements.

6. Certification that the WORK has been field-tested and the WORK complies with the indicated requirements.

7. Equipment tolerances

8. Electrical data including control and wiring diagrams.

9. Address and telephone number of local service representative.

1.7 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** An authorized service representative of the manufacturer shall visit the site and witness the following:

1. Installation of the equipment.

2. Inspection, checking, and adjusting the equipment.

3. Startup and field-testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with the Specifications.

B. **Instruction of OWNER'S Personnel**:

1. An authorized service representative of the manufacturer shall instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Training shall be specific to the models of equipment provided.

2. The representative shall have at least one year of qualified knowledge in training covering the relevant subjects described in paragraph 11000-1.7B.1. A resume for the representative shall be submitted to the CONSTRUCTION MANAGER.

3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.

4. Proposed training material and a detailed outline of each lesson shall be developed and submitted to the CONSTRUCTION MANAGER for review. Comments from the CONSTRUCTION MANAGER shall be incorporated into the material.

5. Training materials shall remain with the trainees.

6. The OWNER may videotape the training sessions for later use with the OWNER'S personnel.

C. **Local Service:** The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

1.8 FACTORY INSPECTION AND TESTING

A. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture.

1.9 FIELD TESTING

A. **Testing:** Products shall be field-tested for compliance with the indicated requirements.

B. **Witnesses:** The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness field tests.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer. Materials delivered onsite without an approved submittal for verification shall be rejected and payment withheld.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

C. **Protection of Equipment**: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weather tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings. Gears and bearings to be stored for extended periods shall be containerized suitable for export shipment.

D. **Investigation of Failed Products:** Prior to disposal of failed products, the CONTRACTOR shall investigate the causes of failure and submit a report to the CONSTRUCTION MANAGER, who will subsequently direct the CONTRACTOR for disposal.

1.11 UNIT RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a unit by the manufacturer of the driven equipment. The manufacturer of the driven equipment shall assume the unit responsibility. Unless otherwise indicated, the CONTRACTOR shall cause each system component to be furnished by the manufacturer with unit responsibility. The extent of the manufacturer’s responsibilities shall include engineering the specified equipment, preparation of all submittal materials, coordinating manufacture and procurement, compatibility and shipment of

all specified components, design of all equipment supports, providing installation and testing specialists to assist the CONTRACTOR in completing the installation and commissioning the equipment, furnishing factory certified specialists to train the OWNER's staff, and the production and submission of specified operation and maintenance manuals. The CONTRACTOR is responsible to the OWNER for performance of all systems as indicated. The CONTRACTOR shall ensure the submittal of a Certificate of Unit Responsibility signed by the manufacturer with unit responsibility.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **General:** Only products meeting the indicated requirements shall be provided.

B. **Manufacturers:** Products shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. **Products:** Materials shall be suitable for the intended purpose and free of defects and shall be recommended by the manufacturer for the application indicated.

D. **No Endorsement**: The listing of a manufacturer shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the indicated requirements. No preference is implied by the order of listing of named manufacturers, and the listings are not intended to be comprehensive. The manufacturer listings are only an indication that the OWNER and DESIGN CONSULTANT believe that the named manufacturers are capable of producing equipment and products which will satisfy the indicated requirements.

2.2 GENERAL REQUIREMENTS

A. **Noise Level:** When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure.

B. **Service Factors:** Service factors shall be applied in the selection and design of mechanical power transmission components where so indicated in individual Sections. When not indicated there, minimum service factors shall be 1.25.

C. **Welding:** Except as otherwise indicated, welding shall comply with ANSI/AWWA D100 and AWWA C206 and the following:

1. Composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds and shall prevent entrance of air or moisture.

2. Welding shall be by the metal-arc method or gas-shielded arc method described in the American Welding Society's "Welding Handbook" as supplemented by other AWS standards. Qualification of welders shall comply with AWS Standards.

3. In assembly and during welding, the component parts shall be clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall comply with the AWS code. Upon completion of welding, weld splatter, flux, slag, and

burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

D. **Identification of Equipment Items:** Each item of equipment shall have an indelible, legible identifying mark corresponding to the equipment number indicated.

E. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the shop drawings.

F. **Tolerances:** The variation in length of members without machine finished ends and which are to be framed shall not exceed 1/16-inch for members 30 feet or less and shall not exceed 1/8-inch for members over 30 feet.

G. **Machine Finish:** The type of finish shall be the most suitable for the application in micro-inches complying with ANSI B46.1. The following finishes shall be used:

1. Surface roughness of surfaces in sliding contact shall not exceed 63 micro-inches.

2. Surface roughness shall not exceed 250 micro-inches except where a tight joint is indicated.

3. Surface roughness for other mechanical parts shall not exceed 500 micro-inches.

4. Surface roughness of contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall not exceed 32 micro-inches.

H. **Seismic Design:** The seismic design of equipment shall be based on the horizontal peak ground acceleration in accordance with California Building Code 2016 (CBC). Unless otherwise indicated, Occupancy Category shall be III, and seismic design importance factors shall be Ip = 1.5 in accordance with Table 11.5-1 per ASCE7 latest edition. Determination of seismic forces and load combinations shall follow procedures in the ASCE7 latest edition, Chapter 13.

2.3 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. **Equipment Supports:** Equipment supports, anchors, and restrainers shall be designed for static, dynamic, wind, and seismic loads per Section 01640.

B. **Equipment Foundations:** Unless otherwise indicated, equipment foundations shall conform to the requirements of Section 11002.

2.4 PIPE HANGERS, SUPPORTS, AND GUIDES

A. Pipe connections to equipment shall be supported, anchored, and guided to minimize stresses and loads on equipment flanges and equipment. Supports and hangers shall comply with the requirements of Section 15020.

2.5 FLANGES AND PIPE THREADS

A. Flanges on equipment shall comply with ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B1.20.1.

2.6 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to minimize shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.

B. The equipment manufacturer shall recommend the size and type of coupling required for each specific application.

C. Taper-lock bushings may be used where indicated.

D. Where universal type couplings are indicated, they shall be of the needle bearing type construction, equipped with commercial type grease fittings. Bearings shall be sized in accordance with ABMA 11, using a 1.25 service factor, for the same L-10 life expectancy as the driven equipment, but not less than 50,000 hours.

2.7 FLEXIBLE CONNECTORS AND DUAL PIPE COUPLINGS

A. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment in accordance with the requirements of the ANSI B31.1.

B. Dual pipe couplings, separated by an 18-inch pipe spool unless otherwise indicated, shall be installed on the suction and discharge of all pumps - inboard of the isolation valves. Dual pipe couplings, separated by not less than two pipe diameters nor more than 5 feet, shall be installed on all piping where it exits a structure. Couplings shall be restrained where required. Dual flexible pipe joints may be used where indicated in buried pipe applications in lieu of dual pipe couplings. Flexible connectors are not permitted where dual pipe couplings are specified.

2.8 INSULATING CONNECTIONS

A. Insulating bushings, unions, couplings, and flanges, shall comply with the requirements of Section 15000.

2.9 GASKETS AND PACKINGS

A. Gaskets shall comply with the requirements of Section 15000.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer.

2.10 TOOLS AND SPARE PARTS

A. **Tools:** The WORK includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. **Spare Parts**: All equipment shall be furnished with the manufacturers' recommended spare parts, as indicated in the individual equipment Sections.

Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.11 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.12 ANCHOR BOLTS, NUTS AND WASHERS

A. Unless otherwise indicated, anchor bolts, nuts and washers for anchoring equipment to foundations and connecting bolts for equipment assemblies supported by other assemblies shall conform to the requirements of Section 05500. Unless otherwise specified, the CONTRACTOR shall provide Type 316 stainless steel anchor bolts and washers, and Type 416 stainless steel or other corrosion resistant, non-galling alloy nuts. In ferrous chloride and ferric chloride containment areas, unless otherwise specified, provide Hastelloy C or Alloy 276 anchor bolts, nuts, washers and connecting bolts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. **General:** Products and equipment shall be installed in accordance with the manufacturer's written installation instructions, the requirements of this Section, the requirements of the individual equipment specifications, and as indicated.

3.2 COUPLINGS

A. Couplings shall be installed in accordance with the manufacturer's installation instructions.

3.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. Hangers, supports, and guides shall be installed in compliance with ANSI/ASME B31.1 and with Section 15020.

3.4 BOLTS AND MISCELLANEOUS METALS

A. Bolts, including anchor bolts, and miscellaneous metals shall comply with paragraph 11000-2.20 and Section 05500. Installation of equipment anchor bolts shall comply with Section 11002.

3.5 PACKAGED EQUIPMENT

A. When any system is provided as pre-packaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.6 PROTECTIVE COATING

A. Equipment shall be painted and coated in accordance with Section 09800. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

**** END OF SECTION ****

SECTION 11002 - EQUIPMENT SUPPORTS, GROUTING AND INSTALLATION

PART 1--GENERAL

1.1 WORK OF THIS SECTION

A. This Section specifies minimum requirements for equipment supports, including concrete housekeeping pads, equipment bases, supports, anchorage, and accessories with weights greater than 200 pounds. If conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.

B. The CONTRACTOR shall provide all supports, anchorage, and mounting of all equipment, unless otherwise specified in accordance with the manufacturers recommendations, and requirements of industry standards. Each piece of equipment shall be anchored to resist the greater of the maximum lateral and vertical forces required by the local governing code or by the manufacturer of the equipment, whichever is greater. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the CONSTRUCTION MANAGER. The CONTRACTOR shall provide all elements required to resist the calculated forces described herein or required by the equipment manufacturer. The CONTRACTOR shall provide certification that for equipment, 20 horsepower and larger, anchor bolt calculations showing adequacy of bolt sizing and anchor embedment have been performed and signed by a registered structural or civil engineer.

1.2 SPECIFICATIONS AND STANDARDS

A. This Section contains references to the following documents. It is a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM C531	Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings.
ASTM C579	Compressive Strength of (Method/B) Chemical Resistant

Reference	Title
	Mortars and Monolithic Surfacings.
ASTM C638	Tensile Properties of Plastics.
ASTM C882	Bond Strength of Epoxy-Resin Systems Used with Concrete
ASTM C884	Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C1181	Creep of Concrete in Compression
ASTM D2471	Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins
SSPC	Society for Protective Coatings Specifications, Vol. 2

1.3 SHOP DRAWINGS AND SAMPLES

A. The following information shall be submitted:

1. Shop drawings for all equipment bases and anchorage details.

2. Certification of anchor bolt calculations specified in paragraph 11002-1.1 B.

3. Machine and equipment base installation schedule with manufacturers' anchor bolt torque requirements, as specified in paragraph 11002-2.1.

4. Results of grout strength tests, as specified in paragraph 11002-3.2 E.

PART 2--PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on concrete housekeeping pads. All equipment shall be mounted on concrete housekeeping pads. Under no circumstances shall equipment supports be grouted directly to concrete slabs or floors. Bases for equipment shall be hot-dip galvanized after fabrication unless otherwise specified. Mounting pads for equipment shall have the zinc layer removed and shall be finished flat and parallel after galvanizing. Sole plates and leveling plates shall not be galvanized. Machined surfaces shall be protected with two layers of duct tape after machining and before shipment from the factory.

B. Prior to initiating any installation efforts, the CONTRACTOR shall produce a machine base schedule containing the expected dates for setting anchor bolts, casting housekeeping pads, preparation of housekeeping pads for grouting, grouting, and final anchor bolt clamping for each item of equipment. The schedule shall list the equipment, by equipment number, and shall be accompanied by written verification of anchor bolt clamping torque from the equipment manufacturer.

C. Installation practices shall follow the guidance presented in Chapters 4 and 5 of API Recommended Practice 686, unless superseded by more restrictive requirements of these specifications or manufacturer requirements.

2.2 CONCRETE HOUSEKEEPING PADS

A. Concrete housekeeping pads for equipment and floor penetrations shall be at least 2 inches larger in plan than the steel or cast base and not less than 4 inches above the finished floor elevation, and shall be shaped to drain liquids away from the base. Housekeeping pad details shall follow the requirements set forth on MWWD Standard Detail M-114A unless superseded by more restrictive requirements of these specifications or the requirements of the equipment manufacturer. All conduits, piping connections, drains, etc., serving the equipment, shall be enclosed by the concrete pad. Unless otherwise specified, no conduits, piping connections, drains, etc., will be accepted which rise directly from the floor.

2.3 EQUIPMENT BASES

A. **General**

1. Unless otherwise specified, mounting bases for equipment 20 horsepower and larger shall be a minimum of 1 inch thick. All bases shall have edges bearing on the grout surface rounded to a radius of not less than 2 inches to avoid producing stress risers on the grouted foundation. Grout pouring holes shall be provided in all bases and all bases shall have grout release holes. Except where vibration isolation systems are specified, all bases shall be grouted as specified in this Section. Internal stiffeners shall be provided and shall be designed to allow free flow of grout from one section of the base to another. The minimum acceptable opening in cross-bracing and stiffeners shall be 2 inches high by 6 inches in length. All welds shall be continuous and free from skips, blow holes, laps and pockets.

2. Mounting holes for anchor bolts in the bases shall be drilled and not burned out and they shall not be open slots. All mounting studs shall be Type 316 stainless steel. Anchor bolts shall be as specified under paragraph 11002-2.6. A non-seize or non-galling compound shall be used on all threads.

3. Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar to 0.002 inch in all directions. Mounting pads shall extend not less than 1 inch on all sides beyond the position for the equipment.

4. Equipment bases - for vertical volute-type pumps weighing more than 2000 pounds - shall be soleplates or leveling boxes under individual feet or support brackets integral with the volute casting. Direct mounting of the volute on housekeeping pads will not be permitted. Sole plates, mounting blocks and baseplates weighing more than 1000 pounds shall be leveled with jackscrews incorporated into the fabrication. Jackscrews shall be located in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

5. Sole plates, mounting blocks and baseplates weighing more than 1000 pounds shall be leveled with jackscrews incorporated into the fabrication. Jackscrews shall be located in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

6. The seismic design of equipment bases shall conform to the requirements of paragraph 11000-2.2J.

2.4 GROUT FOR EQUIPMENT BASES

A. **Epoxy Grout:**

1. Unless otherwise specified, grout for equipment bases shall be non-shrinking epoxy grout conforming to the following requirements:

Test	Result
ASTM C531	Shrinkage shall be less than 0.080% and thermal expansion less than 17 x 10^{-6} in/in/^{o}F
ASTM C579	Strength shall be a minimum of 12,000 psi in 7 days when tested by method B, modified.
ASTM C882	Bond strength to Portland concrete shall be greater than 2000 PSI
ASTM C884	Epoxy grout shall pass the thermal compatibility test when overlaid on Portland cement concrete
ASTM D638	Tensile strength shall not be less than 1700 psi. Modulus of elasticity shall not be less than 1.8 x 10^{6} psi
ASTM C1181	Creep of the epoxy grout shall be less than 0.005 in/in with the test at 70^{o}F and 140^{o}F with a load of 400 psi
ASTM D2471	Peak exothermic temperature shall not exceed 110^{o}F when a specimen 6 inch diameter x 12 inches high is used. Gel time shall be a least 150 minutes

2. The vehicle shall be a two-component (liquid and hardener) system designed to yield the above characteristics when combined with the manufacturer's recommended aggregate system. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperature as high as 150 degrees F, with a load of 1200 psi. Aggregate for equipment base grout shall be as furnished by the manufacturer of the epoxy grout mix.

B. **Cementitious Grout**

1. Cementitious grout for use with equipment supports for equipment rated 5 horsepower and smaller or weighing less than 1000 pounds, whichever is less, shall be non-shrink grout as specified in Section 03315. Procedures for leveling and clamping equipment shall be as specified in this Section.

2.5 EPOXY PRIMER

A. The epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

2.6 ANCHOR BOLTS

A. Anchor bolts shall be as specified in paragraph 11000-2.20, set in PVC sleeves. Sleeves shall allow a free length projection of not less than fifteen bolt diameters above the concrete required to develop the strength of the bolt. Projection above the nut on the baseplate or soleplate shall be no more than 3/4 inch. Anchor bolts shall be located not less than 6 anchor bolt diameters from the foundation edge in all directions.

PART 3--EXECUTION

3.1 GENERAL

A. Equipment that is not mounted on vibration isolators shall be anchored directly to the supporting floor system. In addition to the anchorage, all such equipment shall be internally designed so that all static and moving parts are anchored to the supporting framework to resist all imposed forces. All forces shall be transmitted to the base in order to be anchored as required.

B. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections. Where the equipment manufacturer requires a rigid connection between the machine and connecting piping systems (generally, this will be higher discharge head pumps), the flexible coupling shown may be deleted and the CONTRACTOR shall install the equipment in the following manner:

1. The equipment housekeeping pad shall be prepared as specified under paragraph 11002-3.2 B.

2. The baseplate, soleplate or leveling blocks supporting the equipment shall be installed, leveled, and grouted in place as specified.

3. The equipment shall be installed, aligned and doweled in place as specified.

4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding on the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.

5. All piping shall be fully supported by supports designed to accept their full weight.

6. The final sections of pipe shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.

7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the CONSTRUCTION MANAGER.

C. Conduit and piping for future equipment shall be capped flush with the floor or concrete pad in such a manner to allow future connection.

D. The CONTRACTOR shall coordinate location of electrical conduit and piping penetrations within the concrete pad and equipment base. All penetrations shall stub-up on the same side of the equipment as required for connection to the equipment. Equipment drains shall be located as required for drainage from equipment.

E. Prior to commencing equipment installation WORK, the CONTRACTOR shall cause the manufacturer of the epoxy grout to be used for equipment installation to conduct a training school for the workmen to be using the product. The school shall be not less than 4 hours in length and shall cover all aspects of using the products from mixing to application. This requirement, however, shall not be construed as relieving the CONTRACTOR of overall responsibility for this portion of the WORK.

3.2 INSTALLATION

A. **Anchor Bolts:**

1. Prior to concrete placement**,** anchor bolts shall be accurately set according to the manufacturer's foundation drawings and firmly secured to prevent shifting during concrete placement. Drilled in anchor bolts will not be accepted. The bolts shall be embedded in the structural concrete to develop the full strength of the bolt. Concrete in housekeeping pads cannot be used for this purpose. All anchor bolts shall be dimensionally checked against the foundation drawings for proper length, diameter, thread length, thread projection, etc., by a representative of the equipment manufacturer prior to placing concrete. Prior to placing concrete for the housekeeping pad, plastic sleeves shall be placed around each bolt to provide for minor adjustment of bolt position prior to grouting. Sleeves shall be filled with a pliable, nonbonding material such as silicon rubber or wax to prevent contact between the concrete or grout and the anchor bolt. Bolt threads and projections in the sleeves (refer to paragraph 11002-2.6) above the structural slab shall be protected in the sleeve by heavily greasing or waxing the threads and shank with paste wax and wrapping with plastic sheeting. The protective wrapping shall be firmly secured with tie wires. The protective wrapping shall be removed prior to placing the grout.

2. The equipment manufacturer shall recommend the size of the anchor bolts for the equipment and shall also furnish the recommended tightening torque for the nuts; however, the minimum size bolt shall be 3/4 inch for equipment rated 20 to 100 horsepower, 1 inch for equipment rated over 100 to 300 horsepower and 1-1/4 inches for 300 to 500 horsepower. Anchor bolts for equipment rated over 500 horsepower shall be as recommended by the manufacturer of the equipment and as approved by the CONSTRUCTION MANAGER.

B. **Concrete Housekeeping Pad Preparation:**

1. After the concrete is fully cured (sample cylinders, as specified in Section 03300, shall be taken and tested for all housekeeping pads supporting equipment weighing more than 1000 pounds), the housekeeping pad shall be chipped approximately 3/4 inch to 1 inch to remove all laitance and defective or weak concrete. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the foundation. Abrasive blast, bush-hammer, jack hammers with sharp chisels or needle gun preparation of concrete surfaces to be grouted are not acceptable. The amount of concrete removed shall be such that the final baseplate or soleplate elevation results in not less than 3 inches of grout between the surface of the housekeeping pad and lower baseplate flange or the underside of the soleplate.

2. All edges shall be chamfered 2 to 4 inches at a 45-degree angle. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the foundation shall be covered with protective plastic sheeting. The grout contact surface on the housekeeping pad shall be coated with one coat (not more than 5 mils) of catalyzed epoxy resin.

C. **Equipment Bases and Soleplates:**

1. All surfaces of equipment bases and soleplates to be in contact with epoxy grout shall be cleaned to SP-6 and shall be primed with epoxy primer within 8 hours of cleaning.

D. **Leveling and Shimming:**

1. All machinery shall be mounted and leveled by millwrights in accordance to the equipment manufacturer's requirements. Using precut stainless steel shims, the CONTRACTOR shall level the equipment baseplates, soleplates or mounting blocks against the anchor bolt nuts as per the manufacturer's requirements. The shims shall be placed so the tabs on the shims are easily accessible. A minimum of four shims per anchor bolt shall be used. The total shim thickness at each anchor bolt shall be at least 0.015 inch. Leveling shall be against anchor bolts prior to final grouting.

2. The CONTRACTOR shall level the equipment against the anchor bolt nuts to a tolerance required by the equipment manufacturer, if more stringent. Leveling equipment shall be precision surveying equipment. Machinists' spirit levels will not be permitted for leveling purposes for any base plate or equipment foundation with a plan dimension greater than 4 feet.

3. Leveling nuts may be used for mounting equipment weighing less than 500 pounds. The CONTRACTOR shall level the equipment against the anchor bolt nuts to a maximum tolerance of 0.0005 in./ft or as otherwise required by the equipment manufacturer, if more stringent. Anchor bolt nuts shall be only finger tight during the leveling process. Wedges will not be allowed and under no circumstances shall shims be used as permanent support under baseplates, soleplates or leveling plates.

E. **Grouting:**

1. Grout forms shall be built of minimum of 3/4-inch thick waterproof plywood and shall be securely braced (minimum brace size shall be 2 inches x 4 inches). Forms shall provide a minimum of 2-inch hydrostatic head above the final elevation of the grout to assist in flow during installation.

2. Forms must be coated with three coats of paste wax on all areas that will come in contact with the grout to prevent the grout from bonding to the forms. Forms shall be waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, grease, etc. Forms shall be liquid-tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers. Blockouts shall be provided at all shimming and leveling nut positions to allow removal of shimming equipment after the grout has cured. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound.

3. The 45-degree chamfer strip shall be located at the final elevation of the grout. The final elevation of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange. The top of the grout, on baseplates with solid sides and soleplates, shall be 1.0 inch above the bottom of the baseplate or the underside of the soleplate. The grout's final elevation shall not be so high as to bond the anchor bolt nut and washer.

4. The epoxy resin and hardener shall be mixed in accordance with the grout manufacturer's recommendations. Aggregate shall be slowly added to the mixer one bag at a time. The grout should be mixed only long enough to wet out all the aggregate. Grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids. The grout shall be placed in a manner that avoids air entrapment using a head box to pour grout into the grout holes. When the head box is moved to the next grout hole, a 6-inch high standpipe shall be placed over the grout hole and filled with grout. The CONTRACTOR shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate. Grout placement shall be continuous until all portions of the space beneath the baseplate or soleplate have been filled. Subsequent batches of grout shall be prepared so as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix. After the entire baseplate is full, 6-inch high standpipes shall be maintained over each grout hole, to continue purging of air. When the grout has started to take an initial set (determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.

5. A grout sample shall be taken for each piece of equipment to be grouted. The sample shall be placed in a cylinder of sufficient size to yield three 2-inch x 2-inch x 2-inch test samples. The samples shall be tagged with the equipment number and ambient temperature at the time of placement. The samples shall be tested in accordance with the manufacturer's recommendations. Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours. After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by an independent testing laboratory. The results shall be reported directly to the CONSTRUCTION MANAGER. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the CONSTRUCTION MANAGER.

F. **Completion:**

1. Upon acceptance by the CONSTRUCTION MANAGER and the equipment manufacturer's representative after the grout has reached sufficient strength, the shims shall be removed, and leveling nuts or jack screws backed off to allow the grout to fully support the equipment base, leveling block or soleplate. Removal of extended shimming material (direct mounted baseplates weighing 1000 pounds or less) shall be by sledge hammer, taking care not to damage the grout. Once shims have been removed, or jackscrews backed off, the anchor bolts shall be torqued, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer. Anchor bolts shall be torqued in increments of not more than 25 percent of final value in an alternating pattern to avoid stress concentration on the grout surface. Pockets for access to shims, or leveling nuts shall be filled with grout mix and pointed after the anchor bolts have been torqued to final values.

****END OF SECTION****

SECTION 11293 – SLUICE GATES

PART 1--GENERAL

1.1 WORK OF THIS SECTION

A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to install, ready for operation and field test electrical motor operator actuated gates and appurtenances as shown on the Contract Drawings and as specified herein.

B. The gates and appurtenances shall be supplied in accordance with the latest edition of AWWA C561 Standard for Fabricated Stainless Steel Slide Gates as modified herein. The allowable leakage rate for the stainless steel gates in this specification shall be 1/2 the allowable leakage listed in the latest revision of AWWA C561.

C. Gates installed in drinking water or water treatment applications shall be NSF/ANSI 61 certified. Provide manufacturer certification of conformance to this standard.

1.2 QUALITY ASSURANCE

A. Qualifications

1. Gates shall be manufactured in the USA.

2. The specification is based on the 900 Series Stainless Steel Gate as manufactured by Whipps, Inc. of Athol, Massachusetts or approved equal.

3. The gates and all related accessories including electrical actuators and controls shall be supplied by the UV Disinfection System supplier as an integrated package to the UV Disinfection system. This is to ensure proper integration of the gate operation control with the UV system.

1.3 SHOP DRAWINGS AND SAMPLES

A. The following information shall be submitted:

1. Complete description of all materials including the material thickness of all structural components of the frame and slide.

2. Installation drawings showing all details of construction, details required for installation, dimensions and anchor bolt locations.

3. Maximum bending stress and deflection of the slide under the maximum design head.

4. The location of the company headquarters and the location of the principle manufacturing facility. Provide the name of the company that manufactures the equipment if the supplier utilizes an outside source.

5. Design including calculations for the anchorage for the weir gates shall be performed by a California registered Civil and/or Structural Engineer and submitted to the City for approval.

PART 2--PRODUCTS

2.1 GENERAL

A. Gates shall be as specified herein and have the characteristics and dimensions shown on the Contract Drawings.

B. Leakage shall not exceed 0.05 gpm/ft of wetted seal perimeter in seating head and unseating head conditions.

C. The gate shall utilize self-adjusting seals. Due to the difficulty of accessing gates when they are in service, gates that utilize adjustable wedges, wedging devices or pressure pads are not acceptable.

D. All structural components of the frame and slide shall be fabricated of stainless steel having a minimum thickness of 1/4-inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

E. Slide gate frames shall be shipped fully assembled with the invert member welded to the side frames and the slide installed in the frame unless the overall width of the slide gate exceeds 96 inches or the overall height of the slide gate exceed 25 feet.

F. All welds shall be performed by welders with AWS D1.6 certification.

G. Finish: Mill finish on stainless steel. Welds shall be sandblasted to remove weld burn and scale. All iron and steel components shall be properly prepared and shop coated with a primer.

H. Materials:

Components	Materials
Frame Assembly and Retainers	Stainless Steel, Type 316L
Slide and Stiffeners	Stainless Steel, Type 316L
Stem	Stainless Steel, Type 316
Anchor Studs	Stainless Steel, Type 316
Fasteners and Nuts	Stainless Steel, Type 316, ASTM F593/F594
Invert Seal (Upward Opening Gates Only)	Neoprene or EPDM ASTM D2000
Seat/Seals and Facing	Ultra-High Molecular Weight Polyethylene ASTM D4020
Lift Nuts	Bronze ASTM B584
Pedestals and Wall Brackets	Stainless Steel, Type 316L, ASTM A240
Operator Housing	Cast aluminum or ductile iron

2.2 FRAME

A. The frame assembly, including the guide members, invert member and yoke members, shall be constructed of formed stainless steel plate with a minimum thickness of 1/4-inch.

1. Frame design shall allow for embedded mounting, mounting directly to a wall with stainless steel anchor bolts and grout or mounting to a wall thimble with stainless steel mounting studs and a mastic gasket material. Mounting style shall be as shown on the Contract Drawings.

2. All wall mounted or wall thimble mounted gates shall have a flange frame. Flat frame gates are not acceptable.

3. The structural portion of the frame that incorporates the seat/seals shall be formed into a one-piece shape for rigidity. Guide members that consist of two or more bolted structural members are not acceptable. Guide member designs where water loads are transferred through the assembly bolts are specifically not acceptable.

4. Gussets shall be provided as necessary to support the guide members in an unseating head condition. The gussets shall extend to support the outer portion of the guide assembly and shall be positioned to ensure that the load is transferred to the anchor bolts or the wall thimble studs.

5. The frame shall extend to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening gates or downward opening weir gates.

6. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by two structural members affixed to the top of the side frame members to provide a one-piece rigid assembly. The yoke shall be designed to allow removal of the slide. The Yoke shall be sized to withstand normal operating loads as well as the maximum hoist output. The Yoke deflection shall not exceed 1/360 of the gate width or a maximum of ¼" whichever is less at maximum operating load.

7. A rigid stainless steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flushbottom type on upward opening gates.

8. A rigid stainless steel top seal member shall be provided across the top of the opening on gates designed to cover submerged openings.

9. A rigid stainless steel member shall be provided across the invert of the opening on downward opening weir gates.

2.3 SLIDE

A. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of 1/4-inch.

1. The slide shall not deflect more than 1/720 of the span or 1/16 inch, whichever is smaller, under the maximum design head.

2. When the width of the gate opening in feet multiplied by the maximum design head in feet is greater than 80square feet the portion of the slide member that engages the guide shall be 1/2" thick. When the width of the gate opening in feet multiplied by the maximum design head in feet is greater than 120 square feet, the portion of the slide that engages the guide members shall be of a "thick edge" design. The thick edge portion of the slide shall have a minimum thickness of 2.5 inches.

3. Reinforcing stiffeners shall be welded to the slide and mounted horizontally. Vertical stiffeners shall be welded on the outside of the horizontal stiffeners for additional reinforcement. When required to maintain proper plate stress and deflection intermediate vertical gussets shall be provided. Appropriate safety factors shall be applied to the ultimate tensile and yield strength of the material.

4. The stem connector shall be constructed of two angles or plates. The stem connector shall be welded to the slide. A minimum of two bolts shall connect the stem to the stem connector.

2.4 SEALS

A. All gates shall be provided with a self-adjusting seal system to restrict leakage in accordance with the requirements listed in this specification.

1. All gates shall be equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide. Seat contact pressure shall not exceed 600 psi at the design head.

2. The seat/seals shall extend to accommodate the 1-1/2 x the height of the slide when the slide is in the fully closed or fully opened position.

3. All upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and it shall be held in place with stainless steel attachment hardware.

4. All downward opening weir gates shall be provided with UHMW polyethylene seat/seals across the invert member.

5. The seal system shall be durable and shall be designed to accommodate high velocities and frequent cycling without loosening or suffering damage.

6. All seals must be bolted or otherwise mechanically fastened to the frame or slide. Arrangement with seals that are force fit or held in place with adhesives are unacceptable.

7. The seals shall be mounted so as not to obstruct the water way opening.

8. Gates that utilize rubber "J" seals or "P" seals are not acceptable.

9. The seal system shall have been factory tested to confirm negligible wear (less than 0.01") and proper sealing. The factory testing shall consist of an accelerated wear test comprised of a minimum of 25,000 open-close cycles using a well-agitated sand/water mixture to simulate fluidized grit.

2.5 STEM

A. A threaded operating stem shall be utilized to connect the operating mechanism to the slide. On rising stem gates, the threaded portion shall engage the operating nut in the manual operator or motor actuator. On non-rising stem gates, the threaded portion shall engage the nut on the slide.

1. The threaded portion of the stem shall have a minimum outside diameter of 1-1/2 inches. Stem extension pipes are not acceptable.

2. The stem shall be constructed of solid stainless steel bar for the entire length, the metal having a tensile strength of not less than 75,000 psi.

3. The stem shall be threaded to allow full travel of the slide unless the travel distance is otherwise shown on the Contract Drawings.

4. Maximum L/R ratio for the unsupported part of the stem shall not exceed 200.

5. The operating stem shall be designed to transmit in compression at least 2 times the rated hoist output with an effort of 40 lb on the crank or handwheel. The Euler column formula shall be utilized. Where a hydraulic or electric actuator is used, the stem design load shall not be less than 1.25 times the output thrust of the hydraulic cylinder with a pressure equal to the maximum working pressure of the fluid supply or 1.25 times the output thrust of the electric actuator at the stalled condition.

6. The stem shall be designed to withstand the tension load caused by the application of a 40 lb effort on the crank or handwheel without exceeding 1/5 of the ultimate tensile strength of the stem material.

7. The threaded portion of the stem shall have machine rolled threads of the full Acme type with a 16 microinch finish or better. Stub threads are not acceptable.

8. Stems of more than one section shall be joined by stainless steel or bronze couplings. The coupling shall be bolted to the stems.

9. Stems, on manually operated gates, shall be provided with adjustable stop collars to prevent over closing of the slide.

2.6 STEM GUIDES

A. Stem guide shall be provided when necessary to ensure that the maximum L/R ratio for the unsupported part of the stem is 200 or less.

1. Stem guide brackets shall be fabricated of stainless steel and shall be outfitted with UHMW or bronze bushings.

2. Adjustable in two directions.

2.7 WALL THIMBLES

A. Wall thimbles shall be provided when shown on the Contract Drawings.

1. The wall thimble depth shall be equal to the thickness of the concrete wall in which the thimble is to be mounted.

2. Wall thimbles shall be fabricated stainless steel construction of adequate section to withstand all operational and reasonable installation stresses.

3. Wall thimbles shall be constructed of 1/4-inch minimum thickness stainless steel and the front face shall have a minimum thickness of 1/4–inch.

4. The fabrication process shall ensure that the wall thimble is square and plumb and the front face is sufficiently flat to provide a proper mounting surface for the gate frame.

5. The face of the wall thimble shall only be machined if recommended by the gate manufacturer. If the wall thimble is to be machined, the front face shall have a minimum thickness of 1/4-inch after machining.

6. A water stop shall be welded around the periphery of the thimble. Wall thimbles shall be designed to allow thorough and uniform concrete placement during installation.

7. Studs and nuts shall be stainless steel. Water stop may be stitch welded.

8. A suitable gasket or mastic shall be provided to seal between the gate frame and the wall thimble.

2.8 MANUAL OPERATORS

A. Unless otherwise shown on the Drawings, gates shall be operated by a manual handwheel or a manual crank-operated gearbox. The operator shall be mounted on the yoke of self contained gates or on the pedestal of non-self contained gates.

1. The gate manufacturer shall select the proper gear ratio to ensure that the gate can be operated with no more than a 40 lb effort when the gate is in the closed position and experiencing the maximum operating head.

2. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate.

3. Handwheel operators shall be fully enclosed and shall have a cast aluminum housing.

   a. Handwheel operators shall be provided with a threaded cast bronze lift nut to engage the operating stem.

   b. Handwheel operators shall be equipped with roller bearings above and below the operating nut.

   c. Positive mechanical seals shall be provided above and below the operating nut to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.

   d. The handwheel shall be removable and shall have a minimum diameter of 15 inches.

4. Crank-operated gearboxes shall be fully enclosed and shall have a cast aluminum or ductile iron housing.

    a. Gearboxes shall have either single or double gear reduction depending upon the lifting capacity required.

    b. Gearboxes shall be provided with a threaded cast bronze lift nut to engage the operating stem.

    c. Bearings shall be provided above and below the flange on the operating nut to support both opening and closing thrusts.

    d. Gears shall be steel with machined cut teeth designed for smooth operation.

    e. The pinion shaft shall be stainless steel and shall be supported on ball or tapered roller bearings.

    f. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.

    g. The crank shall be cast aluminum or cast iron with a revolving nylon grip.

    h. The crank shall be removable.

5. All gates having widths in excess of 72 inches and widths greater than twice their height shall be provided with two gearboxes connected by an interconnecting shaft for simultaneous operation.

    a. Interconnecting shafting shall be constructed of aluminum or stainless steel.

    b. Flexible couplings shall be provided at each end of the interconnecting shaft. Couplings shall be stainless steel or non-metallic.

    c. One crank shall be provided to mount on the pinion shaft of one of the gearboxes.

    d. If the operating assembly is motorized, a stainless steel enclosure shall be provided over the interconnecting shaft to comply with OSHA regulations.

6. An extended operator system utilizing chain and sprockets shall be furnished by the manufacturer when the centerline of the crank or handwheel, on a non-geared operator, is located over 48-in above the operating floor. Chain wheels are not acceptable.

    a. A removable stainless steel or aluminum cover shall be provided to enclose chain and sprockets.

    b. The extended operator system shall lower the centerline of the pinion shaft to 36-in above the operating floor.

    c. A handwheel may be utilized in conjunction with a gearbox in lieu of the extended operator system if the centerline of the pinion shaft is 60-in or less above the operating floor.

7. Pedestals shall be constructed of stainless steel. Aluminum pedestals are not acceptable.

    a. The pedestal height shall be such that the handwheel or pinion shaft on the crank-operated gearbox is located approximately 36-in above the operating floor.

b. Wall brackets shall be used to support floor stands where shown on the Drawings and shall be constructed of stainless steel.

c. Wall brackets shall be reinforced to withstand in compression at least two times the rated output of the operator with a 40 lb effort on the crank or handwheel.

d. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the ENGINEER. The gate manufacturer shall supply the bracket, anchor bolts and accessories as part of the gate assembly.

8. Operators shall be equipped with fracture-resistant clear butyrate or lexan plastic stem covers.

a. The top of the stem cover shall be closed.

b. The bottom end of the stem cover shall be mounted in a housing or adapter for easy field mounting.

c. Stem covers shall be complete with indicator markings to indicate gate position.

9. When shown on the Contract Drawings, provide 2 inch square nut, mounted in a floor box, with a non-rising stem.

a. The square nut shall be constructed of bronze.

b. The floor box shall be constructed of stainless steel or cast iron and shall be set in the concrete floor above the gate as shown.

c. Provide one aluminum or stainless steel T-handle wrench for operation.

2.9 ELECTRIC MOTOR ACTUATORS

A. See Section 15101 Valve and Gate Operators.

2.10 ANCHOR BOLTS

A. Anchor bolts shall be provided by the gate manufacturer for mounting the gates and appurtenances.

1. Quantity and location shall be determined by the gate manufacturer.

2. If epoxy type anchor bolts are provided, the gate manufacturer shall provide the studs and nuts.

3. Anchor bolts shall have a minimum diameter of 1/2-inch.

PART 3--EXECUTION

3.1 INSTALLATION

A. Installation of the gates and appurtenances shall be done in a workmanlike manner. It shall be the responsibility of the CONTRACTOR to handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's recommendations.

B. The CONTRACTOR shall review the installation drawings and installation instruction prior to installing the gates.

C. The gate assemblies shall be installed in a true vertical plane, square and plumb.

D. The CONTRACTOR shall fill the void in between the gate frame and the wall with non-shrink grout in accordance with the manufacturer's recommendations.

E. The CONTRACTOR shall add a mastic gasket between the gate frame and wall thimble (when applicable) in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation, all gates shall be field tested in the presence of the CONSTRUCTION MANAGER to ensure that all items of equipment are in full compliance with this Section. Each gate shall be cycled to confirm that they operate without binding, scraping, or distorting. The effort to open and close manual operators shall be measured, and shall not exceed the maximum operating effort specified above. Electric motor actuators shall function smoothly and without interruption. Each gate shall be water tested by the CONTRACTOR, at the discretion of the CONSTRUCTION MANAGER, to confirm that leakage does not exceed the specified allowable leakage.

3.3 MANUFACTURERS FIELD SERVICE

A. The CONTRACTOR shall provide for and coordinate with the CONSTRUCTION MANAGER to allow the manufacturer's field representative to train the operators on site. For bid purposes, a minimum of four hours of training shall be considered.

****END OF SECTION****

SECTION 11300 – ULTRA-VIOLET DISINFECTION SYSTEM

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK is to furnish all labor, materials, equipment and appurtenances required to provide an open channel, gravity flow, and low pressure high intensity ultraviolet lamp (UV) disinfection system complete with an automatic chemical/mechanical cleaning system and variable output lamp drivers. The UV system shall be complete and operational with all control equipment and accessories as shown and specified herein. This system shall be capable of disinfecting effluent to meet the water quality standards listed in this section. The system shall meet California Code of Regulations, Title 22 requirements for reclaimed water treatment.

The system to be installed by the CONTRACTOR and tested and commissioned by the UV system manufacturer, as specified in this section.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 01640 Seismic Design of Equipment and Anchorage
2. Section 03300 Cast-in-Place Structural Concrete
3. Section 05301 Aluminum Extruded Flat Covers
4. Section 11293 Sluice Gates
5. Section 13300 Instrumentation and Control
6. Section 13350 Commissioning
7. Section 16030 Electrical Tests
8. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Mechanical Code (UMC)
2. Uniform Plumbing Code (UPC)
3. Uniform Fire Code (UFC)
4. National Electrical Code (NEC)
5. Uniform Building Code (UBC)

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the applicable standards of the following organizations apply to the WORK of this Section:

1. American Society for Testing and Materials (ASTM)
2. National Water Research Institute (NWRI)

3. American National Standards Institute (ANSI)
4. United States Environmental Protection Agency (EPA)
5. American Water Works Association (AWWA)
6. California State Division of Drinking Water (DDW)

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Complete description in sufficient detail to permit an item comparison with the specification.

2. Dimensions and installation requirements.

3. Descriptive information including catalogue cuts and manufacturers' specifications for major components.

4. Electrical schematics and layouts.

5. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics.

6. Independent UV protocol and bioassay validation and dosage calculations demonstrating compliance with the specified RED requirements.

7. Lifetime disinfection performance guarantee.

8. Documentation of Conditional Acceptance of the prototype model unit by the California State DDW.

9. Certified Power Consumption rates by the manufacturer for the flow rates and transmittance listed later in this section.

10. Design of the anchorage system including seismic design. The design shall be prepared, sealed and signed by a California Registered Engineer.

1.6 WARRANTIES

A. Equipment: The equipment furnished under this section shall be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.

B. UV Lamps: The UV lamps shall be warranted for a minimum of 15,000 hours when operated in automatic mode, prorated after 9,000 hours. On/off cycles are limited to an average of four (4) per day accumulated over the guaranteed life of the lamp.

C. Lamp Drivers: Lamp drivers shall be warranted for 10 years, prorated after 1 year.

D. UV Intensity Sensors: UV Intensity Sensors shall be warranted for 5 years.

1.7 QUALITY ASSURANCE

A. **Pre-qualification Requirements:** Any alternate UV manufacturer that is not named or listed as approved equal must submit the following 15 days prior to the bid proposal due date to be considered for approval:

1. Provide documentation that the manufacturer and the proposed model have received Conditional Acceptance of a prototype model unit by the California State Department of Drinking Water.

2. For evaluation, the manufacturer shall submit a reactor (bioassay) validation report and calculation that was approved previously by CA DDW justifying the sizing for the proposed reactor, without exception. The bioassay will have been completed by an independent third party and have followed applicable sections and protocols described in the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (2012). The bioassay must demonstrate that the proposed UV system design and number of lamps will deliver the specified Reduction Equivalent Dose (RED) based on the water quality and operating conditions specified herein.

3. Independent certification of the lamp aging factor must be submitted if values other than the specified default values are being proposed. The lamp aging (or end-of-lamp-life) factor must be determined using the protocol described in the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse.

4. Independent certification of the fouling factor shall only be accepted if performed on the UV lamp and quartz sleeve combination equal to that being proposed by the UV manufacturer. The fouling factor must be conducted on municipal wastewater effluent using the protocol described in the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse.

5. Documentation of UV manufacturer's service capabilities including location and experience.

6. Sample of lifetime disinfection performance guarantee including scope and duration of guarantee.

7. Pre-qualification submittals from manufacturers shall include a complete and detailed proposal of equipment offered, including the number of lamps proposed, bioassay calculation and a detailed description of all exceptions taken to the specification.

8. Power consumption limits mentioned in this specification are met within +5% of the specified limits.

9. Trojan is a prequalified manufacturer. All other UV disinfection system manufacturers shall be required to pre-qualify.

B. **Design Criteria**:

1. Provide equipment that shall disinfect effluent with the following characteristics:

   a) Current Peak Flow: 15 MGD

   b) Average Flow: 6 MGD

   c) Total Suspended Solids: 5 mg/L Max value, 30 Day Average grab samples

   d) Effluent Temperature Range: 33 to 85 °F (1 to 30 °C)

   e) Ultraviolet Transmittance @ 253.7 nm: 62%, minimum

   f) Effluent standards to be achieved : 2.2 Total Coliform/100 ml based on a 7 day Median of daily samples for the effluent standard as specified in a) through f). Effluent standards shall be guaranteed regardless of influent count to UV system.

2. The UV system is to be installed in the existing open channel having the following dimensions (not including the water level controller):

   a) Width: 5.5 feet

3. The maximum effluent depth in the channel shall be 6.23 feet.

4. System configuration:

   a) The UV system configuration shall be as follows:

Number of Channels:	1
Number of Banks per Channel:	8 (7 duty, 1 redundant)
Lamps per Bank:	24
Total Number of Lamps in the UV System:	192
Number of System Control Centers:	1
Number of UV Sensors:	1 per bank
Number of Power Distribution Centers:	3
Number of Level Controllers:	1
Number of Modulating Weir Gates:	1

C. **Performance Requirements:**

1. Provide a UV disinfection system complete with UV Banks and lifting mechanism, System Control Center, Power Distribution Centers, and Water Level Controller as shown on the contract drawings and as herein specified.

2. The ultraviolet disinfection system shall produce an effluent conforming to the following discharge permit: 2.2 Total Coliform/100 ml, based on a 7 day Median. Grab samples shall be taken in accordance with the Microbiology Sampling Techniques found in *Standard Methods for the Examination of Water and Wastewater, 21st Ed.*

3. The UV system shall be designed to deliver a minimum MS2 RED of 100 mJ/cm^2 at peak flow, in effluent with a UV Transmission of 62% at end of lamp life (EOLL) after reductions for quartz sleeve fouling with the largest bank of lamps out of service. The basis for evaluating the RED will be the independent third party bioassay, without exception. Bioassay validation methodology to follow applicable protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (*2012).

4. The RED shall be adjusted using an end of lamp life factor of 0.5 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analysed in accordance with protocols described in the NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse*.

5. The RED will be adjusted using a quartz sleeve fouling factor of 0.8 to compensate for quartz sleeve transmission reduction due to wastewater effluent fouling. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analysed in accordance with protocols described in the NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse*. The data recorded for the determination of the validated fouling factor must be obtained by testing in secondary wastewater effluent utilizing the same lamp, quartz sleeve and cleaning system proposed by the UV manufacturer.

6. Independent validation for use of higher factors (lamp aging and sleeve fouling) must be submitted to the Engineer for consideration a minimum of fifteen (15) days prior to bid. The independent validation shall have oversight by a California registered professional engineer with knowledge and experience in testing and evaluation of UV systems as defined in the EPA UVDGM (Appendix C, Section C.3.3)

7. The system shall be designed for complete outdoor installation.

8. Power Consumption of the lamps only for the flows at the given UV transmittance and UV dosage shall meet the following within +5%.

Average Daily Flow (MGD)	Daily Power Consumed (KWH) by UV System Lamps for UV Transmittance = 62% and UV Dosage = 100 mJ/cm^2
3	875
6	1525
9	2280
15	3735

PART 2 -- PRODUCTS

2.1 GENERAL

A. General**:** Only products meeting the indicated requirements shall be provided.

B. Manufacturers**:** The ultraviolet disinfection system shall be TROJANUVSigna manufactured by Trojan Technologies or approved equal. The OWNER will consider alternates as equal only if treatment requirements and power consumption limits mentioned in this specification are met without exception. Also, the alternate UV manufacturer shall have to meet the Pre-Qualification requirements outlined in this section.

The physical layout of the system shown on the contract drawings and the equipment specified herein are based on the TrojanUVSigna system. As individual equipment layout varies from manufacturer to manufacturer, the layout and construction details will vary. If the CONTRACTOR opts to use alternate manufacturer's equipment, the CONTRACTOR shall be responsible for designing all the modifications to ensure proper installation of the equipment. The design shall be prepared, sealed and signed by a California registered Engineer experienced in this type of design. The design plans and calculations shall be submitted by the CONTRACTOR to the OWNER for review and approval. If other manufacturer's equipment is proposed, the CONTRACTOR shall demonstrate to the Engineer and the OWNER that all requirements of materials, performance, and workmanship have been met or exceeded by the equipment proposed. CONTRACTORs proposing alternate manufacturers shall be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation.

C. Products**:** Materials shall be suitable for the intended purpose and free of defects and shall be recommended by the manufacturer for the application indicated.

D. No Endorsement: The listing of a manufacturer shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product shall comply with the indicated requirements. No preference is implied by the order of listing of named manufacturers, and the listings are not intended to be comprehensive. The manufacturer listings are only an indication that the OWNER and DESIGN CONSULTANT believe that the named manufacturers are capable of producing equipment and products which shall satisfy the indicated requirements.

2.2 DESIGN, CONSTRUCTION AND MATERIALS

A. General:

1. All UV Bank metal components in contact with effluent shall be Type 316 stainless steel.

2. All wiring exposed to UV light shall be Teflon™ coated.

B. Lamp Array Configuration:

1. The lamp array configuration shall be in a staggered inclined arrangement.

2. The system shall be designed for complete submersion of the UV lamps under all flow conditions including both electrodes and the full length of the lamp arc.

3. To maximize performance and ensure safety, bank light locks shall be used in each bank to prevent potential short circuiting over the top of the lamps.

4. For any UV inclined system that does not contain UV bank light locks to prevent short circuiting, the system shall be supplied with 1 additional UV bank to compensate for short-circuiting over the top of the lamps.

C. UV Bank:

1. Each UV bank shall consist of UV lamps, quartz sleeves and an automatic chemical/mechanical cleaning system mounted in a Type 316 stainless steel frame.

2. Each lamp shall be enclosed in its individual quartz sleeve, one end of which shall be closed and the other end sealed by a lamp end seal. To be considered as an alternate, lamp quartz sleeves that are open at both ends shall be supplied with twice the amount of specified spare seals and lamps.

3. The closed end of the quartz sleeve shall be held in place by a retaining O-ring. The quartz sleeve shall not come in contact with any steel in the frame.

4. Each UV bank shall contain a pre-formed Type 316 stainless steel wall on each side to prevent possible short-circuiting at the side walls of the reactor.

5. Each UV bank shall contain light locks at the top of the bank to prevent short circuiting over the top of the lamps and maximize disinfection efficiency.

6. Each UV bank shall be rated Type 6P. UV banks that are not Type 6P rated are not acceptable.

7. To minimize maintenance, equipment must be provided by the UV manufacturer to enable lifting a complete bank of lamps from the channel at once for inspection and/or servicing.

D. UV Lamps:

1. Lamps shall be high intensity low pressure amalgam design. Lamps that are not amalgam shall not be allowed.

2. The filament shall be significantly rugged to withstand shock and vibration.

3. Electrical connections for the lamp shall consist of four (4) pins at one end of the lamp only. Lamp wiring shall be Teflon insulated stranded wire.

4. Lamps without maintenance coating or that do not have four (4) pins are considered instant-start and are not acceptable due to reduced reliability and increased maintenance and operating costs.

5. Lamps shall be rated to produce zero levels of ozone.

6. The lamp shall withstand an average of four (4) on/off cycles per day without reducing lamp life, warranty or causing any damage to the lamp.

7. Lamps shall be operated by electronic lamp drivers with variable output capabilities ranging from 30% to 100% of nominal power. The lamp assembly shall incorporate active filament heating to maintain a minimum lamp efficiency of 35% across varying water temperatures and between the minimum and maximum stated lamp power levels.

E. Lamp Plugs:

1. Each lamp plug shall be accessible from the top of the UV bank to facilitate lamp removal without moving the UV banks or any other components.

2. Optional: Each lamp plug shall have provisions for a light emitting diode (LED) visual indicator that indicates on/off status for each lamp.

3. An integral safety interlock in the lamp plug shall prevent removal of energized lamps.

4. The lamp plug shall be rated Type 6P.

F. Lamp Drivers:

1. Each lamp driver shall independently power two (2) UV lamps. Failure of one lamp shall not affect operation of the other lamp.

2. The lamp driver shall have a power factor correction circuit to ensure minimum 99% power factor and less than 5% total harmonic distortion (THD) current at the maximum power level and nominal input voltage.

3. The lamp driver electrical efficiency shall be minimum 95% at the maximum power level.

4. The lamp driver shall be programmed-start type utilizing filament preheat followed by a high voltage pulse to ignite the lamp.

5. During lamp operation, variable filament heating current shall be provided according to a predetermined curve to maintain optimum filament temperature and amalgam temperature to ensure maximum lamp life and maintain a minimum lamp efficiency of 35% across varying water temperatures and between the minimum and maximum stated lamp power levels.

6. A ground fault in the output circuit shall be detected and communicated as a warning to the external controls system while the corresponding lamp operates undisturbed.

7. The communication protocol shall be Modbus implemented on an RS485 electrical interface.

8. Local visual diagnostic shall be provided with LEDs for lamp driver status, lamp status (on, idle, preheat, fault), power and communication status.

9. For reliability and to facilitate trouble shooting, at a minimum, the following external indicators (protections, status, warnings and alarms) shall be provided: lamp status, driver status, ground fault, and communication time-out.

10. The lamp driver shall be UL, CE, and RoHS compliant.

G. Quartz Sleeves:

1. Quartz sleeves shall be clear fused quartz circular tubing containing 99.9% silicon dioxide.

2. Sleeves shall have minimum UV transmittance at 254nm of 87% (1mm wall thickness).

3. Sleeves shall be open at one end only and domed at the other end.

H. Cleaning System:

1. An automatic in-situ cleaning system shall be provided to clean the quartz sleeves using both chemical and mechanical methods. Wiping sequence shall be automatically initiated with capability for manual override.

2. The cleaning system shall also incorporate an integrated debris removal device to clear the quartz sleeves of any large solids or debris to maximize the life of the chemical/mechanical cleaning system.

3. The wiper on the cleaning system shall be parked out of the effluent when not in use.

4. Cleaning systems that utilize a screw drive or park the wiper in the effluent while not in use shall not be acceptable due to collection of debris in and around the wetted parts of the wiper.

5. The cleaning system shall be fully operational while UV lamps and modules are submerged in the effluent channel and energized.

6. To minimize maintenance, UV System shall be designed such that cleaning solution replacement can be performed while the UV Bank and lamps are in place and operational in the channel.

7. Cleaning sequence frequency shall be field adjustable to enable optimization with effluent characteristics.

8. Cleaning system operation shall be remote auto (default) or remote manual.

9. The cleaning system shall be provided with the required solutions necessary for initial equipment testing and for equipment start-up.

10. The wipers shall travel the full length of the UV lamp arc. Designs in which the wipers only travel part way along the sleeves shall not be acceptable.

11. The UV intensity sensor shall be cleaned utilizing the same chemical/mechanical cleaning method as that of the lamp quartz sleeves. UV intensity sensors that only utilize a mechanical means shall not be acceptable.

    To be considered as alternate, systems that use only mechanical wiping must have the ability to periodically be cleaned out of channel using a chemical bath. Out of channel cleaning shall include lifting slings, removable banks, cleaning tanks, agitation system and air compressors, as required. The UV manufacturer shall be responsible for supplying all equipment including any equipment not specifically listed required to perform out of channel chemical cleaning. Contactor shall be responsible for installation.

I. Effluent Level Controller (Water Level Controller):

1. Modulating Weir Gate

    a) Modulating Weir Gates (MWGs) shall be self-contained and shall be designed and manufactured by an experienced and reputable manufacturer, based on the AWWA C561 Standard for Fabricated Stainless Steel Slide Gates and AWWA C542 Standard for Electric Motor Actuators for Valves and Slide Gates in effect as of the date of this specification.

b) Modulating weir gates shall be designed to maintain the minimum channel effluent level required to keep lamps submerged at all times

c) MWGs shall be designed for the following performance criteria:

i. MWG actuation speeds shall be between 10" (255 mm) and 14" (356 mm) per minute.

ii. MWG maximum design rate of change of flow shall be limited to 25% of the Peak Design Flow/Channel per minute, or alternatively, flow shall be ramped up (zero to peak) or down (peak to zero) in no less than 4 minutes.

iii. MWG actuators shall employ AWWA S4-50% duty class motors with a rated minimum 900 starts per hour capability.

iv. MWG actuators shall employ AWWA Class B solid-state Thyristor based switchgear capable of at least 5,000,000 modulating steps before overhaul; electromechanical type actuators and controls shall not be permitted.

J. Light Locks

1. Light locks, two (2) per bank, shall be provided to force effluent through the UV treatment zone maximizing disinfection performance.

2. The entire length of the lamp arc shall remain submerged to maximize UV dose delivered to the effluent and to prevent any UV exposure above the water free surface.

K. Electrical:

1. All applicable electrical components shall be UL-listed to ensure safety standards are met.

2. Each UV lamp within a bank shall be powered from a Power Distribution Center.

3. UV Manufacturer to supply all cabling between lamps and drivers.

4. Each electronic lamp driver shall power two lamps.

5. Power factor shall not be less than 99% leading or lagging.

6. Electrical supply to each Power Distribution Center shall be 480V, 3 phase, 4 wire + GND, 50/60 Hz, 82.1 kVA.

7. Electrical supply to the Hydraulic System Center shall be 480V, 3 phase, 3 wire + GND, 60 Hz, 2.5 kVA.

8. Electrical supply to the Water Level Controller shall be 480V, 3 phase, 3 wire + GND, 60 Hz, 12.5 kVA.

9. Electrical supply for the water level sensor shall be provided by the PDC and be 24 Volt DC.

10. Electrical supply to the System Control Center shall be 120V, 1 phase, 2 wire + GND, 60 Hz, 1.8 kVA.

L. Power Distribution Center (PDC):

1. The configuration of Power Distribution Centers (PDCs) shall be 72 lamps per PDC.

2. PDC enclosure shall be rated NEMA 4X 316 Stainless Steel.

3. All internal components shall be sealed from the environment.

4. All PDCs shall be UL approved or equivalent.

5. Each PDC's Available Interrupting Capacity (AIC) shall be rated as shown in the plans.

6. An internal heater shall be provided in the PDC to prevent condensation when the external temperature drops below the dew point.

7. Each PDC shall be able to electrically isolate each bank of lamp drivers and safely replace a lamp driver without de-energizing any other operating banks.

8. Each PDC shall be provided with cooling when the temperature exceeds the safe operating temperature of the components inside the enclosure.

M. Hydraulic System Center (HSC):

1. The Hydraulic System Center (HSC) houses the components required to operate the automatic cleaning system and bank Automatic Raising Mechanism (ARM).

2. HSC enclosure shall be rated NEMA 4X 316 Stainless Steel (IP 66).

3. The HSC shall contain hydraulic power unit complete with pump, fluid reservoir, manifolds, valves and filter.

4. The two HSCs shall be provided with jumper hoses with quick disconnect fittings such that in case one HSC needs servicing, the operator can switch to the other HSC manually and operate all the banks.

N. Control and Instrumentation:

1. System Control Center (SCC):

a) The monitoring, operation, and control of the TrojanUVSigna is managed at the System Control Center (SCC) by an Allen-Bradley CompactLogix PLC with an

Allen-Bradley PanelView Plus 1500 (Outdoor 4X Rated) 15" HMI screen. SCC shall have an Uninterruptible Power Supply (UPS), which shall be sized to run on battery for at least 20 minutes at SCC full load. The SCC shall receive the following hardwired digital inputs from the UPS: UPS in Use, UPS Fault, and UPS Low Battery. These inputs shall be relayed to the DCS via the SCC PLC using ethernet communications. SCC enclosure shall be rated NEMA 4X 316 Stainless Steel. UV manufacturer shall provide all I/O modules, power supply, and programming of the Allen-Bradley CompactLogix PLC for a complete working system in place per the Contract Documents.

b) The SCC is installed outdoors, so the operator interface shall be positioned out of or away from direct sunlight and shall include a sunshade. The operator interface screen shall be designed for a rugged outdoor environment capable of operating at ambient temperatures between -30 Deg C and +70 Deg C with a high brightness display (minimum 1000 Nit). HMI screen shall be certified for outdoor use (UL50E Type 4X Outdoor).

c) Alarms shall be provided to indicate to plant operators that maintenance attention is required or to indicate an extreme alarm condition in which the disinfection performance may be jeopardized. The alarms shall include, but not be limited to:

   i) Individual Lamp Failure

   ii) Multiple Lamp Failure

   iii) Low UV Intensity

   iv) Bank Communication Alarm

d) The 100 most recent alarms shall be recorded in an alarm history register and shall be displayed when prompted.

e) Mode of operation for UV Banks can be manual, automatic or remote.

f) Elapsed time of each bank shall be recorded and displayed on the display screen when prompted.

g) The SCC's Available Interrupting Capacity (AIC) shall be rated as shown in the plans.

2. Low Water Level Sensor with Level Sensor Control Box:

a) The UV Manufacturer shall provide one (1) low water level sensor for each UV channel.

b) During all modes of system operation (manual, automatic and remote), the water level sensor shall ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.

c) The UV Manufacturer shall provide one wall mounted Level Sensor Control Box (316 SST, NEMA 4X), which shall provide a low level signal to each PDC from the low water level sensor.

d) The CONTRACTOR shall install the low water level sensor, level sensor control box and the associated conduits and cables.

3. UV Intensity Sensors:

a) A UV sensor shall continuously monitor the UV intensity produced within each UV Bank.

b) The sensors shall measure only the germicidal portion of light emitted by the lamps.

c) The UV sensor shall be factory-calibrated to US National Institute for Standards and Technology (NIST). Sensors requiring field-calibration are not acceptable.

d) The sensor shall be digitally calibrated to ensure calibration accuracy.

e) To ensure continuous disinfection, the sensor shall be accessible without shutting down the system, lifting a bank/module or removing lamps.

f) Sensors shall be designed to provide UV intensity data for dose monitoring and control functions. Dose pacing program shall enable use of measured UV intensity along with flow rate and UVT to determine the delivered dose during operation.

g) Sensors shall be designed such that reference sensor readings can be taken without interrupting disinfection and without removing UV lamps, banks/modules or sleeves.

4. Dose-Pacing:

a) A dose-pacing system shall be supplied to modulate the lamp UV output. A signal shall be sent from the effluent flow meter via the DCS to the SCC PLC using ethernet communications. A separate signal for dose pacing shall be sent to the SCC PLC from the UV intensity sensor(s).

b) The system to be dose-paced such that as the flow and effluent quality change, the design UV dose is delivered while conserving power.

c) The dose-pacing system shall allow the operator to vary the design dose setting. Logic and time delays shall be provided to regulate UV Bank ON/OFF cycling.

5. On-Line UV Transmission (UVT) Monitor:

a) An on-line UVT monitor shall be provided to automatically and continuously track the UV transmission of the effluent at the 254 nm wavelength. UVT monitor shall be UVAS as manufactured by Hach Company or approved equal.

b) The UVT monitor shall measure transmittances from 25 to 100%.

c) A shielded twisted pair cable to be provided by the CONTRACTOR for connecting the UVT monitor (4-20 mA signal) to the System Control Center. The SCC shall modulate the lamp intensity in response to the effluent UV Transmission.

d) Power feed of 100 – 230 VAC ± 10%, 50/60 Hz, 1 phase, 2 wire (plus ground), 50 VA required to the sensor located at the UV channel as shown on the Drawings.

6. Ultrasonic Water Level Sensor:

a) The UV Manufacturer shall provide one (1) low water level sensor with monitor panel for each weir gate with sufficient length of cable to distribute to the monitor panel. The ultrasonic level sensor and monitor panel shall be used to determine the effluent levels specifically for the weir gate control.

b) The CONTRACTOR shall be responsible for mounting the bracket and the transducer in the UV channel at a location as shown in the plans. The monitor panel shall be mounted in an area as shown in the plans. The CONTRACTOR shall distribute the following cable/wiring between these two components and the SCC in appropriate conduit at each sensor:

1. One (1) 24 V DC, 2 conductors + GND power from the SCC to the Level Sensor Monitor.

2. One (1) 4-20 mA analog shielded twisted pair from the Level Sensor Monitor to the SCC.

3. One (1) communication link using cable supplied by the UV Manufacturer from the Level Sensing Transducer to the Level Sensing Monitor.

O. UV Bank Lifting Device:

1. The lifting device for UV Banks shall be supplied by the UV Manufacturer.

2. An Automatic Raising Mechanism (ARM) shall be designed and supplied to facilitate lifting a UV bank from the channel without use of ancillary equipment.

3. The ARM shall be integrated into the UV Bank for simple and seamless operation.

4. The UV Bank shall be raised from the channel for easier access and maintenance.

5. The ARM design shall provide access to components without having to break electrical connections thus reducing wear on connectors.

P. Spare Parts:

The following spare parts and safety equipment shall be supplied.

1. 1 Bank of UV Lamps and Ballasts

2. 1 Bank of Quartz Sleeves

3. 1 Bank of Lamp Wiper Seals

4. 1 Hydraulic Motor

5. 1 Operators Kit that includes UV-resistant face shield, gloves and cleaning solution.

If the alternate system does not use hydraulic system, then hydraulic motor and associated controls for the hydraulic system shall not be required.

PART 3 - EXECUTION

3.1 INSTALLATION

In accordance with contract drawings, manufacturers' shop drawings, instructions and installation checklist. CONTRACTOR Installation Checklist to be completed and returned at least two (2) weeks prior to date requested for commissioning. Photographs illustrating site readiness are required. The CONTRACTOR assumes all responsibility for the installation readiness of the UV system. All labor, materials and test apparatus necessary for completing the installation shall be furnished by the CONTRACTOR at no additional cost.

The CONTRACTOR shall survey and locate the anchors for the existing equipment and provide them to the UV manufacturer. This is to ensure that the anchors for the new UV equipment will not conflict with the anchors for the existing equipment.

3.2 MANUFACTURER’S SERVICES

A. The manufacturer shall provide installation assistance to the CONTRACTOR as needed.

B. Start-up and field testing: Start-up and Field Services shall be scheduled by the CONTRACTOR after the date and time is approved by the OWNER. The UV Manufacturer's representative shall be present during the start-up and field testing.

C. Operator Training: CONTRACTOR is responsible to schedule the training during the commissioning time allocated. For bid purposes, a minimum of two days for a total of twenty hours of training shall be considered.

D. Technical Pre-Commissioning and Commissioning Meetings: Two meetings, four hours duration each meeting.

E. Warranty Service: Minimum one year warranty on all equipment and workmanship from the day of project acceptance by OWNER.

F. Spot Check Bioassay: Following start-up and functional testing, the UV Manufacturer will hire a third party independent Full Scale Validation consultant to complete the spot check bioassay in accordance with NWRI guidelines (2012). The consultant shall be approved by the Officer-in Charge at California DDW and shall follow a protocol that is approved by the DDW. The Contractor shall notify the City of San Diego, the Engineer and DDW of the test date and protocol.

**** END OF SECTION ****

APPENDIX A
TYPICAL CONTROL PHILOSOPHY

SECTION 11300 ULTRA-VIOLET DISINFECTION SYSTEM

CONTROLS PHILOSOPHY - TrojanUV Signa Sample

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1.0 General

The objective of this document is to provide details regarding the control strategy for TrojanUVSigna disinfection system. The controls philosophy outlines the major hardware components, system status, and modes of operation of the system.

2.0 Acronyms

BCB: Bank Control Board

HCB: Hydraulic Control Board

HSC: Hydraulic System Center

HMI: Human Machine Interface

PDC: Power Distribution Center

PLC: Programmable Logic Controller

RED: Reduction Equivalent Dose

SCADA: Supervisory Control and Data Access

SCC: System Control Center

3.0 Site Specific Configurations

The following parameters were used to configure the UV system and are specific to the site.

Item	Configuration	Description
Number of Channels		
Number of Banks per Channel		
Number of Lamps per Bank		
Number of Lamp Drivers per Bank		
Number of Wiper Groups	(1/Bank)	
Number of SCCs		
Number of PDCs	(1/Channel)	
Number of HSCs		
High Water Level Sensing	(1/Channel)	
Low Water Level Sensing	(1/Channel)	
UV Intensity Measurement	(1/Bank)	
UVT Measurement	1	
Flow Measurement	1	From plant SCADA
SCADA	Ethernet	Fiber optic physical connection
Inlet Gate	(1/Channel)	To be controlled manually and automatically from HMI
Peak Flow		
Design Target Dose		
Lamp Life	≤15000 hours in	

	automatic mode	
Lamp Age Factor	0.86	
Lamp Fouling Factor	0.9	
Pacing Mode	Flow Pacing & Dose Pacing	
Lead Channel Rotation	1~999 hours	
Lead Bank Rotation	1~999 hours	
Lamp Off Delay	0~180 minutes	

4.0 Control System Architecture

The control system consists of the following components: One (1) SCC, Two (2) PDCs and one (1) HSC. The SCC controls two (2) UV channels. Each channel is equipped with one (1) PDC which controls two (2) banks. Each PDC will power and can control up to 64 UV lamps The HSC controls one wiper group in each of the four (4) UV banks.

4.1 System Control Center (SCC)

The SCC includes the host controller of UV disinfection system. It consists of an operator interface (HMI), the PLC, and related electrical components. Through a RS-485 daisy chain, the SCC connects to the PDCs and the HSC.

The operator interface allows users to operate the UV disinfection system. It provides the following functions:

- System setup
- System/channel/bank/lamp driver operations and status indication
- Trending/data logging
- Online help and alarms
- Lamp and driver operations and services
- Wiper operations and services
- System clock
- Alarm information

The PLC provides the following functions:

- Slide gate control
- SCADA communications
- Remote on/off
- UPS monitoring
- Process parameter measurement (UVT, flowrate, high water level, low water level, channel water levels)
- Dose pacing
- PDC supervisory monitoring and control

- HSC supervisory monitoring and control

4.2 Power Distribution Center (PDC)

The PDC controls a bank lamp power. Its central controller is Trojan's Bank Control Board (BCB). The BCB communicates with UV lamp drivers through RS485 daisy-chain.

The BCB performs the following functions:

- Lamp driver power control
- Bank local On/Off
- Bank run hour/cycle management
- UV intensity measurement
- PDC high temperature protection

4.3 Hydraulic System Center (HSC)

The HSC is controlled by a Hydraulic Control Board (HCB). One HCB controls four wiping group and one automatic removal mechanism (ARM) for raising and lowering of the bank.

The HSC does the following functions:

- Automatic wiping controls
- Manual wiping operations
- Hydraulic parameter measurements
- Hydraulic pump protection
- UV Bank pivot function
- Selector switches are provided on the HSC for the following:
    - Wipe or pivot
    - Wiper in Local or Remote
    - Wiper Extend or Retract

5.0 Signal Interface

The following table lists signals that interface between the plant controls system and Trojan UVSigna controls system. Signals are to or from Trojan PLC unless otherwise noted (*).

Index	Signal Type	Signal Name	Description
SCADA	Fiber Optic Ethernet	SCADA	Plant SCADA connection
DI0	DI	SBR/Run	Hardwired run signal from plant
DI1	DI	UIU	UPS in use
DI2	DI	UFT	UPS fault
DI3	DI	LSH1	Channel 1 High Water Level

DI4	DI	LSH2	Channel 2 High Water Level
DI5	DI	LSL1	Channel 1 Low Water Level
DI6	DI	LSL2	Channel 2 Low Water Level
DI7	DI	GIR1	Inlet Gate 1 Ready
DI8	DI	GIO1	Inlet Gate 1 Opened
DI9	DI	GIC1	Inlet Gate 1 Closed
DI10	DI	GIR2	Inlet Gate 2 Ready
DI11	DI	GIO2	Inlet Gate 2 Opened
DI12	DI	GIC2	Inlet Gate 2 Closed
DO0	DO	GCO1	Inlet Gate 1 Open
DO1	DO	GCC1	Inlet Gate 1 Close
DO2	DO	GCO2	Inlet Gate 2 Open
DO3	DO	GCC2	Inlet Gate 2 Close
DO4	DO	CAL	Critical Alarm
DO5	DO	JAL	Major Alarm
DO6	DO	NAL	Minor Alarm
DO1A	DO	B1A	Channel 1 Bank A On (from BCB)*
DO1B	DO	B1B	Channel 1 Bank B On (from BCB)*
DO2A	DO	B2A	Channel 2 Bank A On (from BCB)*
DO2B	DO	B2B	Channel 2 Bank B On (from BCB)*
AI0	AI		(reserved)
AI1	AI	UVT	UV Transmittance
AI2	AI	LI1	Channel 1 Water Level
AI3	AI	LI2	Channel 2 Water Level
AI1A	AI	UVI1A	Channel 1 Bank A UVI (wired to PDC and the signal transferred to SCC through communication)*
AI1B	AI	UVI1B	Channel 1 Bank B UVI (wired to PDC and the signal transferred to SCC through communication)*
AI2A	AI	UVI2A	Channel 2 Bank A UVI wired to PDC and the signal transferred to SCC through communication)*
AI2B	AI	UVI2B	Channel 2 Bank B UVI (wired to PDC and the signal transferred to SCC through communication)*

6.0 Operation Philosophy

The control philosophy is designed to allow automatic operation of the UV equipment under normal conditions. Human intervention is required when critical or major alarms occur and may be required during an event causing extreme or unstable conditions.

6.1 Inlet Gate Control

Inlet gate controls can be set as Manual mode or Auto mode at the HMI.

In Manual mode, an inlet gate is operable by means of the open or close button on the HMI screen. In Auto mode, an inlet gate is operated by the automatic control program in the PLC.

To start up a channel, the PLC will turn lamps on when there is no Channel Low Water Level Warning alarm and open the inlet gate in the predefined time (settable at HMI). When a Channel Low Water Level Warning alarm exists, the PLC will open the inlet gate to let water flow into the channel and then turn lamps on when Channel Low Water Level Warning disappears.

To shut down a channel, the PLC will close the inlet gate and then turn off the lamps when the inlet gate is fully closed.

When the inlet gate cannot be fully opened or fully closed, the HMI will report inlet gate failure alarms (please refer to Section 10.0 Alarm Philosophy).

The HMI indicates inlet gate status as Opened, Closed or Faulted according to operational situations. An inlet gate is faulted if it does not open or close within a predefined time period.

6.2 Power Control

Power of the UV system power may be controlled at three (3) levels: system, channel and bank level. Different control mode can be selected at the HMI screen at each level.

At a bank level, through the HMI, each bank can be put to:

- Auto - dose pacing will turn it on or off and adjust power as necessary
- Manual - bank is turned on and operator adjusts power level or
- Off - which immediately shuts the bank off and it is then not available for dose pacing

At a channel level, each channel is able to be put into:

- Auto - all banks and gates are switched to Auto and dose pacing will start up the channel as necessary
- Manual - all banks are switched to Manual and start and power is controlled by channel power; gate is also switched to Manual and operator must open or close it as they choose or
- Out of Service - which does not change any bank or gate requested mode, but initiates a controlled shut down of the channel by rotating it to the last lag, shutting the inlet gate, then shutting off the banks, regardless of whether it is needed to meet dose or not. When a channel is requested Out of Service, a

minor alarm should be posted when all banks shut off as a reminder that the channel is shut down, or if all banks do not shut down (such as a bank or gate is in manual) after a defined time delay, an alarm is posted that channel failed to complete out of service. No alarms are masked when a channel is Out of Service. The dose pacing routine will never call for this channel to run if it is Out of Service. When a channel is Out of Service, banks or gates can be put to manual and manipulated as desired. A channel is removed from Out of Service mode by putting it back to Auto or Manual which will move all banks and gates to either Auto or Manual.

At the system level, the system is able to be put into:

- Auto – all channels are switched to Auto, except the ones are out of service and flow pacing will start up the channels as necessary
- Manual – all channels are switched to Manual, except for the ones are out of service and start up with the power is controlled by system power
- Off – turns the entire system off (password protected to prevent disoperation).

6.3 Wiper Control

Wiper control can be in Manual or Automatic mode.

All wiper groups can be controlled manually by means of reset, disable/enable and the wiping buttons on the HMI screen. Auto wiping also is controlled based on the entered wiping interval, which is a configurable setting on the HMI. When the wiper interval time is reached, a wiping sequence is triggered automatically. Once a wiper sequence has been completed, the interval timer is reset, and it starts timing for the next wipe. When the wiping interval is set to zero, the automatic wiping is inhibited.

When the system is off, all wiper groups in the system are inhibited from auto wiping. When a channel is off, all wiper groups in the channel are inhibited from auto wiping. Similarly, when a bank is off, the wiper group to this bank is inhibited from auto wiping. In these cases, the manual wiping and local wiping at HSC are still allowed.

When the reset button is activated on the Wiper overview screen or a power on reset occurs (e.g. after power interruption), the controller will activate a reset sequence to bring the wipers to home.

Individual wiper group controls can be managed through respective individual wiper control screens. The user can perform individual wiper initiation.

The HMI indicates the status of wiper groups including: wiper/hydraulic errors, wiper position (home/away), wiper moving direction (extend/retract) and fault information.

7.0 Auto Pacing

In Auto mode, the UV system flow and dose paces automatically. The controller determines the number of channels and banks to power on and varies power of the banks depending on the measured flow and UVT.

Flow-paced logic determines the number of UV channels to operate and the number of banks to be turned ON and OFF to achieve the required level of disinfection. To avoid cycling of the channels and banks, adjustable time delays (0-180 minutes) set at the HMI

prevent the channels and banks from cycling on and off before the respective timer has elapsed.

In auto mode, the dose target for every channel that is in operation is equally divided among all banks in auto mode that are brought into operation by the flow pacing.

To facilitate even wear on the lamps, a lead channel rotation timer will be provided, set at the HMI. The lead channel rotation is fully adjustable from 1~999 hours. Similarly, a lead bank rotation is implemented and adjustable at the HMI.

In Auto mode, the controller will adjust the power level of energized banks to maintain sufficient UV dose (RED) at a given flow while conserving power. A Low UV Dose alarm will be reported when the channel RED is below the target dose setpoint.

8.0 Operator Interface

The operator interface or HMI, allows the Operator to monitor and control the UV system. The Operator will have access to a system overview as well as detailed information on each subsystem. The main menu provides access to following operations:

- System Settings

  Settings can be set up and are retained in non-volatile memory.

- System Overview
  - Process parameters: flowrate, UVT, RED
  - System status: ok, minor alarm, major alarm, critical alarm
- Channel Controls
  - Channel parameters: flowrate, RED
  - Channel status: ok, alarm, lead/lag, in-service or out-of-service
  - Channel mode: auto, off, manual
  - Bank indication: power level, lead/lag, alarm
  - Gate indication: open, close, transition, alarm
- Bank Controls
  - Bank parameters: power level, bank run hour, UVI
  - Bank status: ok, alarm, on ,off
  - Driver indication: addresses, status(ok, error)
  - Lamp indication: on, off, error, lamp run hour, reset
  - Driver operation: reset, on, off
  - Bank mode: SCC (on, off), off, on
- Hydraulic Controls
  - Wiper Control Overview: time to next wipe, reset, wiping, wiper status, mode control

- Individual wiper screen: sequencing, wiper errors, position and alarm information
- Bank pivoting

- Services

  The following tabs are provided:

  - General
    - Date and time setup
  - Driver Troubleshooting Services and Diagnosis
  - UVI Reference Check

- Alarms

  An Active Alarm screen and a Historical Alarm screen are provided.

- Trends

  UVT, flowrate, UVIs and RED are trended with a data sample rate of once per minute. The trended data is retained in HMI for 30 days.

- Security

  Three level access:

  - Level 1: OPERATOR, no password needed.
  - Level 2: MAINTENANCE, usually for plant authorized operation personnel to access, password protected with limited data access. The password protection can be removed by choosing “Service Password” and setting to “Disabled”.
  - Level 3: TECHNICIAN, usually for Trojan authorized personnel to access, password protected.

9.0 Safety

The UVSigna control strategy includes equipment protection interlocks. It monitors a number of alarm conditions that will result in control action designed to maintain the required level of disinfection (please refer to section 10.0 Alarm Philosophy).

When a power loss occurs to the UV system, the control system will recover the disinfection operations automatically when power is restored. The SCC retains the control program in memory and is powered by the UPS. The PLC will report SCC Run on UPS alarm. If the power loss occurs only at the SCC, the PDC will run banks at full power.

When communication failure occurs between the SCC and PDC, the PDC will run banks at full power.

When communication failure occurs between the SCC and the HSC, the HSC will maintain normal operations.

A “PDC High Temperature Shutdown” alarm will shut down the bank to protect it from damage.

When a bank is pivoted, the power to the lamp drivers in the PDC will be disconnected

and the wiper group will be inhibited from automatic wiping.

10.0 Alarm Philosophy

Alarms are prioritized using the following structure:

- Minor alarm

  Indicates that the UV system requires maintenance but it is operating in compliance. Alarms are not latched and no reset required. No other actions will be taken.

- Major alarm

  Indicates that the UV system requires immediate attention otherwise damage to the equipment may occur or disinfection performance may be compromised. The UV system does not shutdown when major alarms occur.

  The control system usually takes corrective actions when alarm conditions occur, e.g. running one or more banks or more channels at full power, to try and achieve the target RED.

  In case the control system cannot correct the problem, it will report an alarm as soon as the alarm condition is present.

- Critical Alarm

  Indicates immediate attention is required. A critical alarm will cause the UV disinfection system to shutdown partially or completely until the fault is cleared. Alarms may be latched and require a reset from operator interface after the alarm condition is remedied.

The following table summarizes typical alarm conditions for the UV system.

Alarm	Alarm Type	Purpose/Description	Controls Action	Number of Alarms
Low UV Dose	Major	Indicates that a channel calculated UV dose, based on process parameters, i.e., UV intensity, flow rate and UVT, drops below the UV system design dose.	Runs the system at full capacity of disinfection i.e., all available UV channels run at 100% power.	1/System
Low UVT – Out of Validation Range	Major	Online UVT drops below validated conditions.	Runs the system at full capacity of disinfection, i.e., all available UV channels run at 100% power.	1/System
UVT Meter Fault	Major	4~20mA signal from a UVT meter is below 2mA or above 20.5mA	Runs the system to full power for disinfection, i.e., all available UV channels run at 100% power.	1/System
Low Flow	Minor	Online flow rate drops below the low	Depending on the plant process, controls	1/System

		flow set point.	may turn off the channel that experiences this condition after a time delay and turn it on again when process flow comes back to normal range, or the controller will maintain the system on at minimum power level.	
High Flow – Out of Validation Range	Major	Online flow rate runs up to outside of validated range.	Runs the system at full capacity for disinfection, i.e., all available UV channels run at 100% power.	1/System
Flow Meter Fault	Major	4~20mA signal from a flow meter is below 2mA or above 20.5mA	Runs the system at full capacity for disinfection, i.e., all available UV channels run at 100% power.	1/System
Channel Not Ok	Major	Indicates a UV channel cannot achieve the target design dose.	Keeps the channel running at full power for disinfection and turn other available channel on.	1/Channel
Channel Low Water Level Warning	Minor	Channel water level is below low mechanical set point within a predefined period of time (settable at the HMI).	Keeps normal operation.	1/Channel
Channel Low Water Level	Critical	Channel water level is below low mechanical set point above the predefined period of time (settable at the HMI).	The channel will be shut down.	1/Channel
Channel High Water Level	Major	Channel water level is above high mechanically set point.	Report alarm right away and runs the system at full capacity of disinfection.	1/Channel
Inlet Gate Failure	Critical	Indicates an inlet slide gate failure.	HMI shows the reasons for failure: failed to open, failed to close, failed to start opening, failed to start closing.	1/Channel
Low UV Intensity	Major	Indicates the	HMI shows where the	1/Bank

		percentage of measured UV intensity drops below UVI alarm set point.	alarm occurs, i.e., bank location.	
Low UV Intensity Warning	Minor	Indicates the percentage of measured UV intensity drops below UVI warning set point.	HMI shows where the alarm happens, i.e., in what bank.	1/Bank
UVI Sensor Fault	Minor	4~20mA signal from a bank UVI sensor is below 2mA or above 20.5mA.	HMI shows where the alarm occurs, i.e., bank location.	1/Bank
UVI Sensor Reference Check	Minor	Indicates that all bank UVI sensors reference check is required to maintain the system performance.	Human intervention is required to perform UVI sensor reference check.	1/System
HMI - PLC Communication Fault	Minor	Indicates the communication failure between HMI and PLC	Maintains normal operation	1/System
SCC-PDC Communication Fault	Minor	Indicates the communication failure between PDC and SCC.	PDC runs the bank at full power.	1/Bank
PDC Fan Failure	Minor		Maintains normal operation. HMI indicates where the failure occurred.	1/Bank
PDC Air Conditioner Failure	Minor		Maintains normal operation. HMI indicates where the failure occurred.	1/Bank
PDC High Temperature Warning	Minor		Maintains normal operation. HMI indicates where the failure occurred.	1/Bank
PDC High Temperature Shutdown	Critical		Turns the bank off immediately. HMI indicates where the failure occurred.	1/Bank
PDC No Power	Minor		HMI indicates where the failure occurred	1/Bank
Bank Not In Auto	Minor		Bank in excluded from dose contribution.	1/Bank
Bank Not Ok	Minor	Indicates the bank	Bank maintains	1/Bank

		cannot achieve the target design dose.	operation and runs at full power. HMI indicates where the failure occurred.	
HSC Hydraulic Tank Low Level	Critical		Turns hydraulic pump off immediately. HSC disables the wipers. HMI indicates where the failure occurred.	1/HSC
HSC Hydraulic Pressure Signal Lost	Critical		HSC disables the wipers. HMI indicates where the failure happens.	1/HSC
SCC-HSC Communication Fault	Minor	Indicates the communication failure between SCC and HSC.	HSC keeps normal operation. HMI indicates where the failure occurred.	1/HSC
Wiper Failure	Minor		HSC disables the failed wiper. HMI indicates where the failure occurred.	1/HSC
Lamp Failure	Minor		HMI indicates where the failure occurred.	1/System
Lamp Driver Failure	Minor	Indicates the communication failure between BCB and lamp driver(s).	HMI indicates where the failure occurred.	1/System
Lamp Lifetime Exceeded	Minor		Maintains normal operation. HMI indicates where the failure occurred.	1/System
System Power On Reset	Minor		Maintains normal operation as it was before power outage.	1/System
PLC Fault	Minor	Indicates there are one or more PLC hardware faults present.		1/System
UPS Fault	Minor		Maintains normal operation	1/System
SCADA Fault	Minor		Maintains normal operation	1/System
SCC Power Loss	Major		PDC operates the banks at full power	1/System
SCC Run on UPS	Critical		UV system loses power and the PLC in power by an UPS	1/System
Channel Out of Service	Minor		The channel is excluded from auto	1/Channel

			mode	

11.0 SCADA Interface

The SCC provides data to the plant SCADA system to allow users to monitor and control the UV system remotely. The UV PLC acts as slave node and does not initiate any data transfer with plant system, but will respond to polling messages from a master. SCADA information is available in a selection of contiguous word integers as addressed in the table below.

11.1 SCADA Read Data

Symbolic Address	Tag Description	Units
N_SCADA[0].0	LOW UV DOSE ALARM	1=Fault
N_SCADA[0].1	FLOW METER FAULT	1=Fault
N_SCADA[0].2	UVT ANALYZER FAULT	1=Fault
N_SCADA[0].3	COMMON CRITICAL ALARM	1=Fault
N_SCADA[0].4	COMMON MAJOR ALARM	1=Fault
N_SCADA[0].5	COMMON MINOR ALARM	1=Fault
N_SCADA[0].6	COMMON HSC ALARM	
N_SCADA[0].7	SCC RUNNING ON UPS POWER	1=True
N_SCADA[0].8	LOW UV TRANSMITTANCE ALARM	1=Fault
N_SCADA[0].9	WATCHDOG PULSE	2s On then 2s Off
N_SCADA[0].10	RESERVED - SPARE	
N_SCADA[0].11	RESERVED - SPARE	
N_SCADA[0].12	RESERVED - SPARE	
N_SCADA[0].13	RESERVED - SPARE	
N_SCADA[0].14	RESERVED - SPARE	
N_SCADA[0].15	RESERVED - SPARE	
N_SCADA[1]	SYSTEM FLOW	Flow Units x 10
N_SCADA[2]	CALCULATED SYSTEM UV DOSE	mws/cm^2 x 100
N_SCADA[3]	UV TRANSMITTANCE	% x 10
N_SCADA[4]	RESERVED - SPARE	
CHANNEL 1 GENERAL DATA		
N_SCADA[5].0	CH 1 LOW WATER LEVEL	1=Fault

N_SCADA[5].1	CH 1 COMMON INLET GATE FAULT	1=Fault
N_SCADA[5].2	CH 1 INLET GATE NOT CLOSED	1=Channel Open
N_SCADA[5].3	CH 1 HIGH WATER LEVEL ALARM	1=Fault
N_SCADA[5].4	CH 1 COMMON WEIR GATE FAULT	1=Fault
N_SCADA[5].5	CH 1 IN SERVICE	1=In Service, 0=Out of Service
N_SCADA[5].6	CH 1 MODE	1=Auto, 0=Manual
N_SCADA[5].7	CH 1 IN OPERATION	1=In Operation
CHANNEL 1 DISCRETE BANK DATA		
N_SCADA[5].8	BANK 1A IN OPERATION	1=In Operation
N_SCADA[5].9	BANK 1A MAJOR ALARM	1=FAULT
N_SCADA[5].10	BANK 1B IN OPERATION	1=In Operation
N_SCADA[5].11	BANK 1B MAJOR ALARM	1=Fault
N_SCADA[5].12	RESERVED – SPARE	
N_SCADA[5].13	RESERVED – SPARE	
N_SCADA[5].14	RESERVED – SPARE	
N_SCADA[5].15	RESERVED – SPARE	
CHANNEL 1 ANALOG BANK DATA		
N_SCADA[6]	BANK 1A LAMP HOURS	Hours
N_SCADA[7]	BANK 1A LAMP POWER	Power (%)
N_SCADA[8]	BANK 1B LAMP HOURS	Hours
N_SCADA[9]	BANK 1B LAMP POWER	Power (%)
N_SCADA[10]	RESERVED – SPARE	
N_SCADA[11]	RESERVED – SPARE	
N_SCADA[12]	RESERVED – SPARE	
N_SCADA[13]	RESERVED – SPARE	
N_SCADA[14]	RESERVED – SPARE	
N_SCADA[15]	RESERVED – SPARE	
N_SCADA[16]	RESERVED – SPARE	

N_SCADA[17]	RESERVED – SPARE	
N_SCADA[18]	CHANNEL 1 WATER LEVEL	
CHANNEL 2 GENERAL DATA		
N_SCADA[19].0	CH 2 LOW WATER LEVEL	1=Fault
N_SCADA[19].1	CH 2 INLET GATE FAULT	1=Fault
N_SCADA[19].2	CH 2 INLET GATE NOT CLOSED	1=Channel Open
N_SCADA[19].3	CH 2 HIGH WATER LEVEL ALARM	1=Fault
N_SCADA[19].4	CH 2 WEIR GATE FAULT	1=Fault
N_SCADA[19].5	CH 2 IN SERVICE	1=In Service, 0=Out of Service
N_SCADA[19].6	CH 2 MODE	1=Auto, 0=Manual
N_SCADA[19].7	CH 2 IN OPERATION	1=In Operation
CHANNEL 2 DISCRETE BANK DATA		
N_SCADA[19].8	BANK 2A IN OPERATION	1=In Operation
N_SCADA[19].9	BANK 2A MAJOR ALARM	1=FAULT
N_SCADA[19].10	BANK 2B IN OPERATION	1=In Operation
N_SCADA[19].11	BANK 2B MAJOR ALARM	1=Fault
N_SCADA[19].12	RESERVED – SPARE	
N_SCADA[19].13	RESERVED – SPARE	
N_SCADA[19].14	RESERVED – SPARE	
N_SCADA[19].15	RESERVED – SPARE	
CHANNEL 2 ANALOG BANK DATA		
N_SCADA[20]	BANK 2A LAMP HOURS	Hours
N_SCADA[21]	BANK 2A LAMP POWER	Power (%)
N_SCADA[22]	BANK 2B LAMP HOURS	Hours
N_SCADA[23]	BANK 2B LAMP POWER	Power (%)
N_SCADA[24]	RESERVED – SPARE	
N_SCADA[25]	RESERVED – SPARE	
N_SCADA[26]	RESERVED – SPARE	
N_SCADA[27]	RESERVED – SPARE	

N_SCADA[28]	RESERVED – SPARE	
N_SCADA[29]	RESERVED – SPARE	
N_SCADA[30]	RESERVED – SPARE	
N_SCADA[31]	RESERVED – SPARE	
N_SCADA[32]	CHANNEL 2 WATER LEVEL	

11.2 SCADA Write Data

Symbolic Address	Tag Description	Units
SCADA WRITE DATA		
N_SCADA_system_ctrl[0]	UV SYSTEM TOTAL FLOW	Flow Units x 10
N_SCADA_system_ctrl[1]	RESERVED - SPARE	
N_SCADA_system_ctrl[2]	RESERVED - SPARE	
N_SCADA_system_ctrl[3]	RESERVED - SPARE	
N_SCADA_system_ctrl[4]	RESERVED - SPARE	
N_SCADA_system_ctrl[5].0	SBR SYSTEM FLOW PRESENT	1=Full Flow Present
N_SCADA_system_ctrl[5].1	SCADA HEARTBEAT SIGNAL	On for 2 s, Off for 2 s
N_SCADA_system_ctrl[5].2	RESERVED - SPARE	
N_SCADA_system_ctrl[5].3	RESERVED - SPARE	
N_SCADA_system_ctrl[5].4	RESERVED - SPARE	
N_SCADA_system_ctrl[5].5	RESERVED - SPARE	
N_SCADA_system_ctrl[5].6	CHANNEL 1 BANK 1A PERMISSIVE RUN	0=Enabled
N_SCADA_system_ctrl[5].7	CHANNEL 1 BANK 1B PERMISSIVE RUN	0=Enabled
N_SCADA_system_ctrl[5].8	RESERVED - SPARE	
N_SCADA_system_ctrl[5].9	RESERVED - SPARE	
N_SCADA_system_ctrl[5].10	RESERVED - SPARE	
N_SCADA_system_ctrl[5].11	CHANNEL 2 BANK 2A PERMISSIVE RUN	0=Enabled
N_SCADA_system_ctrl[5].12	CHANNEL 2 BANK 2B PERMISSIVE RUN	0=Enabled
N_SCADA_system_ctrl[5].13	RESERVED - SPARE	
N_SCADA_system_ctrl[5].14	RESERVED - SPARE	

N_SCADA_system_ctrl[5].15	RESERVED - SPARE	

APPENDIX B
UV SYSTEM TYPICAL DCS I/O LIST

SECTION 11300 – ULTRA VIOLET DISINFECTION SYSTEM

From DCS – System

Tag Name	Modbus Address	Data Type	Description	Units	Scaling
N_SCADA_CTRL[0]	40001	INT	UV system total flow	Flow Units	x10
N_SCADA_CTRL[1]	40002	INT	spare word		
N_SCADA_CTRL[2]	40003	INT	spare word		
N_SCADA_CTRL[3]	40004	INT	spare word		
N_SCADA_CTRL[4]	40005	INT	spare word		
N_SCADA_CTRL[5].0	40006.0	BOOL	SBR system flow present	1=Full Flow Present	
N_SCADA_CTRL[5].1	40006.1	BOOL	DCS heartbeat signal	2s On then 2s Off	
N_SCADA_CTRL[5].2	40006.2	BOOL	spare bit		
N_SCADA_CTRL[5].3	40006.3	BOOL	spare bit		
N_SCADA_CTRL[5].4	40006.4	BOOL	spare bit		
N_SCADA_CTRL[5].5	40006.5	BOOL	spare bit		
N_SCADA_CTRL[5].6	40006.6	BOOL	spare bit		
N_SCADA_CTRL[5].7	40006.7	BOOL	spare bit		
N_SCADA_CTRL[5].8	40006.8	BOOL	spare bit		
N_SCADA_CTRL[5].9	40006.9	BOOL	spare bit		
N_SCADA_CTRL[5].10	40006.10	BOOL	spare bit		
N_SCADA_CTRL[5].11	40006.11	BOOL	spare bit		
N_SCADA_CTRL[5].12	40006.12	BOOL	spare bit		
N_SCADA_CTRL[5].13	40006.13	BOOL	spare bit		
N_SCADA_CTRL[5].14	40006.14	BOOL	spare bit		
N_SCADA_CTRL[5].15	40006.15	BOOL	spare bit		
N_SCADA_CTRL[6].0	40007.0	BOOL	spare bit		
N_SCADA_CTRL[6].1	40007.1	BOOL	spare bit		
N_SCADA_CTRL[6].2	40007.2	BOOL	spare bit		
N_SCADA_CTRL[6].3	40007.3	BOOL	spare bit		
N_SCADA_CTRL[6].4	40007.4	BOOL	spare bit		
N_SCADA_CTRL[6].5	40007.5	BOOL	spare bit		
N_SCADA_CTRL[6].6	40007.6	BOOL	spare bit		
N_SCADA_CTRL[6].7	40007.7	BOOL	spare bit		
N_SCADA_CTRL[6].8	40007.8	BOOL	spare bit		
N_SCADA_CTRL[6].9	40007.9	BOOL	spare bit		
N_SCADA_CTRL[6].10	40007.10	BOOL	spare bit		
N_SCADA_CTRL[6].11	40007.11	BOOL	spare bit		
N_SCADA_CTRL[6].12	40007.12	BOOL	spare bit		
N_SCADA_CTRL[6].13	40007.13	BOOL	spare bit		
N_SCADA_CTRL[6].14	40007.14	BOOL	spare bit		
N_SCADA_CTRL[6].15	40007.15	BOOL	spare bit		

To DCS – System

Tag Name	Modbus Address	Data Type	Description	Units	Scaling
N_SCADA_SYS[0].0	41001.0	BOOL	Common minor alarm	1 = Fault	
N_SCADA_SYS[0].1	41001.1	BOOL	Common major alarm	1 = Fault	
N_SCADA_SYS[0].2	41001.2	BOOL	Common critical alarm	1 = Fault	
N_SCADA_SYS[0].3	41001.3	BOOL	Common hsc alarm	1 = Fault	
N_SCADA_SYS[0].4	41001.4	BOOL	Watchdog pulse	2s On then 2s Off	
N_SCADA_SYS[0].5	41001.5	BOOL	spare bit		
N_SCADA_SYS[0].6	41001.6	BOOL	spare bit		
N_SCADA_SYS[0].7	41001.7	BOOL	spare bit		
N_SCADA_SYS[0].8	41001.8	BOOL	spare bit		
N_SCADA_SYS[0].9	41001.9	BOOL	spare bit		
N_SCADA_SYS[0].10	41001.10	BOOL	spare bit		
N_SCADA_SYS[0].11	41001.11	BOOL	spare bit		
N_SCADA_SYS[0].12	41001.12	BOOL	spare bit		
N_SCADA_SYS[0].13	41001.13	BOOL	spare bit		
N_SCADA_SYS[0].14	41001.14	BOOL	spare bit		
N_SCADA_SYS[0].15	41001.15	BOOL	spare bit		
N_SCADA_SYS[1].0	41002.0	BOOL	SCC run on UPS	1 = Fault	
N_SCADA_SYS[1].1	41002.1	BOOL	reserved		
N_SCADA_SYS[1].2	41002.2	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].3	41002.3	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].4	41002.4	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].5	41002.5	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].6	41002.6	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].7	41002.7	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].8	41002.8	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].9	41002.9	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].10	41002.10	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].11	41002.11	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].12	41002.12	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].13	41002.13	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].14	41002.14	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[1].15	41002.15	BOOL	spare bit for critical system alarms		
N_SCADA_SYS[2].0	41003.0	BOOL	Low UV dose alarm	1 = Fault	
N_SCADA_SYS[2].1	41003.1	BOOL	Not enough healthy channels	1 = Fault	
N_SCADA_SYS[2].2	41003.2	BOOL	UVT meter fault	1 = Fault	
N_SCADA_SYS[2].3	41003.3	BOOL	Low UVT - out of validation range	1 = Fault	
N_SCADA_SYS[2].4	41003.4	BOOL	Flow meter fault	1 = Fault	
N_SCADA_SYS[2].5	41003.5	BOOL	High flow - out of validation range	1 = Fault	
N_SCADA_SYS[2].6	41003.6	BOOL	Low flow alarm	1 = Fault	
N_SCADA_SYS[2].7	41003.7	BOOL	SCC Controller fault	1 = Fault	
N_SCADA_SYS[2].8	41003.8	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].9	41003.9	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].10	41003.10	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].11	41003.11	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].12	41003.12	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].13	41003.13	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].14	41003.14	BOOL	spare bit for major system alarms		
N_SCADA_SYS[2].15	41003.15	BOOL	spare bit for major system alarms		
N_SCADA_SYS[3].0	41004.0	BOOL	SCC Controller low battery	1 = Fault	
N_SCADA_SYS[3].1	41004.1	BOOL	System power on reset	1 = Fault	
N_SCADA_SYS[3].2	41004.2	BOOL	SCC power restored	1 = Fault	
N_SCADA_SYS[3].3	41004.3	BOOL	UPS fault	1 = Fault	
N_SCADA_SYS[3].4	41004.4	BOOL	DCS fault detected	1 = Fault	
N_SCADA_SYS[3].5	41004.5	BOOL	System in transition	1 = In Transition	
N_SCADA_SYS[3].6	41004.6	BOOL	UVT below design value	1 = Fault	
N_SCADA_SYS[3].7	41004.7	BOOL	Low UVT alarm	1 = Fault	
N_SCADA_SYS[3].8	41004.8	BOOL	UVT meter override value used	1 = Fault	
N_SCADA_SYS[3].9	41004.9	BOOL	High UVT – out of validation range	1 = Fault	
N_SCADA_SYS[3].10	41004.10	BOOL	Flow meter override value used	1 = Fault	
N_SCADA_SYS[3].11	41004.11	BOOL	Low flow – out of validation range	1 = Fault	
N_SCADA_SYS[3].12	41004.12	BOOL	spare bit for minor system alarms		
N_SCADA_SYS[3].13	41004.13	BOOL	spare bit for minor system alarms		
N_SCADA_SYS[3].14	41004.14	BOOL	spare bit for minor system alarms		
N_SCADA_SYS[3].15	41004.15	BOOL	spare bit for minor system alarms		
N_SCADA_SYS[4]	41005	INT	System flow	Flow Units	x10
N_SCADA_SYS[5]	41006	INT	Calculated system UV dose	mJ/cm2	x100
N_SCADA_SYS[6]	41007	INT	UV transmittance	%	x10
N_SCADA_SYS[7]	41008	INT	spare word		
N_SCADA_SYS[8]	41009	INT	spare word		
N_SCADA_SYS[9]	41010	INT	spare word		
N_SCADA_SYS[10]	41011	INT	spare word		

To DCS – UV CHANNEL

Tag Name	Modbus Address	Data Type	Description	Units	Scaling
N_SCADA_CH1[0].0	41012.0	BOOL	UV CHANNEL minor alarm	1 = Fault	
N_SCADA_CH1[0].1	41012.1	BOOL	UV CHANNEL major alarm	1 = Fault	
N_SCADA_CH1[0].2	41012.2	BOOL	UV CHANNEL critical alarm	1 = Fault	
N_SCADA_CH1[0].3	41012.3	BOOL	UV CHANNEL HSC alarm	1 = Fault	
N_SCADA_CH1[0].4	41012.4	BOOL	UV CHANNEL in operation	1 = In Operation	
N_SCADA_CH1[0].5	41012.5	BOOL	UV CHANNEL low water level condition	1 = Low Water	
N_SCADA_CH1[0].6	41012.6	BOOL	UV CHANNEL inlet gate fully open	1 = Open	
N_SCADA_CH1[0].7	41012.7	BOOL	UV CHANNEL inlet gate fully closed	1 = Closed	
N_SCADA_CH1[0].8	41012.8	BOOL	spare bit		
N_SCADA_CH1[0].9	41012.9	BOOL	spare bit		
N_SCADA_CH1[0].10	41012.10	BOOL	spare bit		
N_SCADA_CH1[0].11	41012.11	BOOL	spare bit		
N_SCADA_CH1[0].12	41012.12	BOOL	spare bit		
N_SCADA_CH1[0].13	41012.13	BOOL	spare bit		
N_SCADA_CH1[0].14	41012.14	BOOL	spare bit		
N_SCADA_CH1[0].15	41012.15	BOOL	spare bit		
N_SCADA_CH1[1].0	41013.0	BOOL	UV CHANNEL water level signal fault	1 = Fault	
N_SCADA_CH1[1].1	41013.1	BOOL	UV CHANNEL not enough healthy banks	1 = Fault	
N_SCADA_CH1[1].2	41013.2	BOOL	UV CHANNEL high water level alarm	1 = Fault	
N_SCADA_CH1[1].3	41013.3	BOOL	UV CHANNEL design flow exceeded	1 = Fault	
N_SCADA_CH1[1].4	41013.4	BOOL	UV CHANNEL maximum flow velocity exceeded	1 = Fault	
N_SCADA_CH1[1].5	41013.5	BOOL	UV CHANNEL flow limit for wiping exceeded	1 = Fault	
N_SCADA_CH1[1].6	41013.6	BOOL	UV CHANNEL inlet gate failed to start opening	1 = Fault	
N_SCADA_CH1[1].7	41013.7	BOOL	UV CHANNEL inlet gate failed to open	1 = Fault	
N_SCADA_CH1[1].8	41013.8	BOOL	UV CHANNEL inlet gate failed to start closing	1 = Fault	
N_SCADA_CH1[1].9	41013.9	BOOL	UV CHANNEL inlet gate failed to close	1 = Fault	
N_SCADA_CH1[1].10	41013.10	BOOL	UV CHANNEL inlet gate not in remote auto	1 = Fault	
N_SCADA_CH1[1].11	41013.11	BOOL	UV CHANNEL weir gate position signal fault	1 = Fault	
N_SCADA_CH1[1].12	41013.12	BOOL	UV CHANNEL weir gate fail to move	1 = Fault	
N_SCADA_CH1[1].13	41013.13	BOOL	UV CHANNEL weir gate discrete fault	1 = Fault	
N_SCADA_CH1[1].14	41013.14	BOOL	UV CHANNEL weir gate not in remote auto	1 = Fault	
N_SCADA_CH1[1].15	41013.15	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].0	41014.0	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].1	41014.1	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].2	41014.2	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].3	41014.3	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].4	41014.4	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].5	41014.5	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].6	41014.6	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].7	41014.7	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].8	41014.8	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].9	41014.9	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].10	41014.10	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].11	41014.11	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].12	41014.12	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].13	41014.13	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].14	41014.14	BOOL	spare bit for channel alarms		
N_SCADA_CH1[2].15	41014.15	BOOL	spare bit for channel alarms		
N_SCADA_CH1[3].0	41015.0	BOOL	HSC 1 (TYP OF 2) hydraulic tank low level	1 = Fault	
N_SCADA_CH1[3].1	41015.1	BOOL	HSC 1 (TYP OF 2) pump fault	1 = Fault	
N_SCADA_CH1[3].2	41015.2	BOOL	HSC 1 (TYP OF 2) - SCC communication fault	1 = Fault	
N_SCADA_CH1[3].3	41015.3	BOOL	HSC 1 (TYP OF 2) remote wipe inhibited	1 = Inhibited	
N_SCADA_CH1[3].8	41015.8	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].9	41015.9	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].10	41015.10	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].11	41015.11	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].12	41015.12	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].13	41015.13	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].14	41015.14	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[3].15	41015.15	BOOL	spare bit for hsc alarms		
N_SCADA_CH1[4]	41016	INT	UV CHANNEL weir gate position	% Open 0 – 100%	x1
N_SCADA_CH1[5]	41017	INT	UV CHANNEL water level	Water Level Units	x10
N_SCADA_CH1[6]	41018	INT	spare word		
N_SCADA_CH1[7]	41019	INT	spare word		
N_SCADA_CH1[8]	41020	INT	spare word		
N_SCADA_CH1[9]	41021	INT	spare word		

To DCS – UV CHANNEL BANKS

Tag Name	Modbus Address	Data Type	Description	Units	Scaling
N_SCADA_CH1[10].0	41022.0	BOOL	BANK 1 (TYP OF 8) minor alarm	1 = Fault	
N_SCADA_CH1[10].1	41022.1	BOOL	BANK 1 (TYP OF 8) major alarm	1 = Fault	
N_SCADA_CH1[10].2	41022.2	BOOL	BANK 1 (TYP OF 8) critical alarm	1 = Fault	
N_SCADA_CH1[10].3	41022.3	BOOL	BANK 1 (TYP OF 8) HSC alarm	1 = Fault	
N_SCADA_CH1[10].4	41022.4	BOOL	BANK 1 (TYP OF 8) in operation	1 = Operating	
N_SCADA_CH1[10].5	41022.5	BOOL	spare bit		
N_SCADA_CH1[10].6	41022.6	BOOL	spare bit		
N_SCADA_CH1[10].7	41022.7	BOOL	spare bit		
N_SCADA_CH1[10].8	41022.8	BOOL	spare bit		
N_SCADA_CH1[10].9	41022.9	BOOL	spare bit		
N_SCADA_CH1[10].10	41022.10	BOOL	spare bit		
N_SCADA_CH1[10].11	41022.11	BOOL	spare bit		
N_SCADA_CH1[10].12	41022.12	BOOL	spare bit		
N_SCADA_CH1[10].13	41022.13	BOOL	spare bit		
N_SCADA_CH1[10].14	41022.14	BOOL	spare bit		
N_SCADA_CH1[10].15	41022.15	BOOL	spare bit		
N_SCADA_CH1[11].0	41023.0	BOOL	BANK 1 (TYP OF 8) wiper jammed	1 = Fault	
N_SCADA_CH1[11].1	41023.1	BOOL	BANK 1 (TYP OF 8) wiper travel time exceeded	1 = Fault	
N_SCADA_CH1[11].2	41023.2	BOOL	BANK 1 (TYP OF 8) wiper not in remote	1 = Fault	
N_SCADA_CH1[11].3	41023.3	BOOL	BANK 1 (TYP OF 8) wiper unknown position	1 = Fault	
N_SCADA_CH1[11].4	41023.4	BOOL	BANK 1 (TYP OF 8) lift attempted with lamps energized	1 = Fault	
N_SCADA_CH1[11].5	41023.5	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].6	41023.6	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].7	41023.7	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].8	41023.8	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].9	41023.9	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].10	41023.10	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].11	41023.11	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].12	41023.12	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].13	41023.13	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].14	41023.14	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[11].15	41023.15	BOOL	spare bit for bank wiper alarms		
N_SCADA_CH1[12].0	41024.0	BOOL	BANK 1 (TYP OF 8) PDC high temp shutdown	1 = Fault	
N_SCADA_CH1[12].1	41024.1	BOOL	BANK 1 (TYP OF 8) not in place	1 = Fault	
N_SCADA_CH1[12].2	41024.2	BOOL	BANK 1 (TYP OF 8) low water level shutdown	1 = Fault	
N_SCADA_CH1[12].3	41024.3	BOOL	BANK 1 (TYP OF 8) PDC disconnect off	1 = Off	
N_SCADA_CH1[12].4	41024.4	BOOL	BANK 1 (TYP OF 8) SCC-PDC comm fault	1 = Fault	
N_SCADA_CH1[12].5	41024.5	BOOL	BANK 1 (TYP OF 8) multi lamp failure	1 = Fault	
N_SCADA_CH1[12].6	41024.6	BOOL	BANK 1 (TYP OF 8) configuration mismatch	1 = Fault	
N_SCADA_CH1[12].7	41024.7	BOOL	BANK 1 (TYP OF 8) not enough healthy lamps	1 = Fault	
N_SCADA_CH1[12].8	41024.8	BOOL	BANK 1 (TYP OF 8) UVI sensor faulted	1 = Fault	
N_SCADA_CH1[12].9	41024.9	BOOL	BANK 1 (TYP OF 8) UVI lower than expected	1 = Fault	
N_SCADA_CH1[12].10	41024.10	BOOL	BANK 1 (TYP OF 8) BCB DIPSwitch mismatch	1 = Fault	
N_SCADA_CH1[12].11	41024.11	BOOL	spare bit for bank critical/major alarm		
N_SCADA_CH1[12].12	41024.12	BOOL	spare bit for bank critical/major alarm		
N_SCADA_CH1[12].13	41024.13	BOOL	spare bit for bank critical/major alarm		
N_SCADA_CH1[12].14	41024.14	BOOL	spare bit for bank critical/major alarm		
N_SCADA_CH1[12].15	41024.15	BOOL	spare bit for bank critical/major alarm		
N_SCADA_CH1[13].0	41025.0	BOOL	BANK 1 (TYP OF 8) not sealed		
N_SCADA_CH1[13].1	41025.1	BOOL	BANK 1 (TYP OF 8) not in remote auto	1 = Fault	
N_SCADA_CH1[13].2	41025.2	BOOL	BANK 1 (TYP OF 8) low level warning	1 = Fault	
N_SCADA_CH1[13].3	41025.3	BOOL	BANK 1 (TYP OF 8) PDC fan failure	1 = Fault	
N_SCADA_CH1[13].4	41025.4	BOOL	reserved		
N_SCADA_CH1[13].5	41025.5	BOOL	BANK 1 (TYP OF 8) PDC high temperature warning	1 = Fault	
N_SCADA_CH1[13].6	41025.6	BOOL	BANK 1 (TYP OF 8) lamp failure	1 = Fault	
N_SCADA_CH1[13].7	41025.7	BOOL	BANK 1 (TYP OF 8) lamp lifetime exceeded	1 = Fault	
N_SCADA_CH1[13].8	41025.8	BOOL	BANK 1 (TYP OF 8) lamp driver failure	1 = Fault	
N_SCADA_CH1[13].9	41025.9	BOOL	BANK 1 (TYP OF 8) lamp driver comm failure	1 = Fault	
N_SCADA_CH1[13].10	41025.10	BOOL	BANK 1 (TYP OF 8) lamp disabled	1 = Disabled	
N_SCADA_CH1[13].11	41025.11	BOOL	BANK 1 (TYP OF 8) UVI sensor faulted	1 = Fault	
N_SCADA_CH1[13].12	41025.12	BOOL	BANK 1 (TYP OF 8) UVI lower than expected warning	1 = Fault	
N_SCADA_CH1[13].13	41025.13	BOOL	BANK 1 (TYP OF 8) UVI reference check required	1 = Fault	
N_SCADA_CH1[13].14	41025.14	BOOL	BANK 1 (TYP OF 8) UVI reference check active	1 = Active	
N_SCADA_CH1[13].15	41025.15	BOOL	spare bit for bank minor alarm		
N_SCADA_CH1[14]	41026	INT	BANK 1 (TYP OF 8) lamp hours	Hours	x1
N_SCADA_CH1[15]	41027	INT	BANK 1 (TYP OF 8) lamp power	Power (%)	x1
N_SCADA_CH1[16]	41028	INT	BANK 1 (TYP OF 8) UVI	mW/cm2	x1000
N_SCADA_CH1[17]	41029	INT	spare word		
N_SCADA_CH1[18]	41030	INT	spare word		
N_SCADA_CH1[19]	41031	INT	spare word		

ADDRESSING SUMMARY

Description	Tag Name	Modbus Mapping Range	Number of Words	Direction
System Control	N_SCADA_CTRL	40001 thru 40007	7	From DCS to UV System
System Status	N_SCADA_SYS	41001 thru 41011	11	To DCS from UV System
UV CHANNEL Status	N_SCADA_CH1	41012 thru 41021	10	To DCS from UV System
UV CHANNEL Bank 1 Status	N_SCADA_CH1	41022 thru 41031	10	To DCS from UV System
UV CHANNEL Bank 2 Status	N_SCADA_CH1	41032 thru 41041	10	To DCS from UV System
UV CHANNEL Bank 3 Status	N_SCADA_CH1	41042 thru 41051	10	To DCS from UV System
UV CHANNEL Bank 4 Status	N_SCADA_CH1	41052 thru 41061	10	To DCS from UV System
UV CHANNEL Bank 5 Status	N_SCADA_CH1	41062 thru 41071	10	To DCS from UV System
UV CHANNEL Bank 6 Status	N_SCADA_CH1	41072 thru 41081	10	To DCS from UV System
UV CHANNEL Bank 7 Status	N_SCADA_CH1	41082 thru 41091	10	To DCS from UV System
UV CHANNEL Bank 8 Status	N_SCADA_CH1	41092 thru 41101	10	To DCS from UV System

SECTION 13300 - INSTRUMENTATION AND CONTROL

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes the general specification and requirements for the instrumentation and control WORK under this and other applicable Specifications. The WORK also includes providing instrumentation and all related wiring as shown in these Contract Documents.

B. All DCS programming shall be provided and paid by the CITY. The CONTRACTOR is responsible for a complete and functional system. The CONTRACTOR shall meet the functionality, intent, and requirements provided in the control strategies, equipment specific specification, control diagrams, P&ID's, Commissioning, and all other related Contract Documents. Not all information is explicitly provided in each of these documents, but all of the Contract Documents as a whole constitute the requirements to be provided by the CONTRACTOR. It is the intent of the Contract Documents to show information once, and not to repeat that information again and again throughout all the other related documents. The CONTRACTOR is responsible for providing their subs with all the required information.

C. All DCS related panels and internal devices shall be provided by Emerson Process Management Power & Water Solutions, Inc (Emerson). Equivalent products will not be accepted.

D. All network switch configurations shall be provided by the CITY. Any associated third party I/O development hardware addressing shall be supplied by the vendor.

E. Communication protocols between equipment shall be the responsibility of the CONTRACTOR and Emerson.

F. The CONTRACTOR shall be responsible for the design, procurement, installation, testing, training, and documentation for instrumentation and control systems provided under this Contract. The CONTRACTOR shall be responsible for installing and terminating DCS inputs and outputs (I/O), providing power, data links to the DCS, and for installing and testing all equipment.

G. The CONTRACTOR shall be responsible for providing instrument submittals to be used in the generation of panel wiring diagrams and loop drawings which depict the interconnection between all devices shown in the Contract Documents.

H. The CONTRACTOR shall generate complete loop drawings for each measuring or control loop. The loop shall include a minimum of 3 sheets as required in paragraph 1.5 B.3. The CONTRACTOR shall furnish the Project-wide Loop Drawing Submittal (PLDS) that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under the instrumentation sections, and equipment provided under sections in other Divisions.

I. The CONTRACTOR is responsible for providing a complete and functional system. The

CONTRACTOR and their associated vendors shall provide input, coordination, and oversight with regards to the CITY provided DCS programming.

J. All control system field tests including loop tests, plant commissioning, and plant startup, shall be the responsibility of the CONTRACTOR. The CONTRACTOR shall provide knowledgeable personnel including electrical engineer, I&C engineer, and process engineer during all field tests. The CONTRACTOR shall be responsible for providing field and control room personnel to witness the simulation of field inputs associated with the DCS I/O and points that are data linked to the DCS. The CONTRACTOR shall be responsible for providing all competent personnel and NIST certified, current within a year, equipment (current drivers, jumpers, read out devices, oscilloscopes, voltage-resistance meters, etc.) required to perform the loop test simulations. All devices used shall be traceable to the National Institute of Standards and Technology (NIST).

K. The CONTRACTOR shall perform field engineering design as required for mounting and supporting all field mounted components. The CONTRACTOR shall develop any additional schematic and interconnection diagrams which may be required for complete and operable instrumentation.

L. The CONTRACTOR shall provide all components, system installation services, as well as all required and specified ancillary services in connection with the I&C system. The system includes all materials, labor, tools and documentation required to furnish, install, test and place in operation a complete and operable I&C system as shown and/or specified in the contract drawings. The CONTRACTOR shall include, but is not limited to, witnessing the functional testing of all control loops ensuring instruments and wiring for each loop have been correctly installed. The CONTRACTOR shall also ensure, amongst other tasks that, all wires are correctly numbered, drawings are correctly updated and within the required time frame and that all parties concerned work to the project time line to meet project milestones. During commissioning the CONTRACTOR shall coordinate between the relevant subcontractors to ensure that the necessary stage of completion is reached by all involved parties and all functional tests have been performed satisfactorily before that particular phase of the project is scheduled for commissioning. This shall include polarity and functional tests of all field devices, all data communication links are functional and all devices being controlled and monitored are adequately represented on the graphic display including any associated functions, which may be required.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 09800 Protective Coating
2. Division 11 Equipment, as applicable
3. Division 15 Mechanical, as applicable
4. Division 16 Electrical, as applicable

1.3 CODES

A. WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Fire Code
2. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ANSI/ASME B 16.5	Pipe Flanges and Flanged Fittings
API RP-550	Manual on Installation of Refinery Instruments and Control Systems, Part 1 - Process Instrumentation and Control Sections 1 Through 13
ASTM A 105	Specification for Forgings, Carbon Steel for Piping Components
ASTM A 193	Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM A 312	Stainless Steel Piping
ISA-RP60.6	Nameplates, Labels, and Tags for Control Centers
ISA-RP7.1	Pneumatic Control Circuit Pressure Test
ISA-RP12.6	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA-S5.1	Instrument Symbols and Identification
ISA-S5.4	Instrument Loop Diagrams
ISA-S12.4	Instrument Purging for Reduction of Hazardous Area Classification
ISA-S20	Specification Forms for Process Measurement and Control Instrumentation; Primary Elements and Control Valves
ANSI - B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In Through 144 In.
ANSI/AWWA C701	Cold-Water Meters - Turbine Type for Customer Service
ANSI/AWWA C702	Cold-Water Meters - Compound Type
AWWA C704	Cold-Water Meters - Propeller Type for Main Line Applications
ASTM A 126	Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
ASTM B 61	Specification for Steam or Valve Bronze Castings
ANSI/AWWA	Ductile-Iron and Gray-Iron Fittings, 3-In Through C110/A21.10 48-In for Water and Other Liquids
ASME REPORT	Fluid Meters, Sixth Edition, 1971

1.5 SHOP DRAWINGS AND SAMPLES

A. **Presubmittal Conference:**

1. The CONTRACTOR shall arrange and conduct a Presubmittal Conference within 60 days after award of the Contract. The purpose of the Presubmittal Conference is to review and approve the manner in which the CONTRACTOR intends to carry out his responsibilities for shop drawing submittal on the WORK to be provided under this Section. The CONTRACTOR and the CONSTRUCTION MANAGER shall attend. Both the CONTRACTOR and the CONSTRUCTION MANAGER may invite additional parties at their discretion.

2. The CONTRACTOR shall allot one, 4-hour day for the Conference

3. The CONTRACTOR shall prepare the following for discussion at the Conference:

    a. List of equipment and materials for the instrumentation systems, including proposed manufacturer names and model numbers.

    b. List of proposed clarifications to the indicated requirements plus a brief written explanation of each exception.

    c. One complete example of each type of submittal proposed.

    d. A flow chart showing the steps the CONTRACTOR will take in preparing and coordinating each submittal to the CITY's CONSTRUCTION MANAGER.

    e. A bar chart type schedule for the WORK provided under this Section, covering the time period beginning with the conference and ending after startup and training. Dates for the beginning and ending of submittal preparation, submittal review, design, fabrication, programming, factory testing, delivery to the site, installation, field testing, and training shall be scheduled. The schedule shall be subdivided into major items or groups of items which are on the same schedule.

4. The CONTRACTOR shall furnish 3 copies of all the items above to the CONSTRUCTION MANAGER.

5. The CONTRACTOR shall take formal minutes of the Conference, including all events, questions, and resolutions. Prior to adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. **Shop Drawings:**

1. General:

    a. Preparation of shop drawings shall not commence until adjournment of the Presubmittal Conference.

    b. Preliminary Shop Drawings shall be submitted as a single package at one time within 90 days of the commencement data stated in the Notice to Proceed.

c. Both paper (hard copy) and electronic copies are required for both Preliminary and Final Shop Drawing submittals.

d. In the Contract Documents, all systems, meters, instruments, and other elements are represented by symbology derived from the latest version of ANSI/ISA S5.1. The nomenclature and numbers indicated herein shall be used exclusively in all shop drawings. No manufacturer's standard symbology or nomenclature shall replace those indicated in the Contract Documents.

e. During the period of shop drawing preparation, the CONTRACTOR shall maintain a direct, informal liaison with the CONSTRUCTION MANAGER for exchange of technical information. As a result of the exchange, certain minor refinements and revisions to the indicated systems may be authorized informally by the CONSTRUCTION MANAGER but these shall not alter the WORK or cause increase or decrease in the Contract Price. During informal exchanges, no statement by the CONSTRUCTION MANAGER shall be construed as approval of any component or method or exception to or variation from these Contract Documents.

2. **Submittals:**

a. Preliminary Submittal: Four hard copies of the preliminary submittal shall be provided for the City's review. Documents in a PDF format shall also be provided.

b. Final Submittal: All documents, including design and O&M documents, shall be provided on CD-ROM. One set of CD-ROMS shall contain the native file formats (MicroStation, MS Word, MS Excel, etc.), and the other in PDF format, using the same file name with "PDF" or "TIF" as the file extension. Four hard copies of the final submittal shall be provided as well as a pdf copy.

c. Each document shall be indexed, and a database table in Excel shall be provided which includes the following data for each document

(1) Document file name
(2) Document description
(3) Hard Copy Catalog No. (used by facility document coordinator)
(4) Document Type:
  (a) Shop drawings
    i) P&IDs
    ii) Loop Drawings
    iii) Instrument Data Sheets
    iv) Other
  (b) Manufacturer's data
  (c) Maintenance instructions
  (d) Training
(5) Facility Name
(6) Specification Number
(7) Process Name
(8) Unit Process Number

d. Electronic Document Submittal Requirements:

(1) All documents shall be submitted in electronic format, including shop drawings manufacturer's data and O&M manuals.

(2) Documents shall be in Adobe Acrobat PDF format, version as specified by the Contract Manager. Vendor and CONTRACTOR shop drawings developed under the Contract shall be in Bentley MicroStation (.DGN) format. Documents in electronic format (WordPerfect, Microsoft Word, Excel, Lotus, etc.) shall be electronically converted to standard PDF format. In order to minimize file size, drawing conversion from MicroStation files to Acrobat PDF shall be in monochrome.

(3) Deviation from this standard will be accepted only if advance approval is given by the Owner.

(4) Documents not available in electronic format shall be scanned at 300 dpi, bitonal (black and white) for documents without graphics, or 300 dpi color for documents with graphics where color is required for legibility, and converted into Adobe Acrobat (PDF). Scanned image enhancement software shall be used. PDF sub-format shall be full Image + Hidden Text PDF file format.

(5) All PDF documents shall be reviewed, and corrected if necessary, for orientation and legibility.

(6) Individual document files shall not exceed 3 megabytes in size.

e. Paper Document Submittal Requirements

(1) All shop drawings shall include the letterhead or title block of the CONTRACTOR. The title block shall include, as a minimum, the CONTRACTOR registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.

(2) Shop drawing copies shall be submitted as standard size 3-ring, loose leaf, vinyl plastic binders suitable for bookshelf storage. Maximum binder size shall be 2 inches.

(3) A complete index shall be placed at the front of each binder.

(4) A separate technical brochure or bulletin shall be included for each instrument, meter system, and other element. The brochures shall be indexed by systems or loops. If, within a single system or loop, a single item is employed more than once, one brochure may cover all identical uses of that item in the system. Each brochure shall include a list of tag numbers to which it applies. System groups shall be separated by labeled tags.

(5) All shop drawings shall be produced in using MicroStation CAD formats. Each shop drawing submittal shall include the requisite number of hard copies and one (1) MicroStation electronic copy. Upon completion of this project, the CONTRACTOR shall submit four (4) electronic copies of all current shop drawings.

3. **Loop Diagrams:** The CONTRACTOR shall be responsible for the accuracy of the information within the loop drawings. Upon completion of the loop drawings, the CONTRACTOR shall review and upon satisfaction of the accuracy of the documents

shall provide a letter to the OWNER stating that the loop drawings properly reflect the projects as-built condition. Sample loop drawings are provided at the end of this Section in ***Appendix B – Sample Loop Drawings***. The PLDS shall be a singular complete bound package submitted 80 days prior to SUBSTANTIAL COMPLETION. Loop diagrams shall be provided conforming to ISA 5.4 to verify the DCS interfaces with all instrumentation and devices being provided or installed under the project. The loop diagrams shall also define all interfaces with equipment provided by area CONTRACTORs. The following three-sheet format is required:

a. Sheet 1: A device schedule developed from an electronic spreadsheet or database file, which will be submitted with the loop diagrams. The table will show the following:

    (1) Device tag number, with Prefix, Unit Process, ISA Tag Prefix, Tag No. (a three or four-digit number based on the loop number) and Tag suffix
    (2) Equipment Service
    (3) Device Type
    (4) Location
    (5) Device Manufacturer
    (6) Model No.
    (7) Spec. No.
    (8) Area CONTRACTOR (if applicable)
    (9) Submittal No.
    (10) Calibrated Range/Remarks
    (11) Data Sheet No.
    (12) I/O Signal type (AI, AO, DI, or DO)
    (13) Signal Level
    (14) Device Range (full available instrument range)
    (15) Engineering Units
    (16) Process Set Point
    (17) Loop Diagram No., reflecting the field instrument tag number.
    (18) Loop Drawing File Name
    (19) Interconnect Drawing File Name

b. Sheet 2: Loop drawing meeting the Requirements of ANSI/ISA S5.4, except that intermediate terminal junction boxes may be omitted and be shown on Page 3 for clarity. Butt splices and wire nuts shall be shown on as-builts, with the corresponding termination housing (JB, LB, etc. shown on Sheet 3).

c. Sheet 3: (Expansion sheet - required if the number of intermediate devices or terminal junction boxes exceeds what can be legibly shown on Sheet 2). Abbreviated diagram showing instrument, wire and cable numbers, intermediate terminal junction boxes, and PCM terminations. Wire identification numbers will reflect the field instrument tag number, and not the DCS I/O number.

d. DCS I/O tag numbers will generally reflect the device tag number. Each I/O tag number will be unique. The tag prefix will be based on ISA-5.4, with the following additional special acronyms:

Acronym	Signal Use
YL	Ready Signals/ Status
ZL	In Computer status
ZSO	Device Open
ZSC	Device Closed
YL	Motor Run
HS	Equipment Start/Stop

4. **Technical brochures, bulletins and data sheets containing**:

    a. Fully completed ISA S20 data sheets
    b. Component functional descriptions
    c. Locations or assembly at which component is to be installed
    d. Materials of a component's parts which will be in contact with process fluids or gases

5. Schematic and wiring diagrams for control circuits shall be submitted in two stages. Initially, schematic control diagrams shall show complete details on the circuit interrelationships of all devices within and outside each Control Panel. Subsequent to acceptance of all schematic control diagrams, by the CONSTRUCTION MANAGER, piping and wiring diagrams shall be submitted. The diagrams shall consist of component layout drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as pumps, valves, chemical feeders and local control panels. Wiring diagrams shall include MCC Panel, circuit, and breaker number for each power feed

6. Assembly and construction drawings for each alarm annunciator, local indicating panel and for other special enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, surface preparation and finish data, and nameplates. These drawings also shall include enough other details, including prototype photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

7. Installation, mounting, and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.

8. Complete control panel layouts, all drawn to a 1-1/2 inch=1 foot scale showing:

    a. Physical arrangements which define and quantify the physical groupings of annunciators, hand stations, recorders, indicators, pilot lights and all other instrumentation devices associated with control panel sections, auxiliary panels, subpanels and racks.
    b. All cutout locations fully dimensioned. All outside panel dimensions shall be shown.
    c. Locations of back-of-panel stiffeners.
    d. Terminal point locations for all panel and back-of-panel piping and wiring connections. Terminations shall be coded with identifiers for wiring and piping connections for all electric, hydraulic and pneumatic terminations.

e. Nameplate engraving list.

f. A complete and detailed bill of material list shall be submitted for each field mounted device or assembly as well as cabinet assemblies and subassemblies. Bills of material shall include all items within an enclosure. An incomplete submittal shall be rejected and no further evaluation performed until a complete and detailed bill of material is submitted

1.6 OWNER'S MANUAL

A. The Owner's Manual shall be submitted in both paper and electronic format. Electronic format shall conform to the Electronic Document Submittal Requirements for Shop Drawings.

B. Information included in the OWNER'S MANUAL:

1. Two copies of the OWNER'S MANUAL shall be submitted after acceptance of all submittals under Paragraph 1.5. One set will be returned to the CONTRACTOR with comments.

2. Final copies of the OWNER'S MANUAL, after revisions, shall be submitted to the CONSTRUCTION MANAGER 15 days prior to startup.

C. The following shall be included in the OWNER'S MANUAL:

1. Installation, connection, operating, troubleshooting, maintenance, and overhaul instructions from the manufacturer.

2. Exploded or details views of all instruments, assemblies, and accessory components.

3. Parts lists and ordering instructions.

4. Wiring diagrams.

5. A list of spare parts for 1 year operation recommended by the manufacturers of all DCS equipment.

1.7 AS-BUILT DRAWINGS

A. As-built drawings shall be prepared with the following exceptions and changes:

1. The CONTRACTOR shall keep current an approved set of complete loop diagrams and schematic diagrams which shall include all field and panel wiring, all piping and tubing runs, all routing, all mounting details, all point-to-point diagrams with cable, wire, tube and termination numbers. These drawings shall include all instruments and all instrument elements for the complete instrument loop as provided under Divisions 11, 13, 14, 15, and 16 of this Contract.

2. One set of original drawings and two copies of each as-built drawing under this Section shall be submitted to the CONSTRUCTION MANAGER after completion of field checkout but before placing the systems in service for the OWNER'S use.

3. Drawings shall also be submitted in electronic format (MicroStation)

1.8 SERVICES OF MANUFACTURER

A. **Calibration, Testing and Startup**: A technical service representative of the manufacturer shall visit the site and perform the following on all devices.

1. Inspection, checking and calibrating the equipment.
2. Startup and field testing for proper operation.
3. Performing field adjustments to ensure that installation and operation comply with the Specifications.

B. **Instruction of OWNER'S Personnel**: The manufacturer's technical service representative shall instruct the OWNER'S personnel as indicated in Paragraph 3.4.

1.9 SPECIAL GUARANTEE

A. The CONTRACTOR shall guarantee the WORK of this section for two years following final acceptance of the WORK. In making any warranty repairs, the CONTRACTOR shall utilize technical service personnel designated by the manufacturer of the failed device. Repairs shall be completed within 5 days after written notification by the OWNER.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials**: Products delivered to the site for incorporation into the WORK of this Section shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

1.11 CABLE NUMBERING

A. The first two characters denote the facility or area number.

B. The second group of characters identifies the device being served.

C. The third section uses one of the four suffixes in the table below. Where multiple circuits of the same type are routed to the same endpoint, the suffix will be P1, P2, as required.

D. At each device or termination point, the circuit identification number is appended with the individual wire number. For Direct-Current (DC) circuits only, wire polarity is shown in parentheses as (+) or (-).

E. Spaces are not allowed, and letters are not case-sensitive, and written in upper case.

SUFFIX	CIRCUIT TYPE	EXAMPLE
(A)	24 v dc analog (4-20 mA)	01FIT022(A)-1(+)
(C)	120 volt AC control	05P320(C)-2
(D)	24v dc digital status or control	55LSH201(D)-1(+)
(P)	Power (120 volt, 480 V, 5 KV, 15 KV, etc.)	01MCC6101(P)-2

PART 2 -- PRODUCTS

2.1 GENERAL

A. All meters, all instruments, and all other components shall be of the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise indicated.

B. 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 of one manufacturer.

C. Outdoor instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations. Heating, cooling, and dehumidifying devices shall be incorporated with the outdoor instrumentation in order to maintain it within its rated environmental operating ranges. The CONTRACTOR shall provide all power wiring for these devices. Outdoor enclosures suitable for the environment shall be provided.

D. All instrumentation in hazardous areas shall be intrinsically safe or be approved for use in the particular hazardous classification in which it is to be installed.

E. Mercury switches and components containing liquid mercury shall not be used.

F. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the measured variable, except as indicated. Electrical signals outside control board(s) shall be 4 to 20 milliamperes DC except as noted. Signals within enclosures shall be 1-5 volts DC unless otherwise specified. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity.

G. The accuracy of each instrumentation system or loop shall be expressed as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracies" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of ± 0.5 percent of full scale and a minimum repeatability of ± 0.25 percent of full scale unless otherwise indicated. Instruments which do not conform to or improve upon these criteria are not acceptable.

H. Each control loop shall be individually fused.

I. Color Conventions: Lens covers for indicating lights on all panels will be colored as follows:

1. Red-ON when;
   Motor not running (STOPPED)
   Valve CLOSED (not fully opened)
   Device energized.
   Circuit breaker CLOSED

2. Green-ON when;
   Motor running in forward direction (fast speed for multi-speed motors).
   Valve OPEN (not fully closed)

Device not energized.
Circuit breaker OPENED

3. White-ON when;
Power available
System in AUTOMATIC mode.
Monitoring taking place.

4. Amber-ON when;
Malfunction trip.
Equipment locked out.
Alarm condition

J. **Nameplates:** Nameplates shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front panel(s) as indicated. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, and electronic trip mounted inside the panel(s). Nameplates shall be descriptive to define the function and system of such element. These nameplates shall be of the same material as those on the front of the panel(s). Adhesives shall be used for attaching nameplates. Nameplates shall be fabricated from black face white-center laminated engraving plastic. Painted surfaces shall be prepared to allow permanent bonding of adhesives. Colors, lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP60.6 with an intended viewing distance of 3 feet to 6 feet.

K. **Factory Inspection:**

1. Panels shall be inspected for compliance with requirements at the factory before shipment to the site. The CONTRACTOR shall notify the CONSTRUCTION MANAGER 2 weeks in advance of the testing date. A representative of the CONSTRUCTION MANAGER will visit the factory to make the inspection.

2. CONTRACTOR shall perform the following tests prior to arrival of the CONSTRUCTION MANAGER:

   a. All alarm circuits rung out to determine their operability.
   b. Electrical circuits checked for continuity and where applicable, operability.
   c. Nameplates checked for correct spelling and correct size of letters.
   d. Other test required to place the panel in an operating condition.

3. It shall be the responsibility of the CONTRACTOR to furnish all necessary testing devices and sufficient manpower to perform the tests required by the CONSTRUCTION MANAGER to determine conformance to the requirement of the Contract documents.

4. If the above tests have not been performed prior to the arrival of the CONSTRUCTION MANAGER, the CONTRACTOR shall reimburse the OWNER for the cost of the extra time required for the inspector's services and travel expenses.

L. **Shipment: Panels** shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during

shipment. Instruments which are shipped with the panel shall have suitable shipping stops and cushioning material installed to protect instrument parts from mechanical shock damage during shipment. Each panel crate shall be provided with removable lifting lugs to facilitate handling

2.2 ELECTRICAL REQUIREMENTS FOR CONTROL PANELS

A. The CONTRACTOR shall provide all wiring, conduit, wireways, and switches required to make instruments and other panel electrical devices operational. Conduit, wireways, junction boxes and fittings shall be installed for all signal wire, all thermocouple and resistance thermometer lead wire including those between temperature sensors and temperature indicators.

B. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. All wiring shall be identified with stamped tubular wire markers.

C. Freestanding panels shall be provided with switched back-of-panel LED lights which are powered from a source independent from that which powers the panel devices. One light shall be provided for every 4 feet of panel width and shall be mounted inside in the top of the back-of-panel area.

D. Freestanding panels shall be provided with a 15-amp, 120 volt service outlet circuit within the back-of-panel area which are powered from a source independent from that which powers the panel devices. The circuit shall be provided with one 3-wire, 120-volt, 15-ampere, duplex receptacle for every 4 feet of panel width spaced evenly along the back-of-panel area. As a minimum, 2 duplex outlets shall be provided for each panel.

E. Smaller panels shall be sized to adequately dissipate heat generated by equipment mounted in or on the panel.

F. Where smaller panels are mounted outside or in unshaded areas, they shall be provided with thermostatically controlled heaters capable of maintaining inside temperatures above 40 degrees F.

G. Smaller panels shall be provided with a hand-switch controlled LED light and a breaker protected 120-volt, 15-amp duplex receptacle.

H. Wiring Methods: Wiring methods and materials for all panels shall be in accordance with the NEC requirements for General Purpose unless otherwise indicated. Opening wiring in close cabinet type panels is allowed when indicated.

I. Construction: Shall meet the following unless otherwise shown on the Contract Drawings.

1. Wire for 115-volt circuits shall be No. 14 AWG stranded with Type THWN or THHN insulation. All terminals for external wiring connections shall be suitable for No. 12 AWG wire.

2. Flexible conduit is not acceptable.

3. Conduit fittings shall be cast fittings.

4. Soldered or pressure crimped wire splicing in conduits shall be acceptable.

5. For case grounding, panels shall be provided with a 1/4-inch by 1-inch copper ground buss completed with solderless connector for one No. 4 AWG bare stranded copper cable. The CONTRACTOR shall connect the copper cable to a system ground loop.

6. Single case annunciator units with no remote logic which are installed at the top of a panel may be considered as being a terminal box when top of panel wire entry is indicated. If bottom of panel entry is indicated, terminal box shall be provided at the bottom of the panel and wired to the annunciator. Terminals shall be identified with plastic marker strips.

7. Terminal boxes for incoming and outgoing signal leads shall be located at the top or bottom of the panel as indicated or as otherwise required.

J. **Power Supply Wiring:**

1. Unless otherwise indicated, all instruments, all alarm systems, and all motor controls shall operate on 24 VDC circuits.

2. The CONTRACTOR shall furnish terminal box connections for the main power supply entry as indicated.

3. Power supply switches for alarm units shall be three pole type, arranged to open both the power and alarm circuits. Each annunciator shall be equipped with a separate switch.

4. Instruments located on a single panel section which serve one process unit may be connected to a common branch power circuit. The number of branch circuits shall be such that no circuit load exceeds 10 amps. Different panel sections and instruments serving different process units shall not use common branch circuits. A 15-amp, two-pole circuit breaker shall be provided in each branch circuit. When instruments do not come equipped with integral fuses, the panel fabricator shall furnish and install fuses as required for the protection of individual instrument against fault currents. Fuses shall be mounted on the back of the panel, in a fuse holder, with each fuse identified by a service name tag.

5. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags listing the associated instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated.

6. Where alarm units are single unit types, one switch may be used to disconnect not more than six alarm units located on the same or adjacent panels.

K. **Signal Wiring:**

a. Computer and Non-Computer Use: Signal wire shall be twisted shielded pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG copper signal wires with THWN or THHN insulation. Color code for instrument signal wiring shall be:

(1) Positive - Black (+)

(2) Signal Ground Negative - White (-)
(3) Equipment Ground - Green
(4) Ungrounded - Red
(5) Energized by voltage sound external to panel - Yellow
(6) DC circuit - Blue

b. Multiconductor cables where indicated shall consist of No. 16 AWG copper signal wires twisted in pairs, with 600 volt fault insulation. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

c. Multi-conductor cables, wireways and conduit shall provide for 10 percent allocation of spare, unused signal wires in addition to the indicated requirements.

L. **Terminal Blocks:** Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600-volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid.

2.3 GENERAL INSTRUMENTATION ENCLOSURE COMPONENTS

A. **Signal Isolators, Converters, and Power Supplies:** Signal isolators shall be provided in each measurement and control loop, wherever required, to match adjacent component impedances, or where feedback paths may be generated or to maintain loop integrity when the removal of a component of a loop is required. Signal converters shall be provided where required to resolve any signal incompatibilities. Signal power supplies shall be provided to supply sufficient power to each loop component.

B. **General Purpose Relays:** General purpose relays in the Control Panels shall be plug-in type with contacts **rated** 10 amperes at 120 volts ac; quantity and type of contacts shall be as indicated. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals.

C. **Time Delay Relays:** Time delay relays shall be electronic on-delay or off-delay type with contacts rated 10-amperes at 120-volts AC. Units shall include adjustable dials with graduated scales covering the indicated time range.

D. **Slave Relays:** Slave relays shall be provided when the number or type of contacts indicated exceed the contact **capacity** of the indicated relays and timers.

E. **Circuit Breakers:** Circuit breakers shall be single pole, 120-volt, 15 ampere rating or as required to protect wiring and **equipment**. Circuit breakers shall be mounted inside the panels as shown.

2.4 CONTROL PANEL INSTRUMENTATION

A. **Digital Indicators:**

1. Digital indicators shall be self-contained instruments that display process signals directly in engineering units. The unit shall be suitable for panel mounting and shall utilize an LED display where numerals are no less than 0.5-inch height.

2. The input signal to the digital process indicator shall be 4-20 mA DC or 1-5 VDC. The input sample rate of the unit shall be a minimum of 2 per second. The unit shall have an auto-zeroing feature and shall have provisions for field adjustable scaling and offset. Accuracy shall be plus or minus 1 least significant digit. Input power to the digital indicator shall be 120 VAC, 60 Hz.

B. **Selector and Pushbutton Switches**: Selector and pushbutton switches shall be rated 10 A at 600 volts, shall be heavy-duty, oil-tight, and shall have the number of positions and poles indicated. Operators shall be corrosion resistant.

C. **Indicating Lights**: Indication lights shall be LED push-to-test type and shall be heavy-duty, oil-tight. Each light shall have a screwed-on glass lens approximately 1-inch in diameter. Each light shall have a factory-engraved legend plate as indicated. Indicating lights shall be 120 VAC type with transformers for use with LED.

2.5 FIELD INSTRUMENTATION

A. All field instrumentation shall first meet the requirements shown in the Contract Drawings, then in addition meet the following standard requirements set forth in the Contract Specifications.

B. For the following type of field instruments see respective Sections:

1. 11300 Ultra-Violet Disinfection System

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall employ installers who are skilled and knowledgeable in the installation and connection of all elements, all instruments, all accessories, and all assemblies provided under this Contract.

B. The CONTRACTOR shall install all instruments according to the manufacturer's installation instructions and the following:

1. Perform field engineering as required for mounting and supporting all field mounted components.

2. Prepare any additional schematic and interconnection diagrams required for installation.

3. Assemble and interconnect instrument components disconnected for shipping purposes.

4. Remove all temporary supports, bracing, and padding inserted in instrument control panels and other equipment to prevent damage during shipping, storage, or installation.

5. All piping shall be field measured prior to fabrication and erection. Any significant

discrepancies between drawings and field conditions shall be reported to the CONSTRUCTION MANAGER. The OWNER will not be responsible for any costs to the CONTRACTOR for rework because of CONTRACTOR failure to take measurements prior to fabrication.

6. Adequately support and protect capillary tubing. All extra tubing shall be carefully coiled, tied, and protected at the instrument location.

C. It is the intent of the Contract Documents that all wiring external to Control Panels be provided under the requirements of Division 16. Further, it is the general intent that all 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, and Control Panel input and output wiring, be provided under Division 16 and be terminated and identified under Division 13.

D. The CONTRACTOR's attention is directed to the electrical and mechanical schematics and details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of WORK required.

E. Monitoring and control system configurations are diagrammatic only. Locations of equipment are approximate unless dimensioned on the drawings. Exact locations and routing of wiring and cables shall be governed by structural conditions, physical interferences, and locations of electrical terminations on equipment.

F. Where job conditions require minor changes in approximated locations and arrangements, the CONTRACTOR shall make such changes without additional cost to the OWNER.

G. All instruments shall be located and installed for ready access by the OWNER'S operation and maintenance staff. The OWNER reserves the right to require minor changes in location of equipment prior to roughing without any additional cost to the OWNER.

H. Meters shall be installed in easily accessible locations and orientated for ease of reading and maintenance, and where shown, for balancing flow. Wherever possible, meters shall be inserted in such a way to comply with the manufacturer’s recommendations. Meters, shut-off and balancing valves shall be properly supported. In-line meters shall be installed to ensure full-line flow and not less than the manufacturer’s recommended head at all times.

3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

A. **Wiring Installation:** All wires shall be in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing-out panel to components on the fixed structure, and (4) wiring to panel-mounted components. Wiring from components on a swing-out panel to other components on fixed panels shall be tied into bundles with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

B. Wiring to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

C. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

D. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be permanently marked heat-shrink plastic.

3.3 INSTRUMENT CABLE TESTS

A. **General:** The following tests shall be performed on each instrumentation and control system cable. All tests shall be end-to-end tests of installed cables with the ends supported in free air, not adjacent to any grounded object. All test data shall be recorded on forms which are available from the CONSTRUCTION MANAGER. Complete records of all tests shall be made and delivered to the CONSTRUCTION MANAGER. Each form shall be signed by the CONSTRUCTION MANAGER or the CONSTRUCTION MANAGER's Representative who witnessed the testing.

B. Continuity tests shall be performed by measuring wire/shield loop resistance of each signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall vary by more than plus or minus 2 ohms from the calculated average loop resistance value.

C. Insulation resistance tests shall be performed by using a 500 volt megometer to measure the insulation resistance between each channel wire, between each channel wire and the channel shield, between individual channel shields in a multichannel cable, between each individual channel shield and the overall cable shield in a multi- channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 1 megohms shall be unacceptable.

3.4 INSTALLATION, CALIBRATION, TESTING, PRECOMMISSIONING, STARTUP AND INSTRUCTION

A. **Installation and Connection:** The CONTRACTOR shall install and connect all field-mounted components and assemblies under the following criteria:

1. Process sensing lines and air signal tubing shall be installed to the installation of conduit indicated under Section 16050. Individual tubes shall be run parallel and near the surfaces from which they are supported. Supports shall be used at intervals not longer than 3 feet of tubing.

2. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before insertion into fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.

3. All flexible cables and all capillary tubing shall be provided in flexible conduits. Lengths shall be sufficient to withdraw the cables and tubing for periodic maintenance.

4. All power and all signal wires shall be terminated with spade type lugs.

5. All connectors shall be, as a minimum, water tight.

6. After all installation and connections have been completed, a technical field representative of the CONTRACTOR shall check the WORK for polarity of electric power and signal connections, leaks at all process connections, and conformance with requirements. The technical field representative shall certify in writing to the CONTRACTOR that each loop and system meets requirements.

7. All wire and all cable shall be connected from terminal to terminal without splices, arranged in a neat manner and securely supported in cable groups. All wiring shall be protected from sharp edges and corners.

B. **Calibration:** All analog instrumentation and all control system equipment shall be calibrated and tested after installation to verify that requirements are satisfied. The CONTRACTOR shall provide all necessary labor, tools, and equipment to calibrate and test each instrument in accordance with the manufacturer's instructions. Each instrument shall be calibrated at a minimum of three points using test equipment to simulate inputs and read outputs. All test equipment and all instruments used to simulate inputs and read outputs shall be suitable for the purpose intended and shall have an accuracy better than the required accuracy of **the** instrument being calibrated. Test equipment shall have accuracies traceable to the NIST as applicable. All analog instruments shall be calibrated and tested in place without removal. Test data, applicable accuracy requirements, all instrument manufacturer published performance specifications and all permissible tolerances at each point of calibration shall be entered on test forms available from the CONSTRUCTION MANAGER. These test forms shall verify compliance with all. A report shall be delivered to the CONSTRUCTION MANAGER for each instrument, certifying that the instrument has been calibrated in the presence of the CONSTRUCTION MANAGER or the CONSTRUCTION MANAGER's designated representative and meets contract and system requirements.

C. **Analog Loop Tests:** The CONTRACTOR shall be responsible for loop checking and testing all instrumentation loops with this project. The CONTRACTOR shall coordinate all loop check functions with the CSP to ensure that a single total loop check is conducted. The intent of the loop checks is to confirm and document each loop's component specification conformance up to and including all field-situated CSP devices. The CSP will have all control room personnel present to witness and confirm loop check results at the CRT level. The CONTRACTOR shall provide all necessary labor, tools, and equipment to field test, inspect and adjust each instrument to its indicated performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or any published manufacturer performance specification for functional and operational parameters, whether or not indicated in the Contract Documents, shall be repaired or replaced, at the discretion of the CONSTRUCTION MANAGER at no additional cost to the OWNER.

1. At least 15 days before installation testing begins, the CONTRACTOR shall submit to the CONSTRUCTION MANAGER a detailed description, in duplicate, of the installation tests to be conducted to demonstrate correct installation of the instrumentation and control system and the anticipated dates the testing will occur.

2. Controllers and electronic function modules, shall be tested and exercised by the

CONTRACTOR to demonstrate correct operation, first individually and then collectively as functional analog networks. Each hardwired analog control network shall be tested to verify proper performance within indicated accuracy tolerances. Accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy tolerances. Individual component accuracy tolerances shall be as indicated by contract requirements, or by published manufacturer accuracy specifications, whenever contract accuracy tolerances are not indicated.

3. Each analog network shall be tested by applying simulated inputs to the first element(s). Simulated sensor inputs corresponding to 10 percent, 50 percent, and 90 percent of span shall be applied, and the resulting outputs read to verify compliance to network accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation of discrete devices. Temporary settings shall be made on controllers, alarms, etc., during analog loop tests. All analog loop test data shall be recorded on test forms, which include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

4. When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the CONSTRUCTION MANAGER or the CONSTRUCTION MANAGER's representative as a witness, with test data entered, shall be submitted together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, fully inspected, and fully tested.

D. **General System Pre-commissioning:** The CONTRACTOR shall be responsible for demonstrating the operability of all systems provided under this specification. The CSP will assist and coordinate the operability assessment with the CONTRACTOR. Pre-commissioning shall commence after acceptance of all wire, all calibrating and loop tests, and all inspections have been conducted. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under actual operating conditions.

1. The CONTRACTOR shall develop and submit to the CONSTRUCTION MANAGER for approval a Pre-Commissioning Plan which describes detailed test procedures, checklists, blank forms and data to be recorded, test equipment to be used and calculated tolerance limits.

2. System pre-commissioning activities shall include means to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based

controllers shall be assured by adjusting the controllers, as required, to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments, as required, to eliminate excessive oscillatory amplitudes and decay rates.

3. All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset or rate setting(s) as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 10 percent, 50 percent and 90 percent of span and the results checked against indicated accuracy tolerances. Accuracy tolerances are defined as the root-mean-square summation of individual component accuracy tolerances.

   Individual component accuracy tolerances shall be as indicated in the Contract Documents or as specified by published manufacturer accuracy specifications whenever not indicated.

4. The CONTRACTOR shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and which shall include a listing of all instrumentation and all control system maintenance and repair activities conducted during the pre-commissioning testing. The CONSTRUCTION MANAGER must accept the instrumentation and control system pre-commissioning testing before the seven day operational testing may begin. Final acceptance of the control system shall coincide with final acceptance of the WORK.

E. **7-Day Operational Testing:** The CONTRACTOR shall furnish his own personnel, electrical personnel, and any instrument manufacturers' representatives as required during the testing period to produce a fully operational system.

F. **Instruction:** The CONTRACTOR shall train the OWNER'S maintenance personnel in the maintenance, calibration and repair of all instruments provided under this contract.

1. The training shall be scheduled a minimum of 3 weeks in advance of the first session. The training shall be performed concurrent with the pre-commissioning in subparagraph D.

2. The training shall be performed by qualified representatives of the instrument manufacturers and shall be specific to each instrument model provided.

3. Each training class shall be a minimum of 8 hours in duration and shall cover Operational Theory, Maintenance, Trouble Shooting/Repair, and Calibration of the instrument.

4. Proposed training material, including resumes for the proposed instructors and a detailed outline of each lesson shall be submitted to the CONSTRUCTION MANAGER at least 30 days in advance of when the lesson is to be given. The

CONSTRUCTION MANAGER shall review the submitted data for suitability and provide comments which shall be incorporated into the course.

5. Within 10 days after the completion of each lesson the CONTRACTOR shall present to the CONSTRUCTION MANAGER the following:

   a. A list of all OWNER personnel that attended the lesson.

   b. An evaluation of OWNER personnel knowledge through written testing or equivalent.

   c. A copy of text utilized during the lesson with all notes, diagrams, and comments.

3.5 PROCESS CONTROL STRATEGIES

A. The control strategies shown in Appendix A1 complement the Process and Instrumentation Diagrams (P&IDs). All materials and components shall be furnished, whether explicitly indicated or not, to effect the functional requirements defined on the P&IDs and in the process control strategy descriptions. The CITY shall utilize the control strategies as a resource in generating control narratives to be included in the analog hardware submittal.

B. Common functions that are generally applicable to all strategies or to similar strategies are described under the heading "General Functions". These functions are not repeated in the descriptions for each strategy.

3.6 INSTRUMENT TAGGING LIST

A. The CONTRACTOR shall provide a final master Instrument Tagging List based on field installation.

3.7 EQUIPMENT TAGGING LIST

A. The CONTRACTOR shall provide a final master Equipment Tagging List based on field installation.

3.7 SAMPLE LOOPS

A. **General:** Sample loops are presented at the end of this Section in Appendix B to show the formatting and layout of the loops per City's current standards so that the CONTRACTOR can comply with the requirements of this specification.

** END OF SECTION

APPENDIX A - CONTROL STRATEGIES GENERAL

SECTION 13300 - INSTRUMENTATION AND CONTROL

LEGEND

PCM - Process Control Module (Transmits process data to and from the field and provides plant automation)

DCS - Distributed Control System (Plant Computer Control System)

UPS - Uninterruptable Power System (Provides battery back-up power to the PCM)

DH – Data Highway (Plant process network where PCM, workstation, and historian communications take place)

DIN - District Information Network (Fiber Optic Transmission to COMC)

LCP - Local Control Panels

PID - Proportional-Integral-Derivative

PLC - Programmable Logic Controller

GENERAL CONTROL AND MONITORING

These control strategies are not intended to be all-inclusive operational procedures for the operation of the complete facility. In general, control and monitoring functionality is as follows:

1. Alarm monitoring and generation, process sequencing, automatic control of auxiliary systems and equipment interlocking control strategies are resident within the DCS.

2. Fault tolerant PCM(s) communicate with the DH and contain enhanced DCS automatic control algorithms for process sequencing control based on level, pressure, flow, or other conditions.

3. The DCS workstations shall serve as the operation staff's "window" into the process, enabling operations to locally monitor, interrogate, and manipulate plant processes.

4. The DCS shall provide reporting, historian, diagnostic, client access and other file server functions.

5. The DCS provides information to the District Information Network (DIN) via the communication link between DCS and DIN

6. All alarms shall be fail safe and activate upon loss of power.

COMMON DCS/PLC FUNCTIONS

Common functions and terms for basic monitoring and control operations are provided as a standard of implementation for the control system. These terms and functions address items that are typical for process control loops and most operator initiated actions. These functions are not necessarily repeated in each individual control strategy. Unless otherwise stated they are considered a part of each implemented control strategy.

Provision shall be made to include certain control functions that apply to all analog inputs, virtual variables, analog controllers and discrete control whether or not shown on the P&IDs, even though one or more of the functions may be disabled by the user for a given data base point:

1. **Verification of Digital Outputs**: In Semi-Auto and Auto mode each command will be monitored for the desired results before proceeding to the next step and if the desired results are not achieved in a certain predetermined time an alarm will be generated. The operator will have the ability to override and move to the next stage.

2. **Analog Data Scaling**: This control function shall scale all analog inputs to a common span and shall normalize the digital representation of each analog input to a percent of the operating span. The processed value shall be expressed as a binary number that specifies the analog input's position on a straight line lying between zero and full scale as defined for a given input by the zero span values in the data base.

3. **Amplitude Limit Check**: This control function shall perform dual level, high/low amplitude limit checking and shall identify a limit violation every time a measured or virtual variable goes out-of-limits and returns back into limits. The control function shall determine the time at which each limit excursion occurred. A dead-band shall be provided on each limit and shall be expressed as a percentage of span or in engineering units.

4. **Engineering Unit Conversion**: This control function shall convert scaled analog data to engineering units by means of the following equation:

   $$Y = (H - L)\,(D/DH) + L$$

   where:

   Y = value in engineering units

   H = high value of span, expressed in engineering units

   L = low value of span, expressed in engineering units

   D = digitized scale input value in counts

   DH = full scale digitized value in counts

5. **Discrete Event Monitor**: This control function shall monitor an alarm (where appropriate) all discrete status changes.

6. **Manual Control**: It shall be possible for the operator or plant engineer to interrupt any sequence, loop or automatic operation and operate the same manually from remote.

The following terms are used in the descriptions of DCS/PLC functions:

1. **Operator Settings (Set points)**: Operator set or entered values that are adjustable or set from operator displays. Examples of operator set or entered values are controller set points, batch set points, timers, counters, mode selection, etc. Specific values that are required to be operator settable are noted (bracketed [ ]) in the process control strategy descriptions. Unless otherwise stated to be tunable or fixed, a set point value is operator settable.

2. **Tunable Values**: Tunable values are set points that are adjustable at password protected engineer level displays without requiring any PLC or DCS software reconfiguration. Examples of tunable values are tunable time settings, tunable alarm set points, PID tuning constants, etc. These values are not adjustable from operator level displays. Tunable values are also identified and their preliminary values are shown in brackets [xxx].

3. **Fixed Values**: Fixed values are constants that are contained within the PLC or DCS control logic normally inaccessible by the DCS system. Modification of fixed values requires a modification to the control logic via the PLC programming, configuration and diagnostics software package.

4. **Displayed Values**: The term "displayed" means that the value, or information referred to, is displayed in an easily read and understood format on the DCS workstation. Values are identified by their device tag reference and associated equipment number. For analog variables the value is tagged and its associated engineering units are displayed.

5. **Hardware Interlocks**: Hardware interlocks refer to interlocks directly wired within the electrical control circuits of equipment that, when activated, shall cause the equipment to shutdown or otherwise prevent operation of the equipment. Hardware interlocks do not necessarily pass through or depend on the PLC or DCS to be operable.

   Hardware interlocks may also be derived by local control panels or switches wired directly to the PLC or DCS to provide direct hardwired alarm status to the PLC or DCS for processing.

6. **Software Interlocks**: Software interlocks refer to interlocks that are generated by the PLC or DCS logic or otherwise pass through the PLC or DCS. Software interlocks are not operable when the PLC is not operable or if for some reason equipment is operated while by-passing the PLC logic.

7. **Hardware Generated Alarms**: Hardware generated alarms are alarms that are generated external to the PLC by equipment such as local control panels, analytical devices and process switches.

   a. Direct wired alarms that do not depend on the PLC or DCS to be operable. An example would be a High H2S level signal from the H2S monitor and wired directly to an alarm light or horn.

   b. Direct PLC wired alarms such as a High-High pressure switch that interfaces directly with the PLC.

8. **Software Generated Alarms**: Alarms that are processed or generated by PLC or DCS logic are referred as software generated. Software generated alarms are displayed on the DCS workstation alarm screens and are available for archiving.

9. **Local Automatic Control Mode**: Local automatic control refers to control logic performed in a local control panel independent of the PLC or DCS. An example is a standalone blower package that, when in the local automatic control mode, automatically controls the blower to maintained air pressure within a fixed dead band.

10. **Local Manual Control Mode**: Local manual control refers to the mode where operators control equipment from the equipment location. Examples are hoist and trolley that may be stopped or started from the hoist/trolley's local control panel (LCP), or a gate that may be opened or closed from the gate operator.

11. **DCS Automatic Control Mode**: In DCS automatic mode equipment is controlled automatically per predetermined control schemes residing in the DCS usually without operator intervention. However, in some cases the operators may be required to initiate certain automatic functions, or enter set points.

12. **DCS Manual Control Mode**: DCS manual control refers to the remote manual control of equipment from the DCS workstation. In this mode, the operators override the DCS automatic control logic but, usually, DCS safety interlock logic remains in effect.

13. **DCS Override Control**: DCS override control refers to the ability to override specific software interlocks and initiate control actions. Software interlocks or permissives that can be overridden are identified within the individual control strategies. Override control is an abnormal control operation and a "SAFETY INTERLOCK OVERRIDE ALARM" shall be initiated for the specific override condition whenever an override command is in effect.

COMMON DCS/PLC SOFTWARE FUNCTIONS

To provide for a standard of implementation, various software control and monitoring functions are defined. The standard functions may not be fully delineated within each control strategy, however, unless otherwise stated the standard function shall be utilized to provide the defined alarm, action, display or control action.

The following provides for common PLC and DCS software functions:

1. All equipment status items monitored by the DCS/PLC and generated within the DCS/PLC control strategies are displayed at the DCS. Unless otherwise specified the following is displayed for each equipment item:

    a. Equipment READY status

    b. Equipment RUNNING or ON status

    c. Equipment OFF status

    d. Equipment FAILURE alarm

    e. Equipment FAIL-TO-OPERATE alarm

f. Equipment OUT-OF-SERVICE

2. All analog inputs transmitted to the DCS shall have instrument bad/failure indications or alarms when the input is below 0 percent or above 100 percent.

3. All discrete alarm and failure inputs are alarmed by the DCS application software and displayed at the DCS. Each discrete alarm input shall have an associated alarm delay that prevents nuisance tripping. A discrete alarm shall be generated based on a tunable set point of 10 seconds after the discrete event is initiated.

4. Where alarms are specified in the control strategy descriptions, those alarms are initiated by the DCS control logic based on the applicable analog input signals. User tunable trip points shall be provided for each analog input to establish High- High, High, Low, Low-Low, and Rate-Of-Change events. Each trip point shall be provided with a user tunable dead band for set and reset operations. Individual signal trip points shall be provided with a tunable delay to alarm activation.

5. DCS alarm activation and annunciation shall adhere to a priority hierarchy that is established and maintained at the DCS system. Each alarm shall have an associated priority level defined as:

Level 1 - Life Threatening or Danger Conditions

Level 2 - Critical process alarms that shall create a plant shutdown condition, cause a critical process failure or severely hinder plant operation.

Level 3 - Minor process alarms associated with warning conditions and minor equipment failures.

Level 4 - Informational alarms shall not hinder operation or cause equipment failure.

6. All process related analog inputs are trended at the discretion of the operator.

7. All flow inputs and equipment run times are totalized, recorded and displayed at the DCS. Totalizers are resettable at the engineer level only.

8. **Displays**: DCS system shall have adequate number of displays for each system to enable the operator to effectively monitor and control the system. Displays are grouped functionally for ease of operation. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display. Displays shall show process graphics, alarms, equipment status, system mode of operation, control strategy implementation, etc.

9. Most interlocks, permissives and start sequences are provided at the DCS level. Unless otherwise stated or shown, all discrete outputs shall be provided as follows:

   a. For equipment START functions, the PLC or DCS shall issue a maintained START command until a RUNNING state is detected or the START command is removed.

   b. When a momentary command is required, the PLC or DCS shall issue the command for a minimum 2 seconds, then remove the signal.

10. For equipment that the DCS/PLC is allowed to control, the DCS/PLC shall provide a FAIL-TO-OPERATE alarm if the equipment fails to comply with a DCS/PLC command signal. The (START, STOP, OPEN, CLOSE) shall be present for more than a tunable time period. In this event, the command shall be removed subsequent to the expiration of the tunable time period.

11. In the event of a DCS system failure the system shall retain the last command from the DCS system for all equipment that is in service. All interlocks are enabled during a DCS communications or systems failure.

12. All PID control functions (P, PI, and PID) are provided with standard analog controller functions and operator interfaces including, but not limited to, the following:

    a. AUTO/MANUAL mode selection: In AUTO, the output of controller shall be based on the PID control calculation. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.

    b. LOCAL/REMOTE set point selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.

    c. Set point, process variable, and controller output shall be displayed. Provisions shall be included to prevent reset windup.

    d. Dead band limits shall be placed on PID control algorithms to avoid hunting and continuous change actions. Dead band limits shall maintain a constant control until the process variable exceeds the dead band boundaries. A dead band value of zero shall disable the dead band.

    e. Bumpless transition shall be provided when PID is invoked after a transition from manual to PID control or when pump start logic utilizes minimum speed controls for starting applications. The transition from current speed to calculated speed shall be provided as a user tunable set point percentage per second value.

13. When main equipment is tagged OUT-OF-SERVICE, a DCS function, all associated equipment and devices are automatically placed in OUT-OF-SERVICE status and their alarms inhibited until the tagged equipment is tagged IN SERVICE. Associated equipment for each piece of main equipment shall be determined on a case by case basis.

14. **Verification of Result**: Whenever a command is issued, DCS/PLC shall verify that its command is implemented before proceeding to the next step, e.g., a valve open command is issued, the DCS/PLC software shall verify that the valve open limit switch is activated after a preset time, before proceeding to the next step in the program. If no verification is received an alarm will be generated and operator intervention will be necessary to resume the automatic operation.

APPENDIX B
SAMPLE LOOP DRAWINGS

SECTION 13300 - INSTRUMENTATION AND CONTROL

LOOP NO:
05F7331

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	SERVICE DESCRIPTION	DEVICE TYPE	LOCATION	DEVICE MANUF'R/SUPP	MODEL NO	SPEC NO	AREA CONTRACTOR	SUBMITTAL NO	REMARKS
P	05	FCV	7331		BLOWER 1 CONTROL VALVE	SET POINT	CONTROL VALVE	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	FIC	7331		BLOWER 1 CONTROL VALVE	SET POINT	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13300	ORION	43	
P	05	ZI	7331		BLOWER 1 CONTROL VALVE	POSITION	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13300	ORION	43	
P	05	ZL	7331		BLOWER 1 CONTROL VALVE	REMOTE	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13300	ORION	43	
P	05	ZT	7331		BLOWER 1 CONTROL VALVE	POSITION	CONTROL VALVE	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	HS	7331	A	BLOWER 1 CONTROL VALVE	LOCAL/REMOTE	3-WAY SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	HS	7331	B	BLOWER 1 CONTROL VALVE	OPEN/CLOSE	2-WAY SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	HS	7331	C	BLOWER 1 CONTROL VALVE	STOP	3-WAY SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	HS	7331	D	BLOWER 1 CONTROL VALVE	OPEN/CLOSE	2-WAY SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	ZSC	7331		BLOWER 1 CONTROL VALVE	VALVE CLOSED	LIMIT SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	ZSO	7331		BLOWER 1 CONTROL VALVE	VALVE OPENED	LIMIT SWITCH	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	ZLC	7331		BLOWER 1 CONTROL VALVE	VALVE CLOSED	INDICATOR	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	
P	05	ZLO	7331		BLOWER 1 CONTROL VALVE	VALVE OPENED	INDICATOR	05FCV7331	EIM CONTROLS	TEC2000	15101	ORION	46	

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	DATA SH NO	I/O SIGNAL	SIGNAL LEVEL	DEVICE RANGE	ENGR UNITS	PROC SET PT	AREA LOOP DIAGRAM NO	P&ID DWG NO	LOOP FILENAME	INTERCONNECT FILENAME
P	05	FCV	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	0-100	PCT	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	FIC	7331		BLOWER 1 CONTROL VALVE	N/A	AO	4-20 MA	0-100	PCT	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZI	7331		BLOWER 1 CONTROL VALVE	N/A	AI	4-20 MA	0-100	PCT	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZL	7331		BLOWER 1 CONTROL VALVE	N/A	DI	24 VDC	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZT	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	0-100	PCT	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	HS	7331	A	BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	HS	7331	B	BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	HS	7331	C	BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	HS	7331	D	BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZSC	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZSO	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZLC	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003
P	05	ZLO	7331		BLOWER 1 CONTROL VALVE	S20.50	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05F7331	5-I-24	P05F7331.002	P05F7331.003

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-500
FLOW & PIPING PLAN:	5-M-4 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-14 & 5-E-17
ELECTRICAL POWER PLAN:	5-E-101, 130
CONTROL WIRING:	5-E-23
EIM CONTROLS:	TEC-3102-0000

DESTROY ALL PRINTS BEARING EARLIER DATE					APPROVAL	
REV	DATE	DESCRIPTION	BY	CKD	ENGR	MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

LEE&RO, Inc.

POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM DEVICE SCHEDULE
GRIT AERATION BLOWER 1
CONTROL VALVE

FILE 05F7331.001

LOOP NO.	DWG NO.	SHEET	REV
05F7331	LD-PLWTP05F7331	1 OF 3	C

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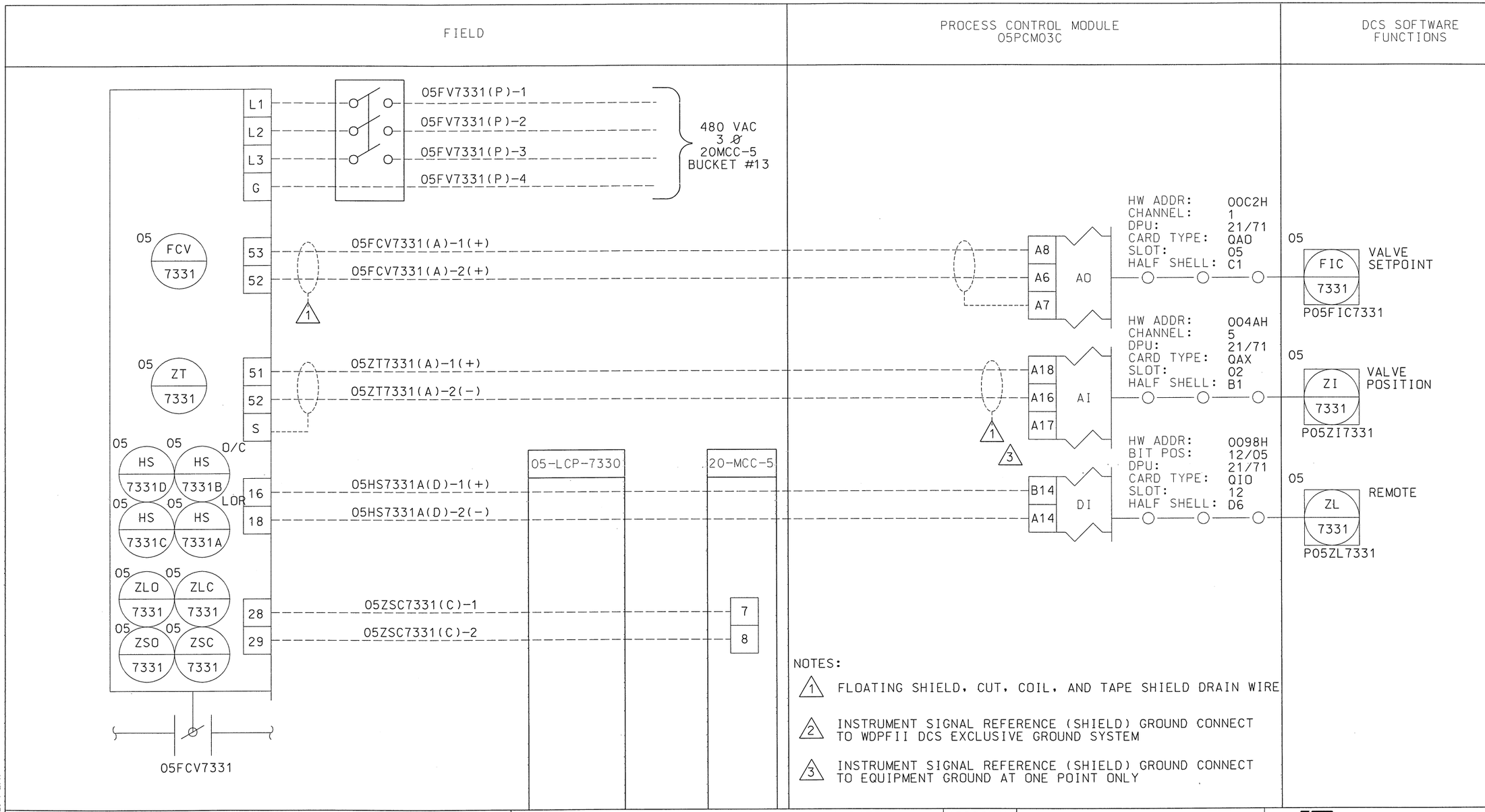

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-500
FLOW & PIPING PLAN:	5-M-4 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-14 & 5-E-17
ELECTRICAL POWER PLAN:	5-E-101, 130
CONTROL WIRING:	5-E-23
EIM CONTROLS:	TEC-3102-0000

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

LEE&RO, Inc.
San Diego, California

POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM
GRIT AERATION BLOWER 1
CONTROL VALVE

FILE 05F7331.002

LOOP NO.	DWG NO.	SHEET	REV
05F7331	LD-PLWTP05F7331	2 OF 3	C

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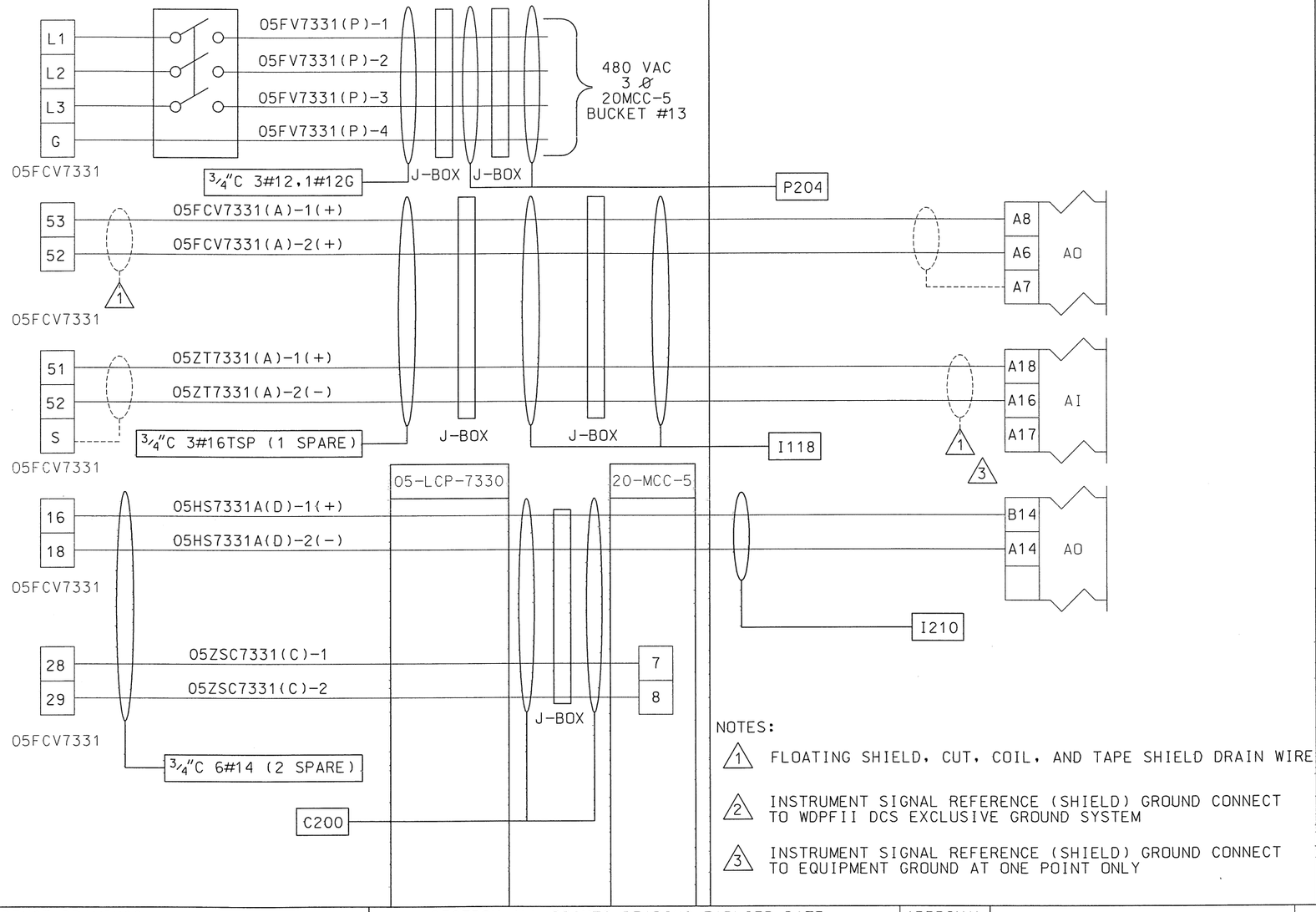
FIELD	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



NOTES:

1. FLOATING SHIELD, CUT, COIL, AND TAPE SHIELD DRAIN WIRE
2. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO WDPFII DCS EXCLUSIVE GROUND SYSTEM
3. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO EQUIPMENT GROUND AT ONE POINT ONLY

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-500
FLOW & PIPING PLAN:	5-M-4 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-14 & 5-E-17
ELECTRICAL POWER PLAN:	5-E-101, 130
CONTROL WIRING:	5-E-23
EIM CONTROLS:	TEC-3102-0000

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

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METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INTERCONNECTION DIAGRAM
GRIT AERATION BLOWER 1
CONTROL VALVE

FILE 05F7331.003

LOOP NO.	DWG NO.	SHEET	REV
05F7331	LD-PLWTP05F7331	3 OF 3	C

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LOOP NO:
05F7359

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	SERVICE DESCRIPTION	DEVICE TYPE	LOCATION	DEVICE MANUF'R/SUPP	MODEL NO	SPEC NO	AREA CONTRACTOR	SUBMITTAL NO	REMARKS
P	05	FIT	7359		GRIT AERATION BLOWER FLOWMETER	AIR FLOW	FLOW METER	05FIT7359	FCI	ST98-2	13300	ORION	13	
P	05	FI	7359		GRIT AERATION BLOWER FLOWMETER	AIR FLOW	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13300	ORION	43	

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	DATA SH NO	I/O SIGNAL	SIGNAL LEVEL	DEVICE RANGE	ENGR UNITS	PROC SET PT	AREA LOOP DIAGRAM NO	P&ID DWG NO	LOOP FILENAME	INTERCONNECT FILENAME
P	05	FIT	7359		GRIT AERATION BLOWER FLOWMETER	S20.60	N/A	N/A	0-100	PCT	N/A	LD-PLWTP05F7359	5-I-24	P057359.002	P057359.003
P	05	FI	7359		GRIT AERATION BLOWER FLOWMETER	N/A	AI	4-20 MA	0-100	PCT	N/A	LD-PLWTP05F7359	5-I-24	P057359.002	P057359.003

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-101
FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL EQUIPMENT:	5-E-17
ELECTRICAL PANEL SCHEDULE:	5-E-504
ELECTRICAL CONDUIT PLAN & SCHEDULE:	5-E-101 & 5-E-500

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

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METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM DEVICE SCHEDULE
GRIT AERATION BLOWER
FLOW METER

FILE 05F7359.001

LOOP NO.	DWG NO.	SHEET	REV
05F7359	LD-PLWTP05F7359	1 OF 3	C

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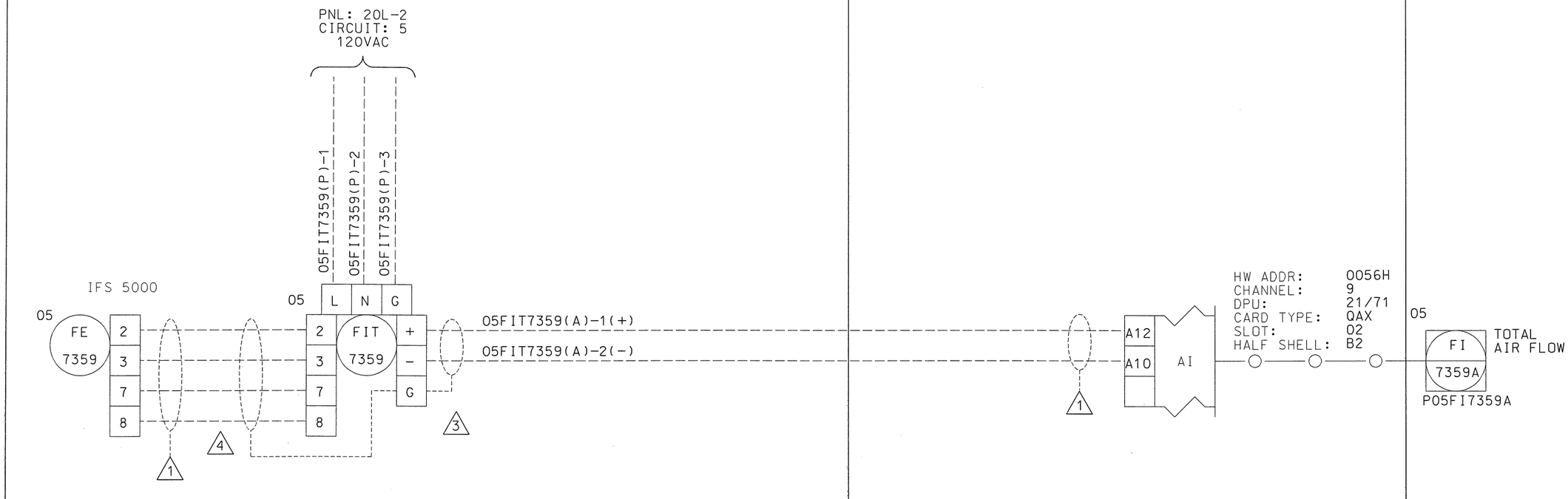

NOTES:

1. FLOATING SHIELD, CUT, COIL, AND TAPE SHIELD DRAIN WIRE
2. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO WDPFII DCS EXCLUSIVE GROUND SYSTEM
3. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO EQUIPMENT GROUND AT ONE POINT ONLY
4. CABLE SUPPLIED BY MANUFACTURER WHEN REMOTE LOCATION OF IFC IS REQUIRED

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-101
FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL EQUIPMENT:	5-E-17
ELECTRICAL PANEL SCHEDULE:	5-E-504
ELECTRICAL CONDUIT PLAN & SCHEDULE:	5-E-101 & 5-E-500

DESTROY ALL PRINTS BEARING EARLIER DATE						
REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

LEE&RO, Inc.
San Diego, California

POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM
GRIT AERATION BLOWER
FLOW METER

FILE 05F7359.002

LOOP NO.	DWG NO.	SHEET	REV
05F7359	LD-PLWTP05F7359	2 OF 3	C

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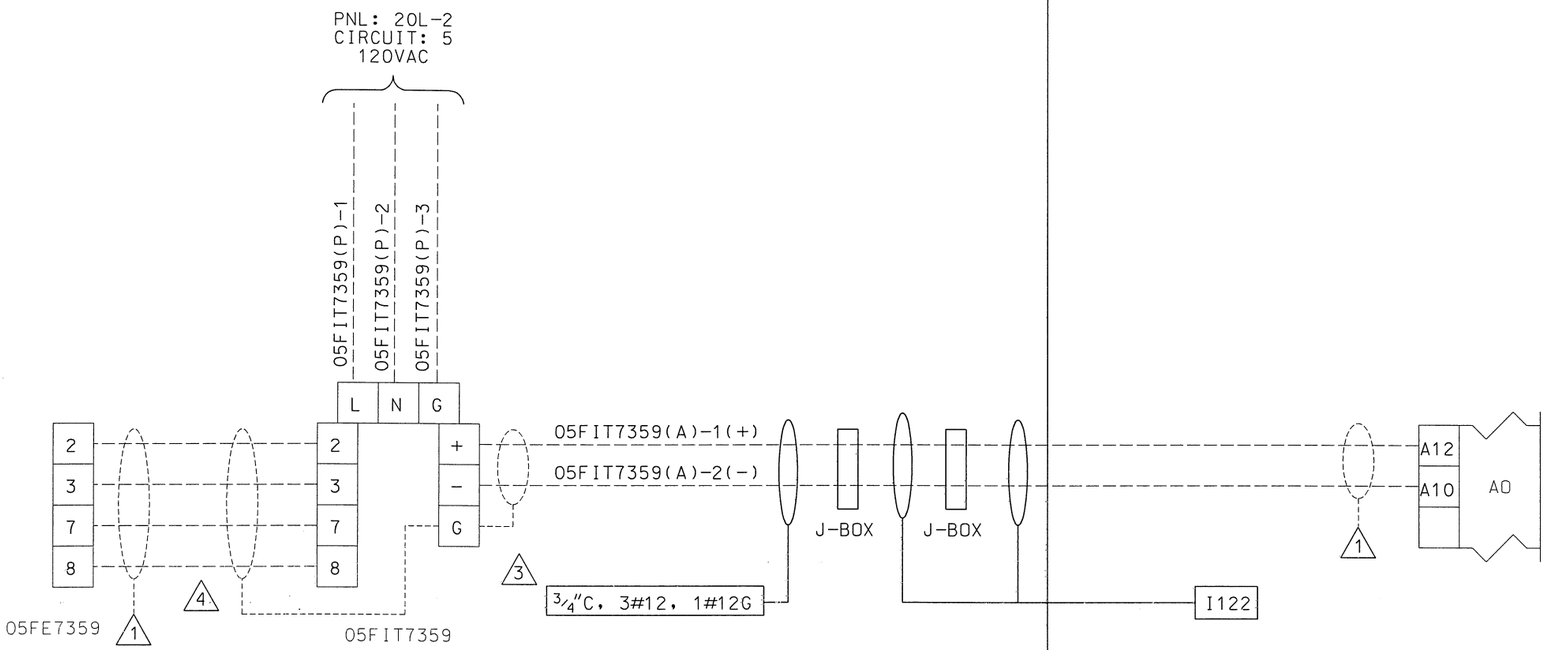
FIELD	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



NOTES:

1. FLOATING SHIELD, CUT, COIL, AND TAPE SHIELD DRAIN WIRE
2. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO WDPFII DCS EXCLUSIVE GROUND SYSTEM
3. INSTRUMENT SIGNAL REFERENCE (SHIELD) GROUND CONNECT TO EQUIPMENT GROUND AT ONE POINT ONLY
4. CABLE SUPPLIED BY MANUFACTURER WHEN REMOTE LOCATION OF IFC IS REQUIRED

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-101
FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL EQUIPMENT:	5-E-17
ELECTRICAL PANEL SCHEDULE:	5-E-504
ELECTRICAL CONDUIT PLAN & SCHEDULE:	5-E-101 & 5-E-500

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS BUILT	TP	RS	LB	JS

LEE&RO, Inc.
San Diego, California

POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INTERCONNECTION DIAGRAM
GRIT AERATION BLOWER
FLOW METER

FILE 05F7359 .003

LOOP NO.	DWG NO.	SHEET	REV
05F7359	LD-PLWTP05F7359	3 OF 3	C

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LOOP NO:
05P7330

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	SERVICE DESCRIPTION	DEVICE TYPE	LOCATION	DEVICE MANUF'R/SUPP	MODEL NO	SPEC NO	AREA CONTRACTOR	SUBMITTAL NO	REMARKS
P	05	PSH	7330		AERATION BLOWER 1	DISCH PRESS	PRESS SWITCH	5-GAB-7330	SOR	14N	13300	ORION		
P	05	PAH	7330		AERATION BLOWER 1	DISCH PRESS	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13400	ORION	43	
P	05	PAH	7330	A	AERATION BLOWER 1	DISCH PRESS	PILOT LIGHT	05LCP7330	AB	800H-QRH10A	13300	ORION	46	

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	DATA SH NO	I/O SIGNAL	SIGNAL LEVEL	DEVICE RANGE	ENGR UNITS	PROC SET PT	AREA LOOP DIAGRAM NO	P&ID DWG NO	LOOP FILENAME	INTERCONNECT FILENAME
P	05	PSH	7330		AERATION BLOWER 1	S20.42	N/A	N/A	0-25	PSI	15 (RISING)	LD-PLWTP05P7330	5-I-24	P05P7330.002	P05P7330.003
P	05	PAH	7330		AERATION BLOWER 1	N/A	DI	24 VDC	N/A	N/A	N/A	LD-PLWTP05P7330	5-I-24	P05P7330.002	P05P7330.003
P	05	PAH	7330	A	AERATION BLOWER 1	N/A	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05P7330	5-I-24	P05P7330.002	P05P7330.003

REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-500
FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-13, 5-E-17, AND 5-E-15
ELECTRICAL POWER PLAN:	5-E-101
CONTROL WIRING:	5-E-23
GARDNER DENVER CONTROLS:	VP1024154

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
A	9-7-07	ISSUED FOR REVIEW	TP	RS	LB	JS
B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

LEE&RO, Inc.
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POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM DEVICE SCHEDULE
GRIT AERATION BLOWER 1 DISCH PRESS

FILE 05P7330.001

LOOP NO.	DWG NO.	SHEET	REV
05P7330	LD-PLWTP05P7330	1 OF 3	C

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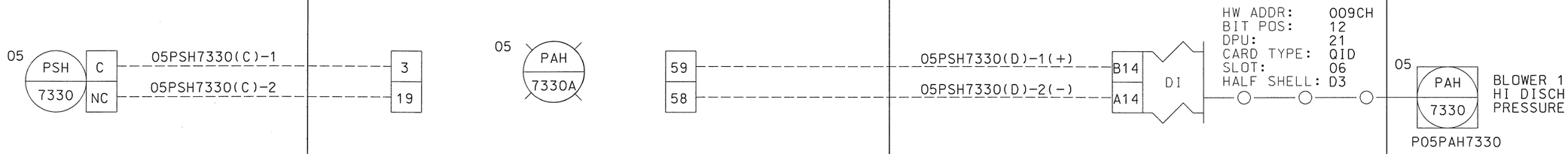
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



REFERENCE DRAWINGS	
P & ID:	5-I-24
ELECTRICAL/CONDUIT DWG:	5-E-500
FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-13, 5-E-17, AND 5-E-15
ELECTRICAL POWER PLAN:	5-E-101
CONTROL WIRING:	5-E-23
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DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
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B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM
GRIT AERATION BLOWER 1 DISCH PRESS

FILE 05P7330.002

LOOP NO.	DWG NO.	SHEET	REV
05P7330	LD-PLWTP05P7330	2 OF 3	C

N:\PROJ\823\PREVIOUS PROJECTS\823-Air Blower Facility\Design\elect\05p7330.ref
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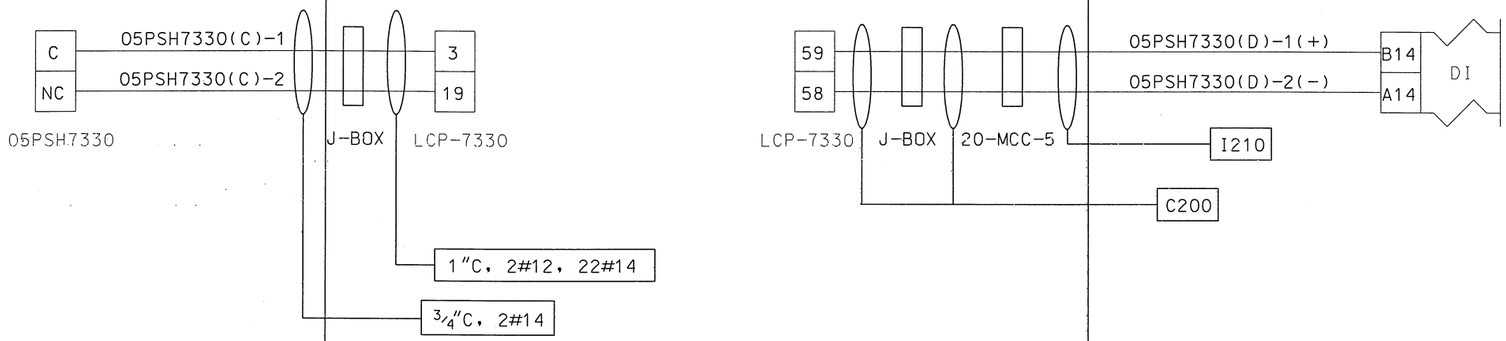
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



REFERENCE DRAWINGS	
P & ID:	5-I-24
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FLOW & PIPING PLAN:	5-M-14 & 5-M-100
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DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
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B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INTERCONNECTION DIAGRAM
GRIT AERATION BLOWER 1 DISCH PRESS

FILE 05P7330.003

LOOP NO.	DWG NO.	SHEET	REV
05P7330	LD-PLWTP05P7330	3 OF 3	C

LOOP NO:
05PD7330

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	SERVICE DESCRIPTION	DEVICE TYPE	LOCATION	DEVICE MANUF'R/SUPP	MODEL NO	SPEC NO	AREA CONTRACTOR	SUBMITTAL NO	REMARKS
P	05	PDSH	7330		AERATION BLOWER 1	HI FILTER PRES	PRESS SWITCH	5-GAB-7330	SOR	107AL	13300	ORION	N/A	RFP-02
P	05	PDAH	7330		AERATION BLOWER 1	HI FILTER PRES	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13400	ORION	43	
P	05	PDAH	7330	A	AERATION BLOWER 1	HI FILTER PRES	PILOT LIGHT	05LCP7330	AB	800H-QRH10A	13300	ORION	46	

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	DATA SH NO	I/O SIGNAL	SIGNAL LEVEL	DEVICE RANGE	ENGR UNITS	PROC SET PT	AREA LOOP DIAGRAM NO	P&ID DWG NO	LOOP FILENAME	INTERCONNECT FILENAME
P	05	PDSH	7330		AERATION BLOWER 1	S20.42	N/A	N/A	0-12	IWC	8 IWC INCR	LD-PLWTP05PD7330	5-I-24	P05PD7330.004	P05PD7330.003
P	05	PDAH	7330		AERATION BLOWER 1	N/A	DI	24 VDC	N/A	N/A	N/A	LD-PLWTP05PD7330	5-I-24	P05PD7330.004	P05PD7330.003
P	05	PDAH	7330	A	AERATION BLOWER 1	N/A	N/A	N/A	N/A	N/A	N/A	LD-PLWTP05PD7330	5-I-24	P05PD7330.004	P05PD7330.003

REFERENCE DRAWINGS	
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ELECTRICAL SINGLE LINE:	5-E-13, 5-E-17, AND 5-E-15
ELECTRICAL POWER PLAN:	5-E-101
CONTROL WIRING:	5-E-23
GARDNER DENVER CONTROLS:	VP1024154

DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
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B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM DEVICE SCHEDULE
GRIT AERATION BLOWER 1 FILTER PRESS

FILE 05PD7330.001

LOOP NO.	DWG NO.	SHEET	REV
05PD7330	LD-PLWTP05PD7330	1 OF 3	C

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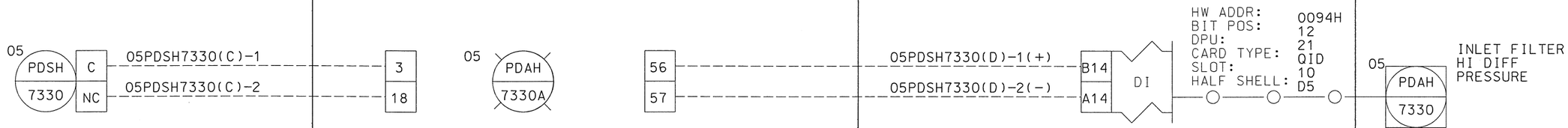
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



REFERENCE DRAWINGS	
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DESTROY ALL PRINTS BEARING EARLIER DATE

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METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM
GRIT AERATION BLOWER 1 FILTER PRESS

FILE 05PD7330.002

LOOP NO.	DWG NO.	SHEET	REV
05PD7330	LD-PLWTP05PD7330	2 OF 3	C

N:\PROJ\823\PREVIOUS PROJECTS\823-Air Blower Facility\Design\elect\05pd7330.ref
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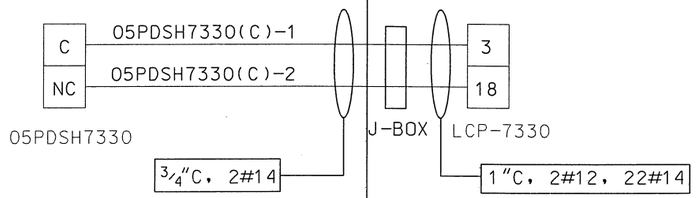
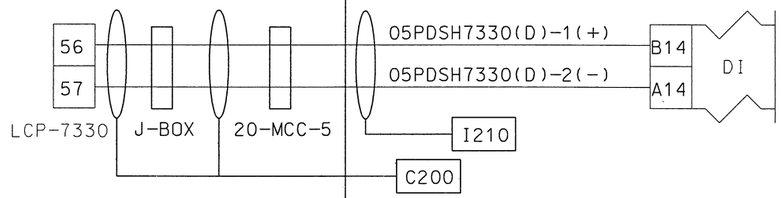
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS





REFERENCE DRAWINGS	
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FLOW & PIPING PLAN:	5-M-14 & 5-M-100
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DESTROY ALL PRINTS BEARING EARLIER DATE

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B	9-10-07	ISSUED FOR CONSTRUCTION	TP	RS	LB	JS
C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INTERCONNECTION DIAGRAM
GRIT AERATION BLOWER 1 FILTER PRESS

FILE 05PD7330.003

LOOP NO.	DWG NO.	SHEET	REV
05PD7330	LD-PLWTP05PD7330	3 OF 3	C

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6/25/2009 1:18:33 PM Daniel Park

LOOP NO:
05T7330

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	SERVICE DESCRIPTION	DEVICE TYPE	LOCATION	DEVICE MANUF'R/SUPP	MODEL NO	SPEC NO	AREA CONTRACTOR	SUBMITTAL NO	REMARKS
P	05	TE	7330	A	AERATION BLOWER 1	INLET BEARING	RTD	5-GAB-7330	LAMSON	300RGA1354	11372	ORION	46	
P	05	TE	7330	B	AERATION BLOWER 1	OUTLET BEARING	RTD	5-GAB-7330	LAMSON	300RGA1354	11372	ORION	46	
P	05	TAH	7330		AERATION BLOWER 1	HI TEMP	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13400	ORION	43	
P	05	TAHH	7330		AERATION BLOWER 1	HI HI TEMP	DCS	05PCM03C	WESTINGHOUSE	WDPFII	13400	ORION	43	
P	05	TI	7330	A	AERATION BLOWER 1	INLET BEARING	PANEL METER	5-GAB-7330	RED LION	PAXT0000	11372	ORION	46	
P	05	TI	7330	B	AERATION BLOWER 1	OUTLET BEARING	PANEL METER	5-GAB-7330	RED LION	PAXT0000	11372	ORION	46	
P	05	TAHH	7330	A	AERATION BLOWER 1	HI HI INL BEAR	PILOT LIGHT	05LCP7330	AB	800H-QRH10A	11372	ORION	46	
P	05	TAHH	7330	B	AERATION BLOWER 1	HI HI OUT BEAR	PILOT LIGHT	05LCP7330	AB	800H-QRH10A	11372	ORION	46	

N	UP NO	TAG PRE	TAG NO	TAG LR	EQUIPMENT SERVICE	DATA SH NO	I/O SIGNAL	SIGNAL LEVEL	DEVICE RANGE	ENGR UNITS	PROC SET PT	AREA LOOP DIAGRAM NO	P&ID DWG NO	LOOP FILENAME	INTERCONNECT FILENAME
P	05	TE	7330	A	AERATION BLOWER 1	S20.13A	N/A	MIL VOLT	400	DEG F	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TE	7330	B	AERATION BLOWER 1	S20.13A	N/A	MIL VOLT	400	DEG F	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TAH	7330		AERATION BLOWER 1	N/A	DI	24 VDC	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TAHH	7330		AERATION BLOWER 1	N/A	DI	24 VDC	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TI	7330	A	AERATION BLOWER 1	N/A	N/A	MIL VOLT	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TI	7330	B	AERATION BLOWER 1	N/A	N/A	MIL VOLT	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TAHH	7330	A	AERATION BLOWER 1	N/A	N/A	120 VAC	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003
P	05	TAHH	7330	B	AERATION BLOWER 1	N/A	N/A	120 VAC	N/A	N/A	N/A	LD-PLWTP05T7330	5-I-24	P05T7330.002	P05T7330.003

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DESTROY ALL PRINTS BEARING EARLIER DATE

REV	DATE	DESCRIPTION	BY	CKD	APPROVAL ENGR	APPROVAL MGR
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C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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POINT LOMA GRIT AERATION SYSTEMS PROJECT
METROPOLITAN WASTEWATER DEPARTMENT
CITY OF SAN DIEGO, CALIFORNIA

CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM DEVICE SCHEDULE
GRIT AERATION BLOWER 1 BEARING TEMP

FILE 05T7330.001

LOOP NO. 05T7330 | DWG NO. LD-PLWTP05T7330 | SHEET 1 OF 3 | REV C

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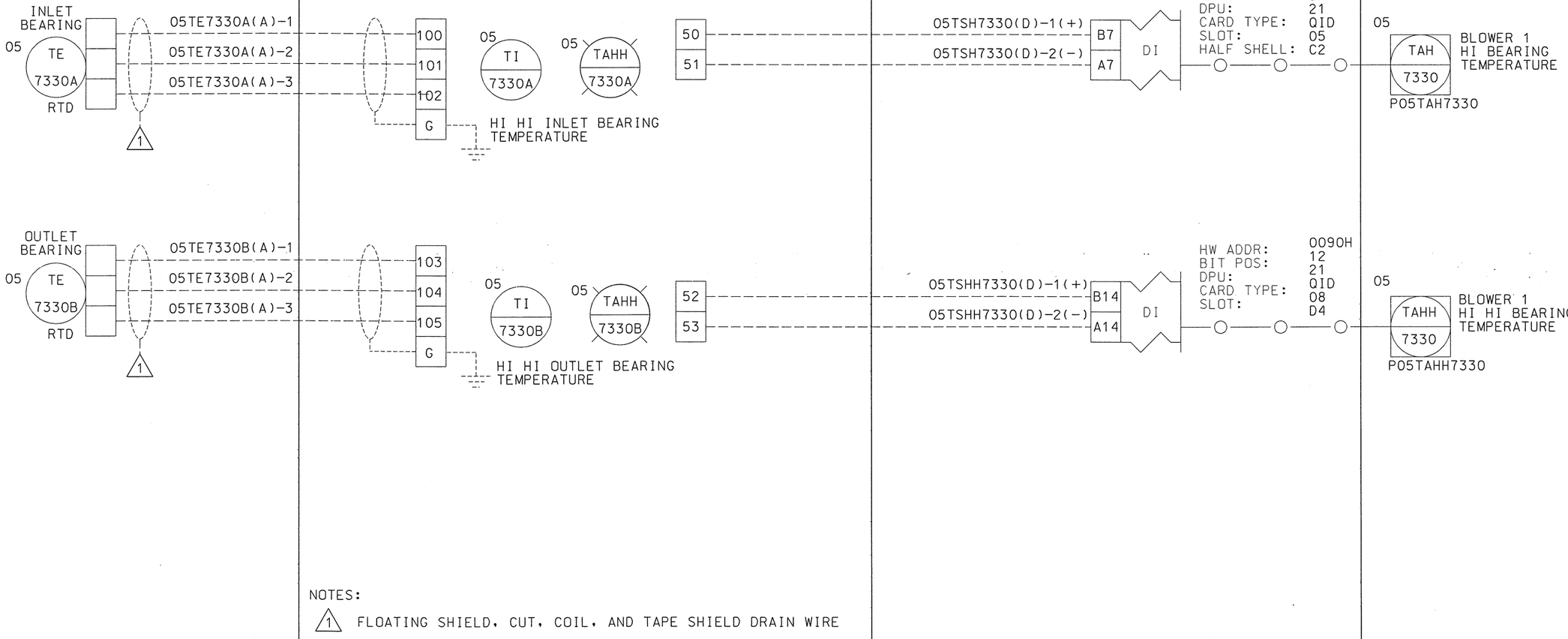
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



NOTES:

1. FLOATING SHIELD, CUT, COIL, AND TAPE SHIELD DRAIN WIRE

REFERENCE DRAWINGS	
P & ID:	5-I-24
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DESTROY ALL PRINTS BEARING EARLIER DATE					APPROVAL	
REV	DATE	DESCRIPTION	BY	CKD	ENGR	MGR
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CIP NO. 46-943.0

INSTRUMENT LOOP DIAGRAM
GRIT AERATION BLOWER 1 BEARING TEMP

FILE 05T7330.002

LOOP NO.	DWG NO.	SHEET	REV
05T7330	LD-PLWTP05T7330	2 OF 3	C

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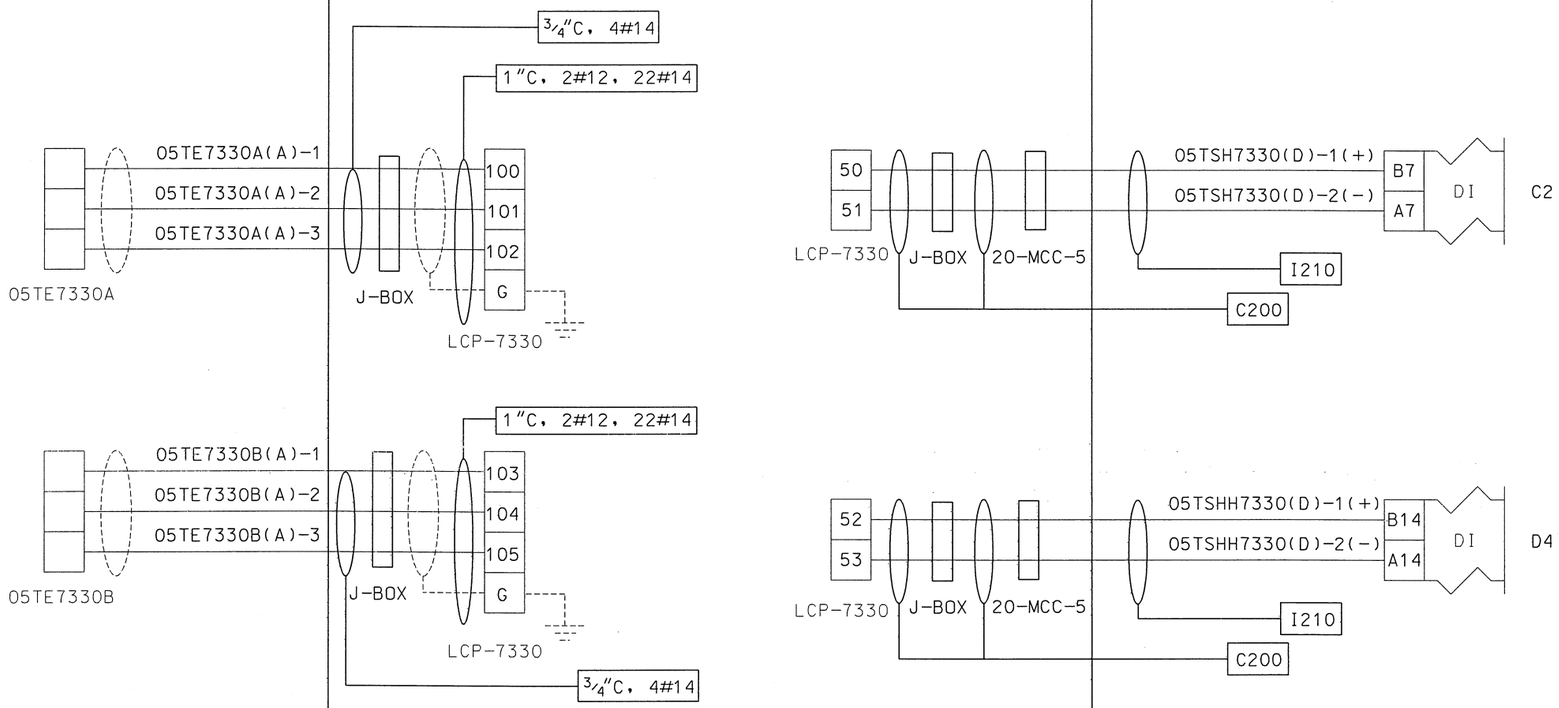
FIELD	05-LCP-7330	PROCESS CONTROL MODULE 05PCM03C	DCS SOFTWARE FUNCTIONS



REFERENCE DRAWINGS	
P & ID:	5-I-24
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FLOW & PIPING PLAN:	5-M-14 & 5-M-100
ELECTRICAL SINGLE LINE:	5-E-13, 5-E-17, AND 5-E-15
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DESTROY ALL PRINTS BEARING EARLIER DATE						
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C	10-10-07	ISSUED FOR AS-BUILT	TP	RS	LB	JS

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INTERCONNECTION DIAGRAM
GRIT AERATION BLOWER 1 BEARING TEMP

FILE 05T7330.003

LOOP NO.	DWG NO.	SHEET	REV
05T7330	LD-PLWTP05T7330	3 OF 3	C

N:\PROJ\823\PREVIOUS PROJECTS\823-Air Blower Facility\Design\elect\0517330.ref
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SECTION 13350 – COMMISSIONING

PART 1 -- GENERAL

1.1 SUMMARY

A. This section includes requirements for pre-commissioning and commissioning activities.

B. Pre-commissioning activities include all the activities associated with the first time startup of all equipment, instruments, and electrical gear, including all checks and tests before running equipment.

C. Commissioning activities include the satisfactory completion of testing the WORK, completed within the Contract time. Commissioning shall successfully implement and reliably demonstrate the operation of the facility in compliance with the control strategy.

D. The UV system shall be tested at various flow rates. The UV system shall be tested for 5 consecutive days during the reliability acceptance test. If there is a fault during the 5-day test period, the test shall be restarted.

E. CONTRACTOR shall provide all required equipment and personal necessary to perform WORK specified herein.

F. The CONTRACTOR shall coordinate with the City for water required for testing and commissioning purposes. The City will not charge for the water used for testing and commissioning purposes.

G. The City will provide the DCS programming, and the UV system manufacturer will provide the PLC programming.

1.2 REFERENCES

A. Instrument Society of America

5.4 Instrument Loop Diagrams

B. International Electrical Testing Association

1.3 SUBMITTALS

A. Commissioning coordinator’s qualifications.

B. Pre-commissioning and commissioning test plans and procedures, including testing schedule.

1. UV system reliability acceptance testing plan, procedure and schedule.

C. Certification of proper installation from all equipment manufacturers.

D. Credentials and certification of the testing laboratory proposed for calibration of all test equipment.

E. Lock-out and tag-out procedures to be used by the CONTRACTOR during pre-commissioning and commissioning testing.

F. Operator training plan.

G. Pre-commissioning report.

H. Commissioning report.

I. Certification of proper operation from all the equipment manufacturers.

1.4 COMMISSIONING TEAM

A. The commissioning team shall be made up of personnel from the CONTRACTOR, City, Engineer of Record, and equipment manufacturer's representatives. The commissioning coordinator shall be authorized to commit the CONTRACTOR's personnel and resources during commissioning.

B. Commissioning Coordinator. The commissioning coordinator shall utilize representatives of the CONTRACTOR's mechanical, electrical and instrumentation subcontractors, and others as appropriate for pre-commissioning and commissioning activities and testing. This team shall be available at the Project site during construction working hours. The commissioning coordinator shall at all times be ready to provide emergency repairs, adjustments and corrections to the equipment and systems installed and modified as a part of this Contract.

1. Responsibilities. Direct and be responsible for all pre-commissioning activities, commissioning tests, and related documentation, including the commissioning plan, and pre-commissioning and commissioning submittals. Provide technical instruction for pre-commissioning and commissioning and direct the facility's operation during equipment testing and facility testing. Perform all facility operations and tests in the presence of the Engineer. Specific responsibilities include, but are not limited to the following.

a. Prepare the submittals required for pre-commissioning and commissioning.

b. Develop and implement test procedures.

c. Develop and implement the commissioning plan.

d. Develop a detailed pre-commissioning and commissioning schedule.

e. Develop a standard testing log, accepted by the Engineer, to record the testing of each equipment item. Include the following in the log: equipment name; completion dates for checking, manufacturer inspection and acceptance, verification of instrumentation and controls, and testing; problems or issues with the equipment; and date of Engineer acceptance.

f. Develop commissioning forms to be used to record testing of each equipment item.

g. Notify the Engineer and all respective equipment manufacturers at least 30 days before the date when each equipment system is scheduled to be initially started. Submit pre-commissioning and commissioning testing plan stating schedule, and quantity and source of utilities and other materials needed.

h. Prepare and update the test schedule and incorporate testing activities in the project progress schedule.

i. Provide all documentation that equipment is ready for testing.

j. Provide all test reports after each test, including the final commissioning report. Include in the report all data collected during the test.

k. Perform the pre-commissioning tests or supervise the performance of pre-commissioning tests by manufacturer's field service representatives for various pieces of equipment.

l. Perform the Operational Readiness Tests.

m. Perform the Functional Acceptance Tests.

n. Perform the Reliability Acceptance Test.

o. Operate the facility during RAT with the support of City staff.

p. Schedule operation and maintenance training for City personnel at least 30 days before the start of training.

C. Commissioning Activities

1. Furnish labor, materials, consumables, tools, instruments, oils, fluids, test water and services for checking and testing all equipment during pre-commissioning and commissioning. This includes services from manufacturers' representatives, subcontractors, electricians, instrumentation technicians, and pipe-fitters that may be required during pre-commissioning and commissioning.

2. Obtain and furnish qualified manufacturer's representative to assist the testing of each equipment type and system in accordance with manufacturer's field services.

3. Maintain and service all equipment, generators, electrical gear, and instrumentation during pre-commissioning and commissioning.

4. Provide NETA acceptance testing during the pre-commissioning phase. Tests on newly installed power systems and apparatus shall be conducted before energizing, to ensure that the installation and equipment comply with intended use and with regulatory and safety requirements.

5. Provide operator and maintenance training to the City staff in accordance with Contract Documents.

6. Provide operations and maintenance manuals in accordance with the Contract Documents.

1.5 PRE-COMMISSIONING

A. Pre-commissioning includes all the activities to be completed before commissioning may begin, including but not limited to construction, factory testing, documentation, component testing, and isolated equipment and component testing including electrical continuity testing. Pre-commissioning concludes with the Engineer's acceptance of Operational Readiness Tests.

B. Once all equipment and components have been tested individually and all required deliverables have been accepted by the Engineer, request in writing to proceed to commissioning. If the Engineer agrees the pre-commissioning activities have been completed successfully, then the CONTRACTOR shall be notified in writing that commissioning may begin.

1.6 MANUFACTURERS FIELD SERVICES

A. Provide manufacturer's representatives who are an employee of manufacturer who is factory trained and knowledgeable in technical aspects of the products and systems for each equipment item requiring field services as indicated in the individual Sections of the specifications.

B. Procure and provide the services of manufacturer's representatives for equipment installation, facilities testing, pre-commissioning, commissioning, and training of City personnel.

C. After installation, each manufacturer's representative shall submit to the Engineer a written report, certificate of proper installation, certifying that all equipment was installed properly in accordance with the manufacturer's installation instructions.

D. After the RAT, each manufacturer's representative shall submit to the Engineer a written report, certificate of proper operation, certifying that all equipment was properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions as required by the Contract Documents.

E. Scheduling Manufacturer's Field Services. The manufacturer representatives shall visit the Project site to inspect, check, adjust if necessary, and approve the equipment installation. The manufacturer representatives shall be present when the equipment is being tested and placed into operation. The manufacturer representatives shall revisit the Project site as often as necessary until all equipment issues are corrected.

1. Schedule all manufacturer representative Project site visits to inspect equipment and make normal adjustments. Do not use the manufacturer's representative to remedy defective WORK.

2. Manufacturer representatives shall resolve assembly or installation problems attributable to or associated with, their products and equipment. During the testing, the manufacturer representatives shall assist, as applicable, the initial equipment and system adjustments and calibrations. After all commissioning tests have been completed, but before Substantial Completion, the CONTRACTOR shall recheck all equipment for proper alignment and adjustment, check oil levels, re-lubricate all bearing and wearing points, and, in general, ensure that all equipment is in proper condition for regular continuous operation.

1.7 PRE-COMMISSIONING AND COMMISSIONING TESTS

A. Coordinate the following tests, to be led by the commissioning coordinator during pre-commissioning and commissioning. Provide the Engineer with a preliminary copy of the test data within two days of completing each test.

B. The CONTRACTOR shall successfully complete each pre-commissioning test and receive written confirmation from the Engineer before starting any commissioning tests.

1. Factory Demonstration Test. The purpose of the FDT is for the CONTRACTOR and Engineer to inspect and witness the factory testing of Contract equipment at the manufacturer facilities.

2. Operational Readiness Test. Perform the ORT after installation and calibration of instruments is complete. The purpose of this test is for the CONTRACTOR to check and document the complete control system, including I/O to and from the PLC register and DCS register, excluding the operation of the application software. Test the equipment in Hand mode for operation and functionality.

C. Commissioning

1. Functional Acceptance Test. The FAT shall test the combined software and hardware system. The purpose of this test is to ensure that the control panel, operator graphics software configuration, and integration of mechanical and electrical systems, are working together as intended by the control strategy. This test shall be conducted with the system on-line under operating conditions. Application software problems encountered during the test shall be investigated and corrected by the CONTRACTOR. Issues with DCS software programming, completed by the City, will be corrected by the City. Issues with PLC software programming, completed by the UV system manufacturer, will be corrected by the UV system manufacturer. The FAT shall follow the Engineer accepted FAT testing procedures submittal, and include testing scenarios to simulate as close as possible real conditions that the equipment will see throughout the lifetime of the facility, including simulating all emergency scenarios.

2. Reliability Acceptance Test. The purpose of the RAT is for the CONTRACTOR to demonstrate that all systems are capable of operating continuously in the intended manner for an extended period without a significant interruption. During the RAT, operate the system within the design parameters reflecting the daily operation of the facilities for an uninterrupted period of 5 days unless noted otherwise herein.

3. After FAT and RAT are successfully completed, Bioassay tests and reporting procedures can commence.

PART 2 -- PRODUCTS

2.1 COMMISSIONING PLAN

A. The commissioning coordinator shall prepare the detailed commissioning plan. No testing shall begin until the commissioning plan is accepted by the Engineer. Submit the commissioning plan at least 90 days before the start of the first test.

B. The detailed commissioning plan shall include written test plans and procedures detailing the coordinated sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure. Test plans shall be specific as to support systems required to

complete the testing, temporary systems required during the testing, subcontractor and manufacturer representatives to be present, and expected test duration. As a minimum, the test plans shall include the following.

1. FDT and ORT checkout procedures reviewed and accepted by the respective equipment manufacturers.

2. Detailed testing procedures, setting forth step-by-step descriptions of the procedures proposed by the CONTRACTOR for the systematic testing of all equipment and systems installed under this Contract.

3. Include forms and checklists to be used to control and document the required tests.

4. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage current and using appropriate indicators to confirm that the circuit is properly identified and connected to the proper device.

5. Calibration record of all analysis instruments and control sensors. Include identification by make, manufacturer, model, and serial number of all test equipment; date of original calibration; date of subsequent calibrations; calibration method; and calibration equipment's test laboratory.

6. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the Contract Documents.

7. System tests and testing scenarios designed to duplicate, as closely as possible, operating conditions described in the Contract Documents, simulating conditions the equipment will see during the lifetime of the facility, equipment failure, and emergency scenarios. Provide a detailed list of every scenario to be tested and accepted by the Engineer.

8. For each test, the written procedure form should clearly define the following:

    a. Test Number, Equipment Number, or System Name.

    b. Test Objective: Describe the specific results to be observed or obtained.

    c. Test Description and Method: Describe the setup for the test and the steps required to complete the test.

    d. Date of test.

    e. Acceptance Criteria: Describe the criteria for passing or failing the test.

    f. Test results.

    g. Provide space on the form for the Engineer's comments and for CONTRACTOR sign-off.

    h. Test on a loop-by-loop basis. Every loop shall be signed off by the CONTRACTOR individually.

i. Test schedule.

j. A list of all test equipment to be available for the test.

k. A block diagram showing the test setup arrangement. The diagram shall illustrate the equipment under test, any special test equipment, and indicate equipment interconnections.

l. Staffing required for each test. Identify roles and responsibilities.

m. Instrumentation list with calibration methods and calibration dates.

C. Schedule. The commissioning coordinator shall produce a testing schedule setting forth the sequence contemplated for performing the testing. Include the following.

1. Detail the equipment and systems to be tested, and shall be part of the CONTRACTOR's Baseline Construction Schedule.

2. For each pre-commissioning and commissioning activity, identify the start date, duration of the test, and completion date.

3. Include the test activities in the CONTRACTOR's baseline schedule. At a minimum, include all NETA testing, FDT, ORT, FAT and RAT testing activities, operations and maintenance training classes, and document submittal dates.

a. At least half the time identified for the FAT in the CONTRACTOR's baseline schedule shall be dedicated to troubleshooting the PLC system and DCS system.

4. Update the test activities monthly, showing actual dates of test WORK, and systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents.

5. Daily Activities

a. During the pre-commissioning and commissioning tests, the commissioning coordinator shall meet each day with the Engineer.

b. The meeting purpose is to review the test schedule, the test results from the previous day, and when applicable, to coordinate the testing activities with City personnel.

2.2 DOCUMENTATION

A. During all phases of commissioning, the commissioning coordinator shall maintain a failure log at the Project site. The failure log shall consist of any equipment failures that have occurred, the condition of the failure, the reason for the failure, time of failure, and suggested corrective action. The purpose of the failure log is to trouble-shoot equipment and systems that may fail under complex conditions or when the commissioning coordinator is not at the Project site.

B. Loop Diagrams. The CONTRACTOR shall submit loop diagrams and be responsible for the accuracy of the information within the loop drawings. The CONTRACTOR shall certify to the

Engineer that the loop drawings properly reflect the Project's as-built condition. The loop diagrams shall be a singular complete bound package submitted 60 days before Substantial Completion. Loop diagrams shall be provided conforming to ISA 5.4, and shall verify the appropriate control panel interfaces with all instrumentation and devices being provided or installed under the Project. The following two sheet format is required.

1. Sheet One. A device schedule developed from an electronic spreadsheet or database file, which shall be submitted with the loop diagrams. The device schedule shall include the following:

    a. Device tag number.

    b. Equipment service.

    c. Device type.

    d. Location.

    e. Device manufacturer.

    f. Model number.

    g. Specification section number.

    h. Submittal number.

    i. Calibrated range and remarks.

    j. Data sheet number.

    k. I/O signal type: AI, AO, DI, or DO

    l. Signal level.

    m. Device range, full available instrument range.

    n. Engineering units.

    o. Process set point.

    p. Loop diagram number, reflecting the field instrument tag number.

    q. Loop drawing file name.

    r. Interconnect drawing file name.

2. Sheet 2: Abbreviated diagram showing instrument, wire and cable numbers, intermediate terminal junction boxes, and terminations. Wire identification numbers shall reflect the field instrument tag number, not the PLC I/O number or the DCS I/O number.

    a. PLC I/O tag numbers and DCS I/O tag numbers shall generally reflect the device tag

number. Each I/O tag number shall be unique. The tag prefix shall be based on ISA 5.4.

b. Include technical brochures, bulletins and data sheets containing fully completed ISA S20 data sheets.

c. Component functional descriptions

d. Locations or assembly at which component is to be installed.

C. Provide the following documentation. Do not start any commissioning activities until the following documentation is accepted by the Engineer. The Engineer will provide written notice to the CONTRACTOR when all the documents are accepted.

1. Equipment submittal.

2. RFIs.

3. All electrical equipment tests.

4. All instrumentation equipment tests.

5. All mechanical equipment tests.

6. Loop drawings.

7. P&ID drawings.

8. CONTRACTOR lock-out tag-out procedures.

9. All vendor and manufacturer certificates of proper installation.

10. All pressure test reports.

11. All loop test reports.

12. All conductivity test reports.

13. All instrument calibration reports.

14. All electrical breaker setting reports.

15. All mechanical alignment reports.

16. Control system test reports while in Hand.

17. Draft operations and maintenance manual.

18. All operating permits.

19. Commissioning plan.

20. Operator training plan.

21. Pre-commissioning report.

D. Provide the following documentation associated with the commissioning tests.

1. Updated as-built drawings.

2. Final punch list.

3. All vendor and manufacturers certificates of proper operation.

4. Commissioning report.

E. Reports

1. Pre-commissioning report. The pre-commissioning report shall include all test reports, test data, certificates, and commissioning forms produced during the pre-commissioning testing. The first section of this report shall summarize the contents and certify that all tests and procedures have been successfully completed.

2. Commissioning report: The commissioning report shall include all test reports, test data, certificates and commissioning forms produced during the commissioning testing. At a minimum, include the following in the report.

a. The first section shall summarize the contents and certify that all tests and procedures have been successfully completed.
b. Field recorded dimensional measurements and clearances.
c. Pressure, pressure differential, level, flow and other field settings.
d. Field settings for all electrical devices.
e. Operational pressure tests, control system timing tests and settings and other test data specified.
f. Field wiring changes made, including marked up drawings.

PART 3 -- EXECUTION

3.1 PRE-COMMISSIONING MEETINGS

A. Periodic Progress Meetings. One month before the start of the RAT, and until all phases of pre-commissioning and commissioning are complete, the commissioning status shall be included on the agenda for the periodic construction progress meetings as required by the CONSTRUCTION MANAGER.

B. Technical Pre-Commissioning and Commissioning Meetings. The purpose of these meetings is to provide a technical discussion and coordination between the commissioning team and the manufacturers. The frequency of these meetings shall be based on the Project's needs, agreed to by the Engineer, and coordinated by the commissioning coordinator. The meetings listed are the assumed minimum number of meetings required; if additional meetings are deemed necessary by the Engineer, then the CONTRACTOR shall have the manufacturers' representatives attend any additionally required meetings, at no additional cost to the City.

1. UV system manufacturer: Two meetings, four hours duration each meeting.

C. Typical discussion items may include, but are not limited to, the following topics: set points, ramp rates, alarms, values, calibration, specific lines of programming code, specific HMI screens, MODBUS IP communication "word messages", proportional integral derivative (PID) control, PID constants, system response, operator training, control philosophy logic, hard I/O, soft I/O, review of documentation, scheduling, and motor protection relay set points.

D. The Engineer will schedule meetings with the CONTRACTOR as needed to discuss the PLC programming and DCS programming.

3.2 RELIABILITY ACCEPTANCE TEST CRITERIA

A. Subject to the Engineer's acceptance, the reliability acceptance test shall begin as soon as possible after completion of the functional acceptance test.

B. During the reliability acceptance test, a significant interruption may include any of the following events.

1. Failure of a system that is not permanently corrected within six hours after such failure occurs.

2. Failure of a mechanical, electrical, or instrumentation equipment unit that is not permanently corrected within eight hours after such failure occurs.

3. Permanently corrected shall mean the system or equipment unit does not repeat a failure during the remaining duration of the test. Permanently corrected consists of all of the following:

a. WORK repaired and replaced to conform to specified requirements.

b. Parts and components replaced as recommended by original manufacturer without impacting the warranty, and conforming to accepted submittals.

c. Piping and valves properly installed and connected.

d. Wiring properly terminated.

e. The facility is back on line and operating within normal operating parameters.

4. Occurrence of a significant interruption shall require the restart of the reliability acceptance test at day one, after permanent corrections are made.

C. Retesting of Equipment. When testing or operation of the equipment demonstrates that the equipment does not meet the specified requirements, the CONTRACTOR shall repeat or perform all additional tests as necessary and required by the Engineer.

SECTION 15000 - PIPING COMPONENTS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing fittings, hangers, supports, anchors, expansion joints, flexible connectors, insulation, lining and coating, testing, disinfection, and accessories.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 05500 Miscellaneous Metalwork
2. Section 11000 Equipment General Provisions

1.3 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. California Mechanical Code
2. California Plumbing Code
3. California Fire Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following applies to the WORK of this Section:

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/ASME B31.1	Power Piping
ANSI/AWWA C111	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
ANSI/AWWA C150	Thickness Design for Ductile Iron Pipe
ANSI/AWWA C153	Ductile Iron Compact Fittings, 3 In through 24 In and 54 In Through 64 In for Water Service
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in. Through 144 in.
ANSI/AWWA C213	Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In Through 12 In for Water Distribution
ANSI/AWWA C905	Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In through 36 In
ANSI/AWS D10.9	Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing

ASTM A 123	Specification for Zinc Coatings on Iron and Steel Products
ASTM A 536	Ductile Iron Castings
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Shop drawings showing dimensions and details of pipe joints, fittings, fitting specials, valves and appurtenances.

2. Detailed layout, spool, or fabrication drawings showing pipe spools, spacers, adapters, connectors, fittings, and pipe supports.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's product data.
2. Manufacturer's installation instructions.
3. Manufacturer's certification of compliance.
4. Statement from the pipe fabricator certifying that all pipe will be fabricated subject to a Quality Control Program.
5. Outline of Quality Control Program.

1.7 INSPECTION, TESTING AND WELDING

A. **Inspection:** Products shall be inspected at the manufacturer's plant.

B. **Tests:** Materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

C. **Welding Requirements:** Welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D10.9. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. **Welder Qualifications:** Welding shall be performed by skilled operators who have had adequate experience in the methods and materials to be used and have been qualified under the provisions of ANSI/AWS D10.9 by an independent approved testing agency not more than 6 months prior to commencing WORK on the pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests.

1.8 FACTORY TESTING

A. **Product Testing:** Products shall be tested at the factory for compliance with the indicated requirements.

B. **Witnesses:** The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness factory tests.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Coating:** Pipes above ground or in structures shall be color-code field-painted. Colors shall be as selected by the CONSTRUCTION MANAGER.

B. **Pressure Rating:** Except as otherwise indicated, piping systems shall be designed for 150 percent of the maximum indicated pressure.

C. **Grooved Piping Systems:** Grooved couplings on buried piping must be bonded. Grooved fittings, couplings, and valves shall be from the same manufacturer.

2.2 PIPE FLANGES

A. **Flanges:** Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-lb class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-lb class. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-lb class. Flanges shall be attached to the pipe in accordance with ANSI/AWWA C207.

B. **Blind Flanges:** Blind flanges shall comply with ANSI/AWWA C207. Blind flanges for pipe sizes 12 inches and larger shall include lifting eyes in form of welded or screwed eye bolts.

C. **Flange Coating:** Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. **Flange Bolts:** Bolts and nuts shall comply with Section 05500. Studs and bolts shall extend through the nuts a minimum of 1/4-inch. All-thread studs may be used only on valve flange connections where space restrictions preclude the use of regular bolts.

E. **Insulating Flanges:** Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter. Existing flanges where new insulating gaskets are required for the project may require boring the holes greater or replacement of the flanges at no additional cost to the CITY.

F. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated and shall consist of insulating gaskets (retainer), insulating bolt sleeves, and double insulating washers. All insulating components shall be NEMA G-10 epoxy glass. Insulating gaskets (retainers) shall be

full face, Type E and shall have a Buna-N (nitrile) O-ring type sealing element such as PSI Linebacker or equal.

Insulating flange kits shall be tested and inspected by the City's Corrosion Engineer. The City's Corrosion Engineer shall be contacted at (858) 614-5560 a minimum of 48 hours prior to the assembly of any insulating flange kits. Insulating flange kits shall be installed and tested in accordance with NACE SP0286-07. Insulating flange kits shall be tested using a minimum of two test methods. The first test method shall utilize a Gas Electronics Model 601 Insulator Checker specifically designed for testing insulating flanges. Additionally, insulating flanges shall be tested by measuring pipe-to-soil potentials on either side of the insulating joint as described in SP02186-07 Paragraph 9.2.2.

The installation of the insulating flange kit shall be considered complete when the testing above indicates that no shorts or partial shorts are present. Any insulating flange kit that is determined to be ineffective shall be repaired or replaced at the CONTRACTOR'S expense.

G. **Flange Gaskets:** Gaskets for flanged joints shall be full-face, 1/8-inch thick sheets of neoprene, suitable for temperatures to 550 degrees F, a pH of 0 to 14, and pressures to 1400 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

2.3 THREADED INSULATING CONNECTIONS

A. **General:** Threaded insulating bushings, unions, and couplings shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are indicated.

B. **Materials:** Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties suitable for the service and loading conditions indicated.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. **General:** Cast mechanical-type couplings shall be provided where shown. Bolts and nuts shall conform to Section 05500. Gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations suitable for the highest pressure indicated.

2.5 SLEEVE-TYPE COUPLINGS

A. **Construction:** Sleeve-type couplings shall be installed where indicated and shall include steel bolts, without pipe stop, and shall be sized to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to Section 05500. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. **Pipe Preparation:** The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. **Gaskets:** Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer. The rubber in the gasket shall comply with the following:

1. Color - Jet Black
2. Surface - Non-blooming
3. Durometer Hardness - 74 ± 5
4. Tensile Strength - 1000 psi Minimum
5. Elongation - 175 percent Minimum

The gaskets shall resist deterioration caused by impurities normally found in water or wastewater. Gaskets shall comply with ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as otherwise indicated. Gaskets shall be compatible with the piping service and fluid utilized.

D. **Insulating Couplings:** Where insulating couplings are indicated, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to insulate coupling metal parts from the pipe.

E. **Restrained Joints:**

1. Harnesses for flexible sleeve type couplings shall be in accordance with the requirements of the appropriate reference standards and standard practices.

2. Mechanical and Push-On Joints: Restraints shall be provided where shown and may be provided in lieu of concrete thrust blocks.

    a. Mechanical joint restraint mechanisms shall consist of individually activated multiple gripping devices which incorporate breakoff actuating units and permanent nuts for future disassembly. Pressure ratings shall be:

        (1) Ductile Iron Pipe
            (a) 3 to 6 inch diameter: 350 psi (2:1 safety factor)
            (b) 18 to 48 inch diameter: 250 psi (2:1 safety factor)

        (2) PVC Pipe

            (a) 3 to 36 inch diameter: full pressure rating or pressure class of pipe (2.5:1 safety factor)

    b. Push-on joints for steel pipes shall be in accordance with the appropriate reference standards and standard practice.

c. Restrained push-on joints for all other pipe materials shall be comprised of two rings with connecting rods. The restraint ring shall be on the spigot, and a plain or slit bell ring shall be on the bell. Pressure ratings shall be:

(1) Ductile Iron Pipe

(a) 3 to 16 inch diameter: 350 psi (2:1 safety factor)
(b) 18 to 48 inch diameter: 250 psi (2:1 safety factor)

(2) PVC Pipe

(a) 3 to 10 inch diameter: 200 psi (4:1 safety factor)
(b) 12 inch diameter: 150 psi (4:1 safety factor)
(c) 14 to 16 inch diameter: 235 psi (2:1 safety factor)
(d) 18 to 30 inch diameter: 165 psi (2:1 safety factor)
(e) 36 inch diameter: 125 psi (2:1 safety factor)

(3) Dimensions of push-on bell restraints shall be compatible with ANSI/AWWA C150 and C900 or C905 for ductile iron or PVC pipe, respectively.

d. Restraint glands shall be of ductile iron conforming to ASTM A 536. Dimensions of the glands shall be compatible with standard mechanical joint bell and tee head bolts conforming to ANSI/AWWA C111 and C153, respectively.

e. Bolts and nuts shall conform to Section 05500.

2.6 FLEXIBLE CONNECTORS

A. Flexible connectors shall be provided in all piping connections to engines, pumps, blowers, compressors, vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged reinforced neoprene or butyl rubber spools, rated for working pressures of 40 to 150 psi or reinforced flanged rubberized duck, as best suited for the application. For temperatures above 180 degrees F, flexible connectors shall be flanged braided Type 316 stainless steel spools with inner corrugated stainless steel hose rated for minimum 150 psi working pressure unless indicated otherwise. Connectors shall be minimum of 9 inches face to face between flanges. Material selection shall be proposed by the manufacturer based on the application.

2.7 PIPE THREADS

A. Pipe threads shall comply with ANSI/ASME B1.20.

2.8 MANUFACTURERS

A. **Manufacturers**: Products of the type or model (if any) indicated shall be manufactured by one of the following (or equal):

1. **Insulating Flanges:**
JM Red Devil, Type E
Maloney Pipeline Products Co.
PSI Products, Inc.

2. **Flange Gaskets:**
   John Crane, Style 2160
   Garlock, BLUE-GARD® Style 3000

3. **Steel Pipe Couplings:**
   Gustin-Bacon (banded or grooved)
   Victaulic Vic-Ring® Style 41 or 44 (banded)
   Victaulic Style 77 or Zero-Flex® Style 07 (grooved)

4. **Ductile Iron Pipe Couplings**:
   Gustin-Bacon
   Victaulic Style 31

5. **Couplings for PVC Pipe:**
   Gustin-Bacon
   Victaulic Style 775

6. **Sleeve-Type Couplings:**
   Dresser, style 38
   Ford Meter Box Co., Inc., Style FC1 or FC3
   Smith-Blair, Style 411

7. **Dismantling Joints:**
   Romac Industries, Inc DJ400
   Smith-Blair, Inc 970 Series

PART 3 -- EXECUTION

3.1 GENERAL

A. Pipes, fittings, and appurtenances shall be installed in accordance with the manufacturer's installation instructions.

**** END OF SECTION ****

SECTION 15020 - PIPE SUPPORTS

PART 1-- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing pipe supports, hangers, guides, and anchors.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 05500 Miscellaneous Metalwork
2. Section 15000 Piping Components

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ANSI/ASME B31.1	Power Piping
ANSI/MSS SP-58	Standard Pipe Support Components

1.4 SHOP DRAWINGS AND SAMPLES

A. Submittals shall comply with Section 15000 and shall include:

1. Shop drawings of pipe supports including details of concrete inserts.

2. Manufacturer's catalogue information demonstrating compliance with the specifications.

3. Hanger and support location drawings with a legend that lists at a minimum, support identification number, support type, seismic restraint locations, anchor locations, pipe size, service and weight.

4. Seismic restraint calculations signed by an engineer registered in California.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **General:** Piping systems including connections to equipment shall be properly supported to prevent deflection and stresses. Supports shall comply with ANSI/ASME B31.1, except as otherwise indicated.

B. **ANSI/MSS Types**: Except as otherwise indicated, pipe support components shall comply with the types in ANSI/MSS SP-58.

C. **Material:** Unless otherwise indicated, all pipe supports components and hardware shall be stainless steel type 316.

D. **Support Spacing:** Supports for horizontal piping shall be properly spaced. Except as otherwise indicated, pipe support spacing shall comply with the following:

1. **Support Spacing for Schedule 40 & 80 Steel Pipe**:

Pipe Size (inches)	Max. Span (feet)
1/2	6
3/4 & 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 & 10	19
12 & 14	23
16 & 18	25
20 & Above	30

2. **Support Spacing for Copper Tubing:**

Tube Size (inches)	Max. Span (feet)
1/2 to 1-1/2	6
2 to 4	10
6 & Above	12

3. **Support Spacing for Schedule 80 PVC Pipe:**

Pipe size (inches)	Max Span (@100 degrees F) (feet)
1/2	4
3/4	4
1	5
1-1/4	5
1-1/2	5
2	6
3	7
4	8
6	10
8	11
10	12
12	13

4. **Support Spacing for Welded, Fabricated Steel Pipe:**

Practical Safe Spans for Simply Supported Pipe in 120-deg Contact Saddles

Nominal Size in.	Wall Thickness-in 3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
	Span, L-ft									
24	33	37	40	43	45	47				
26	33	37	41	43	45	47				
28	33	38	41	44	46	48				
30	34	38	41	44	47	49				
32	34	38	42	45	47	50				
34	34	38	42	45	48	50				
36	34	39	42	45	48	50	54			
38	34	39	43	46	48	51	55			
40	34	39	42	46	49	51	55			
42	35	39	43	46	49	52	56			
45		39	43	47	50	52	56			
48		40	44	47	50	53	57	61		
51		40	44	47	50	53	58	61		
54		40	44	47	51	53	58	62		
57		40	44	48	51	54	58	62		
60		40	44	48	51	54	59	63	66	69
63		40	44	48	51	54	59	63	67	70
66		40	45	48	52	54	59	64	67	71
72		41	45	49	52	55	60	64	68	72
78		41	45	49	52	55	61	65	69	72
84		41	45	49	53	56	61	66	70	73
90		41	45	49	53	56	61	66	70	74
96		41	46	50	53	56	62	67	71	75

For steel pipe sizes not indicated, the support spacing shall be designed to ensure that the stress on the pipe does not exceed 5,000 psi calculated from the following formula:

$$L = \frac{7500tD}{32t+D}$$

t = thickness, in.
D = Diameter, in.
L = Safe span, ft.

Maximum deflection of pipe shall be limited to 1/360th of the span.

5. **Support Spacing for Ductile Iron Pipe:**

Pipe Size	Max. Span
All Sizes	2 Supports per length or 10 feet (One of the 2 supports located at joint)

6. **Variances:** For temperatures other than ambient temperatures and for other piping materials or wall thicknesses, the above spacings shall be modified in accordance with the pipe manufacturer's recommendations.

7. **Additional Supports:** Additional supports complying with ANSI B31.1 shall be provided at critical elbows, valves, gauges, and meters.

E. **Pipe Hangers:** Pipe hangers shall be capable of supporting the pipe, shall allow for free expansion and contraction of the piping, and shall prevent excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed so that they cannot become disengaged by any movement of the pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading, only.

F. **Hangers Subject to Horizontal Movements:** At hanger locations where lateral or axial movement is indicated, suitable linkage shall be provided to permit movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from minimum to maximum temperature, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

G. **Spring-Type Hangers:** Spring-type pipe hangers shall be provided for piping where vibration or vertical expansion and contraction is indicated, (engine exhausts and similar piping). Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions indicated. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be designed for a maximum variation of 25 percent for the total travel resulting from thermal movement.

H. **Thermal Expansion:** Wherever expansion and contraction of piping is indicated, a sufficient number of expansion loops or joints shall be provided, with rolling or sliding supports, anchors, guides, pivots, and restraints. They shall permit the piping to expand and contract freely in directions away from the anchored points and shall be structurally suitable to withstand all loads imposed.

I. **Heat Transmission:** Supports, hangers, anchors, and guides shall be designed and insulated so that excessive heat shall not be transmitted to the structure or to other equipment.

J. **Riser Supports:** Risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

K. **Freestanding Piping:** Free-standing pipe connections to equipment, including chemical feeders and pumps, shall be firmly attached to fabricated steel frames made of angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands, consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps installed to secure piping.

L. **Point Loads:** Meters, valves, heavy equipment, and other point loads on PVC, and other plastic pipes, shall be supported on both sides according to manufacturer's recommendations to avoid pipe stresses. Supports on plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

M. **Noise Reduction:** To reduce transmission of noise in piping systems, copper tubes shall be wrapped with a 2-inch wide strip of rubber fabric at each pipe support, bracket, clip, and hanger.

N. **Structural Design:** Pipe supports, anchors, and restrainers shall be designed for static, dynamic, wind, and seismic loads. The horizontal seismic design force shall be per the requirements of the CBC for Seismic Zone 4.

2.2 COATING

A. **Galvanizing:** Fabricated pipe products, except stainless steel or non-ferrous supports, shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM 123.

2.3 MANUFACTURERS

A. Pipe supports shall be manufactured by one of the following (or equal):

Basic Engineers
Bergen-Paterson Corp.
ITT-Grinnell Corp.
NPS Industries, Inc.
Powerstrut
Unistrut

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's installation instructions and ANSI/ASME B31.1.

B. **Appearance:** Supports and hangers shall be installed to produce an orderly, neat piping system. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings as possible and without interference with other work.

**** END OF SECTION ****

SECTION 15100 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing general requirements for valves including epoxy coating, installing, adjusting, and testing of valves and where buried valves are indicated, valve boxes to grade, with covers, stem extensions, and position indicators.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11000 Equipment General Provisions
2. Section 11293 Sluice Gates
3. Section 15000 Piping Components
4. Section 15101 Valve and Gate Operators

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following standards apply to the WORK of this Section:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ASTM A 36	Specification for Structural Steel
ASTM A 48	Specification for Gray Iron Castings
ASTM A 126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Specification for Ductile Iron Castings
ASTM B 61	Specification for Steam or Valve Bronze Castings
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 148	Specification for Aluminum-Bronze Castings
ASTM B 584	Specification for Copper Alloy Sand Castings for General Applications
ANSI/AWWA C500	Gate Valves for Water and Sewerage Systems
ANSI/AWWA C502	Dry-Barrel Fire Hydrants
ANSI/AWWA C503	Wet-Barrel Fire Hydrants
ANSI/AWWA C504	Rubber-Seated Butterfly Valves
ANSI/AWWA C506	Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types
ANSI/AWWA C507	Ball Valves 6 Inches through 48 Inches

AWWA C508	Swing-Check Valves for Waterworks Service, 2 Inches Through 24 Inches NPS
ANSI/AWWA C509	Resilient-Seated Gate Valves for Water and Sewage Systems
AWWA C550	Protective Interior Coatings for Valves and Hydrants
SSPC-SP-2	Hand Tool Cleaning
SSPC-SP-5	White Metal Blast Cleaning

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's product data including catalogue cuts.
2. Manufacturer's installation instructions.
3. Shop drawings showing details and dimensions.
4. Manufacturer's certification that products comply with the indicated requirements.
5. Schedule of valves indicating valve identification and location.
6. Manufacturer's certification that epoxy coatings have been factory tested and comply with the indicated requirements.

1.5 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's installation and operating instructions.
2. Manufacturer's maintenance procedures.
3. List of special tools.
4. Schedule of valves indicating valve identification and location.
5. Manufacturer’s instructions for short term and long term storage.

1.6 FACTORY TESTING

A. **General**: Valves shall be tested in compliance with the AWWA Standards as indicated. Except as otherwise indicated, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

B. **Proof-of-Design Tests**: The CONTRACTOR shall furnish the CONSTRUCTION MANAGER three (3) certified copies of a report from an independent testing laboratory certifying successful completion of proof-of-design testing for all valves of sizes 10-inch and larger unless indicated otherwise in the specific valve Section. In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a representative of a qualified independent testing laboratory representative. Proof-of-design testing shall have been performed on not less than three valves, with all three units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

1.7 FIELD TESTING

A. **Testing**: Valves shall be field-tested for compliance with the indicated requirements.

PART 2 -- PRODUCTS

2.1 VALVES

A. **General:** Shut-off valves, 6-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing position indicators, and valve extensions. Valves mounted higher than 7 feet above working level shall be provided with chain operators.

B. **Valve Flanges:** The flanges of valves shall comply with Section 15000.

C. **Protective Coating:** Except where otherwise indicated, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves 4-inch and larger, and exterior surfaces of submerged valves, shall be epoxy coated conforming to Section 09800. Flange faces of valves shall not be epoxy coated.

D. **Valve Operators:** Where indicated, valves shall include electric operators recommended by the manufacturer. Operators of the same type shall be furnished by the same manufacturer. Valve operators, regardless of type, shall be installed, adjusted, and tested by the valve manufacturer at the manufacturing plant. Except as otherwise indicated, electric, pneumatic, and hydraulic valve operators shall comply with Section 15101.

E. **Nuts and Bolts:** Nuts and bolts on valve flanges, bodies and supports shall comply with Section 05500.

2.2 NAMEPLATES, TOOLS AND SPARE PARTS

A. **Nameplates**: Except as otherwise indicated, a label shall be provided on all valves exclusive of hose bibbs. The label shall be 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, and shall be permanently attached to the valve. Tag shall match valve identification schedule.

B. **Spare Parts:** Two sets of packings, O-rings, gaskets, discs, seats, and bushings shall be furnished with each valve, as applicable.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

A. **General:** Valves, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's installation instructions. Valves shall be independently supported to prevent stresses on the pipe.

B. **Access:** Valves shall be installed to provide easy access for operation, removal, and maintenance and to prevent interferences between valve operators and structural members or handrails.

C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the combinations shall be properly assembled and installed to ensure that systems are accessible for maintenance, are compatible with one another and are operating properly.

** END OF SECTION **

SECTION 15101 - VALVE AND GATE OPERATORS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing all shut off and throttling valves and gates with manual and power operators as indicated. The CONTRACTOR shall provide the valve and gate operators, complete and operable, including all controls, motors, gears, enclosures and other necessary appurtenances as indicated.

B. The WORK also requires that the valve or gate manufacturer accept responsibility for furnishing the WORK in this Section but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.

C. The WORK additionally requires that the one manufacturer who accepts the indicated responsibilities shall manufacture the valve or gate, as a minimum.

D. The WORK also includes coordination of design, assembly, testing and installation.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11293 Sluice Gates
2. Section 15100 Valves, General
3. Section 16050 Basic Electrical Materials and Methods

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	JIC P-1	Pneumatic Standards for Industrial Equipment and General Purpose Machine Tools
2.	NEMA ICS-2	Industrial Control Devices, Controllers and Assemblies

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with the specifications:

1. Electrical wiring and control diagrams.

1.5 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment**: An authorized representative of the manufacturer shall visit the site for not less than 2 days to furnish the indicated services.

B. **Instruction of OWNER'S Personnel**: The authorized service representative shall also furnish the indicated services for instruction of OWNER'S personnel for not less than 2 days.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **General:** Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power operators. The CONTRACTOR shall furnish all operators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All operators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven operators shall be identified by unique numbers.

B. **Manufacturers:** Where indicated, certain valves and gates may be provided with operators manufactured by the valve or gate Manufacturer. Where operators are furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.

C. **Materials:** All operators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.

D. **Mounting:** All operators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or operator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power operators shall be equipped with position indicators. Where possible, manual operators shall be located between 48 and 60 inches above the floor or a permanent work platform.

E. **Standard:** Unless otherwise indicated and where applicable, all operators shall be in accordance with ANSI/AWWA C 540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.

F. **Functionality:** Electric, pneumatic, and hydraulic operators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL OPERATORS

A. **General:** Unless otherwise indicated, all valves and gates shall be furnished with manual operators. Valves in sizes up to and including 32 inches shall have direct acting lever or handwheel operators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual operators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear operators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 4 inches to 24 inches in diameter may have traveling-nut operators, or worm-gear operators as indicated.

B. **Buried Valves:** Unless otherwise indicated, all buried valves shall have extension stems to grade, with wrench nuts located within 6 inches of the valve box cover, position indicators, and cast-iron or steel pipe extensions with heavy valve boxes with stay-put, hot-dip galvanized covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve operators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the ENGINEER. Wrench-nuts shall comply with AWWA C 500 -Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished.

C. **Chain Operator:** Manually-operated valves with the stem located more than 7 feet 6 inches above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve Manufacturer. The wheel and guide shall be of ductile-iron or cast-iron, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-operated valves shall be extra strong to allow for the extra weight and chain pull. For plug valves 8 inches and larger, the actuator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. **Floor Boxes:** Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

E. **Adjustable Shaft Valve Boxes:** Adjustable shaft valve boxes shall be concrete or cast iron valve extension boxes. Box covers on water lines shall be impressed with the letter "W". Gas line covers shall be impressed with the letter "G".

F. **Manual Worm-Gear Operator:** The operator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The operator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The operator shall consist 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. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Operator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the operator. All gearing shall be designed for a 100 percent overload.

G. **Traveling-Nut Operator:** The operator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weather-proof cast-iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the operator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of grease nipples. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR OPERATORS

A. General

1. **Equipment Requirements:** Where electric motor operators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.

2. **Gearing:** The motor operator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4x assembly. The operator 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. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Operator 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 electric operator.

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 operator motor must attain full speed before stem load is encountered.

4. **Switches and Wiring:** Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by a pulse-counter which receives 15 pulses per rotation of the unit. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The operator shall have a number of gear trains as required to produce the operation indicated. The operator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-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. Position limit switches and associated gearing shall be an integral part of the valve operator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Traveling-nuts, cams, or microswitch tripping mechanisms shall not be used. Limit-switches shall be of the heavy-duty open contact type with rotary wiping action.

5. **Handwheel:** 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.

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 all 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. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All 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 operator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire operator is an hermetically-sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

B. Electric Motor Operators (AC Reversing Control Type)

1. **General:** Where indicated, electric motor operators shall be the AC reversing type complete with local control station with open/close and local/remote selector switches.

2. **Operator Appurtenances:** The operator for each valve shall be supplied with open and close status lights; open, close and lock-out-stop push-buttons, and all other devices indicated.

3. **Starter:** The starter shall be suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-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.

C. Electric Motor Operators (AC Modulating Control Type)

1. **General:** Where indicated, modulating electric motor operators shall be the ac modulating type complete with a local control station with open/close/auto/hold functions.

2. **Control Module:** The control module shall be of the electronic solid-state ac type with proportional pulse output to control the speed of the motor.

3. **Starter:** The operator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480-volt, 3-phase, 60-Hz.

4. **Construction:** The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access

memory for storage of calibration parameters and push-button calibration elements for field-setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4-20 mA. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve.

2.4 PNEUMATIC OPERATORS

A. **General:**

1. **Controls:** Pneumatic cylinder operators shall be provided complete with all necessary pneumatic or electro-pneumatic controls for the intended actuation of the valve or gate.

2. **Lubricators:** Where required by the service and type of operator, oil-lubricators shall be provided in the air supply to the operator, according to the Manufacturer's instructions.

3. **Air Supply:** All pneumatic operators shall be sized for the available air pressure as indicated and shall be furnished with isolating valves, adjustable filter-regulators, pressure gauges, and condensate drains. The filter elements shall be replaceable 40 micron units.

B. Diaphragm Operators

1. **Construction:** The operator shall consist of a ductile-iron, aluminum, or carbon steel diaphragm housing and stainless steel or carbon steel stem; a ductile-iron or cast-iron yoke and spring barrel with carbon steel spring, and Nitrile-covered fabric diaphragm of sufficient strength for the maximum expected torque or force.

2. **Manual Override:** Each operator shall be provided with a manual handwheel override, top-mounted for linear actuation, and worm-gear mounted with declutchable handwheel for rotary actuation. The worm-gear construction shall be as indicated for manual operators.

C. Double-Piston Operators

1. **Construction:** The operators shall be of the double-acting cylinder type with provision for later field conversion to spring-return action. A rack-and-pinion drive shall provide a 90-degree rotation of the output shaft, which shall be extended to receive a manual override. The operator shall be totally enclosed in a hard-anodized aluminum, ductile-iron, cast-iron, or steel housing. The cylinders and pistons shall be of hard-anodized aluminum or ductile-iron or steel, honed, and nickel or chrome-plated, or coated with a permanent dry-film lubricant and corrosion inhibitor. The rack, pinion, end caps, and tie-rods shall be of hardened carbon steel. The seals and O-rings shall be Buna N.

2. **Manual Override:** Each operator shall be provided with a manual worm-gear override with declutchable handwheel. The worm-gear construction shall be as indicated for manual operators.

D. Scotch-Yoke Piston Operators

1. **Construction:** The operator shall be of the double-acting cylinder type with provision for later field conversion to spring-return action. The operator may be of the single- or double-cylinder design. A scotch-yoke drive shall provide a 90-degree rotation of the output shaft, which shall be extended to receive a manual override. The unit shall be totally enclosed in a hard-anodized aluminum, ductile-iron, cast-iron, or steel housing. The cylinders and pistons shall be of hard-anodized aluminum, cast-iron, ductile-iron, or steel, honed and nickel- or chrome-plated, or coated with a permanent dry-film lubricant and corrosion inhibitor. The piston rod shall be of hard chrome- or nickel-plated steel. The tie-rods shall be of hardened carbon steel, and the seals and O-rings of Buna N.

2. **Manual Override:** Each operator shall be provided with a manual worm-gear operator override with declutchable handwheel. The worm-gear construction shall be as indicated for manual operators.

2.5 (NOT USED)

2.6 MANUFACTURERS

A. Products shall be from the following manufacturers, or equal.

1. Valve Boxes

Brooks 3RT
Christie G5
Empire 72

2. AC Reversing Control Type Operators

EIM
Keystone
Limitorque
Rotork

3. AC Modulating Control Type Operators

EIM
Limitorque Corporation
Rotork

4. DC Modulating Control Type Operators

EIM "Futronic - III"
Limitorque Corporation, "Modutronic - 10"

5. Pneumatic Cylinder Controls

G.H. Bettis
Fisher Controls
Keystone Controls, Inc.

Miller Fluid Power
Neles-Jamesbury, Inc.

Rexroth Corporation

6. Air Supply Lubricators

   Fisher Controls, Series 67

7. Diaphragm Operators

   Fisher Corporation
   ITT Engineered Valves
   Neles-Jamesbury, Inc.

8. Manual Worm-Gear Override

   G.H. Bettis
   Keystone Controls, Inc.
   Neles-Jamesbury, Inc.

9. Scotch-Yoke Piston Operators

   G.H. Bettis
   Keystone Controls, Inc.
   Neles-Jamesbury, Inc.
   Rotork Controls, Inc.

10. Hydraulic Cylinder Operators

    G.H. Bettis
    Miller Fluid Power
    Rexroth Corporation

11. Power and Control Systems

    G.H. Bettis
    Miller Fluid Power
    Rexroth Corporation

12. Fluid Power Systems

    R.W. Atkinson Co., Inc.
    Miller Fluid Power
    Parker Hannifin Corporation
    Rexroth Corporation

PART 3 -- EXECUTION

3.1 GENERAL

Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.2 SERVICES OF MANUFACTURER

A. Field Adjustments

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric operators shall adjust operator controls and limit-switches in the field for the required function.

3.3 INSTALLATION

A. All valve and gate operators and accessories shall be installed in accordance with Section 15100 - Valves, General.

**** END OF SECTION ****

SECTION 16030 - ELECTRICAL TESTS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes testing, commissioning and demonstrating electrical WORK.

B. The WORK of this Section includes circuit activation, equipment running and installation of temporary jumpers.

C. The WORK of this Section includes correction of defects and retesting.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 13300 Instrumentation and Control
2. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. NETA National Electrical Testing Association, Latest Edition

1.5 SEQUENCE AND SCHEDULING

A. Electrical testing including functional testing of power and controls not tested under Section 13300 shall be completed before commencement of commissioning.

1.6 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Report of testing of electrical WORK.

PART 2 -- PRODUCTS

2.1 TEST EQUIPMENT AND MATERIALS

A. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

PART 3 -- EXECUTION

3.1 TESTING

A. In addition to indicated testing requirements and acceptance criteria, testing shall include the following:

1. **Lighting:** N/A

2. **Power Instrumentation:** N/A

3. Demonstration of mechanical and electrical interlocking by attempting to subvert the indicated sequence.

4. Activation of ground fault tripping by operating test features provided with ground current protective systems and by injecting a known, and reasonable, current in the ground current sensor circuit. Where not otherwise indicated, ground fault tripping shall occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.

5. **Cable Testing:** 480-volt circuits shall be tested for insulation resistance with a 1000-volt megohm meter. Testing shall be done after the 480-volt equipment is terminated.

6. Functional test and testing of electrical components shall be performed prior to subsystem testing and commissioning. Compartments and equipment shall be cleaned before commencement of functional testing. Functional testing shall include:

   Visual and physical check of cables, busswork, circuit breakers, transformers, and connections associated with new and modified equipment.

7. Complete ground testing of all grounding electrodes prior to operating the equipment utilizing a three-point ground test.

B. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated to the CONSTRUCTION MANAGER and after process control devices have been adjusted. The WORK of this Section includes adjusting limit switches and level switches prior to testing and setting pressure switches, flow switches, and timing relays.

C. After initial settings have been completed, each subsystem shall be operated in the manual mode. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify proper start and stop sequence of pumps, proper operation of valves, proper speed control, and similar parameters.

D. Subsystems, in the context discussed here, mean individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, and similar equipment.

3.2 COMMISSIONING

A. Commissioning shall not be attempted until all subsystems have been found to operate satisfactorily; commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable. Simulation of process parameters shall be considered only upon receipt of a written request by the CONTRACTOR.

**** END OF SECTION ****

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing the following:

1. Raceways, Fittings and Supports
2. Concrete Pads, Underground Ducts, Manholes and Pull-Boxes
3. Conductors, Wire and Cable
4. Wiring Devices
5. Disconnect Switches
6. Electrical Identification
7. Pushbuttons
8. Cabinets and Enclosures
9. Process Control Devices

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 02200 Earthwork
2. Section 03300 Cast-In-Place Structural Concrete
3. Section 05500 Miscellaneous Metalwork
4. Section 09800 Protective Coating
5. Section 13300 Instrumentation and Control
6. Section 15034 Gauges
7. Section 16030 Electrical Tests
8. Section 16170 Grounding System
9. Section 16431 Short Circuit and Coordination Report

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC).

1.4 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. California Building Code
2. National Electrical Code

1.5 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. Federal Specifications:

FS W-C-596E/GEN(1)	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
FS W-S-896E/GEN(1)	Switches, Toggle (Toggle and Lode), Flush Mounted (ac)
FS WW-C-581E	Conduit, Metal, Rigid, and Intermediate; And Coupling, Elbow, and Nipple, Electrical Conduit: Steel, Zinc Coated
WW-C-581E	Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated

2. Commercial Standards:

ANSI C80.1	Rigid Steel Conduit, Zinc Coated, Specification For
ANSI/IEEE 386	Separable Insulated Connector Systems for Power Distribution Systems Above 600V
ANSI C37.46	Specifications for Power Fuses and Fused Disconnecting Switches
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B189	Lead Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire

IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
UL 44	Rubber-Insulated Wires and Cable
UL 83	Thermoplastic-Insulated Wires and Cable
UL 67	Underwriters Laboratories, Electric Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 50	Cabinets and Boxes

1.6 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. General

Shop drawings including the following:

Complete material list stating manufacturer and name of each item or class of material.
Front, side, and rear elevations and top views.
Location of conduit entrances and access plates.
Identification of conductors not indicated on drawings.
Identification numbers of conductors.
Manufacturers' equipment drawings.
Details of shielded power cable termination.
Component data.
Connection, terminal and internal wiring diagrams, and conductor sizes.
Layout drawings indicating arrangement, dimensions and weights.
Methods of anchoring.
Finish.
Nameplates.
Temperature limitations, as applicable.

Manufacturer's product data including the following:

Catalogue cuts, bulletins, brochures, or photocopies of applicable pages for mass produced, non-custom manufactured products stamped to indicate the project name, applicable Specification section and paragraph, model number, ratings and options.

Lists of the following:

Materials, equipment, apparatus and fixtures proposed for use; with the list including sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

Test reports of the following:

Factory-fabricated products.
Currents resulting from DC high potential testing.

2. Lighting and Power Distribution Panelboards

Manufacturer's data as follows:

Manufacturer's certification that bus bracing is capable of withstanding the specified short circuit condition.

Quantity and rating of circuit breakers provided with each panelboard.

B. General Requirement

1. All equipment furnished by the CONTRACTOR shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated (UL).

2. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the Cal/OSHA Safety Orders (Title 8, CCR), State Building Standards, and Applicable local codes and regulations.

1.7 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's installation instructions.
2. Manufacturer's maintenance procedures.

1.8 PROJECT RECORD DRAWINGS

A. The following shall be included in the PROJECT RECORD DRAWINGS:

1. Accurate location of conductors including depths and routing of concealed below-grade electrical WORK.

2. Accurate location of electrical WORK (raceway and conductors) where the location differs substantially from the locations indicated.

1.9 AREA DESIGNATIONS

A. **General:** For purposes of delineating electrical enclosure and installation requirements, certain areas are classified as defined below. Electrical installations within these areas shall conform to the indicated code requirements for the area indicated.

B. **General Purpose Locations: (E) Electrical Room;** WORK installed in areas which are not otherwise specifically classified shall be "General Purpose." Enclosures shall comply with the requirements of these Specifications and shall be NEMA Type 1.

C. **Damp Location: (E) Sampler Room;** Locations which are indoors and 2 feet below grade elevation or which are indicated as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations; except, that the air space from walls may be less than 1/4-inch and enclosures shall be NEMA Type 2. "Damp locations" shall include pipe galleries, tunnels, and basements. Rooms housing liquid handling equipment are also classified as damp locations regardless of grade elevation.

D. **Outdoor and Corrosive Locations: (E) UV Channels Area;** Unless noted otherwise in the drawings, locations shall have stainless steel threaded hardware; electrical hardware, fittings, and raceway systems shall be PVC-coated. Enclosures shall be NEMA Type 4X 316 stainless steel.

E. **Hazardous Locations**: NEC "Hazardous (Classified) Locations" shall be as indicated and shall comply with NFPA 820.

1.10 FACTORY TESTING

A. **Product Testing**: Products shall be tested at the factory for compliance with the indicated requirements and as follows:

1. Cabinets and Enclosures: Each motor control center shall be completed, assembled, wired, and tested at the factory. All buses and wiring shall be given a dielectric test in accordance with the latest IEEE and NEMA Standards.

B. **Witnesses:** The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness factory tests.

1.11 FIELD TESTING

A. **Testing**: Products shall be field-tested for compliance with the indicated requirements.

B. **Witnesses:** The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness field tests.

1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements. Products shall not be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry.

C. **Replacement:** Damaged materials or equipment, including face plates of panels and switchboard sections, shall be replaced or refinished by the manufacturer at no expense to the OWNER.

1.13 REGULATORY REQUIREMENTS

A. In addition to other indicated regulatory requirements, the WORK of this Section shall comply with the requirements of SSPWC Subsection 209-1.

1.14 UTILITY REQUIREMENTS

A. The WORK of this Section includes compliance with the requirements of San Diego Gas and Electric Company and payment of related charges.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Listing:** Electrical equipment and materials shall be listed for the intended purpose by an independent testing laboratory including Underwriters Laboratories (UL) or an independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

B. **Unlisted Products:** When a product is not available with a testing laboratory listing for the intended purpose, special testing (if any) required by the authority having jurisdiction shall be included in the original contract price.

C. **Project/Site Conditions:** Unless otherwise indicated, equipment and materials shall be sized and rated for the ambient conditions in San Diego but not less than an ambient temperature of 40 degrees C at sea level without exceeding the manufacturer's stated tolerances.

D. **Product Qualifications**: Equipment and materials shall be new and shall bear the UL label, where UL requirements apply. Equipment and materials shall be the products of reputable manufacturers specializing in the products indicated in this Section. Similar items in the project shall be products of the same manufacturer. Equipment and materials shall be of industrial grade and standard of construction and shall be of sturdy design and manufacture; and shall be capable of reliable, trouble-free service.

2.2 RACEWAY, FITTINGS AND SUPPORTS

A. **Raceway**: Raceway shall comply with the following:

1. **Rigid Steel Conduit:** N/A.

2. **Intermediate Metal Conduit**: N/A.

3. **Fittings:** Locknuts shall be extra heavy electrogalvanized steel for sizes through 2 inches. Locknuts larger than 2 inches shall be electrogalvanized malleable iron. Bushings shall be electrogalvanized malleable iron with insulating collar. Grounding bushings shall be locking type and shall include a feed-through compression lug for securing the ground cables. Unions shall be electrogalvanized ferrous alloy type. Threadless fittings are not acceptable. Gaskets shall be made of neoprene.

   Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

4. **Plastic Coated Rigid Steel Conduit and Fittings:** All indoor conduit, including in the ceilings shall be rigid steel conduit with PVC jacket/plastic coated conduit and shall conform to Federal Specification WW-C-581E, ANSI C80.1, and to Underwriter's

Laboratories specifications. The zinc surfaces of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit through the preparation and application processing. A PVC coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 40 mils. A PVC jacketed coupling shall be provided with each length of conduit. A PVC sleeve equal to the OD of the conduit shall extend 1-1/2 inches from each end of coupling.

Fittings used with plastic coated conduit shall be similarly coated to the same thickness as the conduit and shall be provided with type 304 stainless steel hardware. Conduit and fittings shall be manufactured by the same company. Minimum size shall be 3/4 inch.

5. **Electrical Metallic Tubing:** N/A.

6. **Flexible Metal Conduit:** N/A.

7. **Liquidtight Flexible Steel Conduit:** N/A.

8. **Explosion proof Flexible Conduit:** Explosion proof flexible conduit shall be suitable for use in Class I, Division 1, Groups C and D hazardous areas complying with NEC and shall be watertight.

9. **Rigid Nonmetallic Conduit:** All buried conduit shall be rigid nonmetallic conduit NEMA TC2, EPC-80-PVC high impact, polyvinylchloride (PVC). Fittings used with PVC conduit shall be PVC solvent weld type. Nonmetallic conduits shall be UL listed for applications indicated. Minimum size shall be 2 inch unless otherwise noted.

10. **Wireways:** Wireways and auxiliary gutters shall be JIC EMP-1 sectional flanged oiltight type with hinged covers and shall be 8 inches by 8 inches in cross section unless otherwise indicated.

11. **Cable Trays:** Cable tray systems shall be composed of straight sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1.

    1. The cable tray shall be Grade 316 stainless steel. Fittings and hardware for the cable tray shall be Grade 316 stainless steel.

    2. Cable tray shall be solid trough with a minimum loading depth of 6 inches and a nominal width as shown in Contract Drawings.

    3. Loading capacities shall meet NEMA classification with a safety factor of 1.5.

    4. Barriers and covers shall be of the same materials, finish and construction as the straight trays. The minimum radius of side rails on horizontal elbows, vertical risers, tees and crosses shall be 9 inches except where otherwise indicated.

    5. The trays shall be designed and constructed to support a uniformly distributed load of 50 pounds per linear foot with a maximum deflection of 0.57 inch when tested as a single 10-foot span, simple beam.

12. **Metallic Insulation Bushings:** Metallic insulated bushings shall have ground terminals and smooth and well-rounded surfaces to protect the conductor insulation. The conduit threads shall be deep, clean and easily attached to the conduits. The bushing shall be O-Z/Gedney, Thomas and Betts, or equal.

B. **Boxes and Fittings:** Boxes and fittings shall comply with the following:

1. **Sheet Metal Boxes:** Boxes and fittings installed in areas where electrical metallic tubing is indicated shall be standard UL approved electro-galvanized sheet steel.

2. **Cast Ferrous Alloy Boxes:** Boxes shall be hot-dip galvanized cast ferrous alloy unless otherwise indicated. Integrally cast threaded hubs or bosses shall be provided for conduit entrances and shall provide for full 5-thread contact on tightening. Drilling and threading shall be done before galvanizing. A full body neoprene gasket shall be included with the cover. Type 304 stainless steel screws shall be provided for covers. Where two or more devices are located together, outlet and device boxes shall be gang type. Cover plates shall be hot-dip galvanized cast ferrous alloy unless the particular device requires a cover that is not manufactured in this material.

3. **Floor Boxes**: Floor boxes shall be hot-dip galvanized cast boxes with an NEMA 4 rating. Boxes shall include a recessed ring neoprene gasket, hot-dip galvanized steel checker cover plates and type 304 stainless steel machine screws of not less than 1/4 inch diameter. The cover screws shall be flat head type or recessed socket head screws designed to be flush with cover plate.

4. **Welded Sheet Steel Boxes:** Large boxes shall be fabricated from welded steel and shall be hot-dip galvanized after fabrication. Before finish is applied, a grounding pad drilled for two bolted grounding lugs or a grounding stud shall be welded to the inside of the box. Hardware shall be 304 stainless steel. Boxes shall, as a minimum, meet NEMA 12 and JIC EMP-1 requirements.

5. **Explosion proof Boxes and Seal Fittings:** In areas specified as Class I, Division 1 or 2, hazardous, boxes and fittings shall be NEMA 7, Groups C and D, explosionproof. Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type and UL listed for explosionproof sealing fittings.

6. **Hubs:** Threaded hubs for connection of conduit to junction, device or terminal boxes shall be made of cast ferrous alloy, electroplated with zinc and shall have insulated liner and insulating bushings. The hubs shall utilize a neoprene O-ring and shall ensure a watertight connection.

C. **Raceway Supports**: Raceway supports shall comply with the following:

1. **Conduit Supports:** 316 Stainless steel framing channel shall be used to support groups of conduit. Conduit supports for PVC coated rigid steel shall be one-hole PVC coated clamps or 316 stainless steel.

2. **Ceiling Hangers:** Ceiling hangers shall be adjustable galvanized carbon steel rod hangers. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise indicated hanger rods shall be 1/2-inch full-threaded rods and shall meet ASTM A193.

Hanger rods in Damp or Outdoor Locations as defined per this Section, shall be shall be 316 stainless steel.

3. **Structural Attachments (Racks):** Structural attachments shall be constructed from 316 stainless steel channel as specified.

2.3 CONCRETE PADS, UNDERGROUND DUCTS, MANHOLES AND PULL-BOXES

A. **General:** The WORK of this Section includes concrete pads, manholes, pull-boxes and concrete required for encasement, installation, or construction and shall be 2500-psi concrete conforming to the requirements of Section 03300 and the following:

1. Consolidation of encasement concrete around duct banks shall be by hand puddling, and no mechanical vibration will be permitted.

2. A workability admixture consisting of a hydroxylated carboxylic acid type in liquid form shall be used in encasement concrete, admixtures containing calcium chloride shall not be used.

3. Concrete for encasement of conduit or duct banks shall contain an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

B. **Concrete Pads:** Concrete housekeeping pads shall be provided for floor-standing electrical equipment. Unless noted otherwise, housekeeping pads shall be 3 inches above surrounding finished floor or grade and shall be 2 inches larger in both dimensions than the supported equipment unless otherwise indicated.

C. **Concrete-Encased Ducts:** Where an underground distribution system is indicated, it shall be constructed of multiple runs of single bore non-metallic ducts, concrete encased, with steel reinforcing bars, with underground manholes and pullboxes.

D. **Manholes and Pull-Boxes** Manholes and pullboxes shall comply with the following:

1. Manholes and pull-boxes shall be of precast concrete. Concrete construction shall be designed for traffic loading. Covers shall be parkway type, except as otherwise indicated. "P" covers shall be identified as "High Voltage Electric." "S" covers shall be identified as "Secondary Electric" and "C" covers as "Signal." Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance. Manholes shall have concrete covers with 30-inch diameter lids. Covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Frames shall be factory-primed; covers shall be galvanized and shall have lifting handles.

2. Manholes and pullboxes shall have cable supports so that each cable is supported at 3-foot intervals within the manhole or pullbox. Cable supports shall be fastened with galvanized bolts and shall be fabricated of fiberglass or galvanized steel.

3. Duct entrances shall be grouted smooth. Ducts for primary and secondary cables shall be terminated with flush-end bells. Sections of prefabricated manholes and pullboxes shall be assembled with waterproof mastic. Each manhole or pullbox shall be set on a 6-inch bed of gravel as recommended by the manufacturer.

2.4 CONDUCTORS, WIRE AND CABLE

A. **General**: The type, size and number of conductors shall comply with the indicated requirements. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided.

Conductors, including ground conductors, shall be copper. Insulation shall bear the manufacturer's trademark, type, voltage rating, and conductor size.

B. **Color Coding:** Color coding shall comply with the following:

1. **Control Conductors:** Control conductors color coding shall be manufacturer's standard.

2. **Power Conductors**: Single-conductor power conductors shall have the following colors for 600V or less:

	120/208V	480/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Ground	Green	Green
Neutral	White	Grey

Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.

General purpose ac control conductors shall be pink. General purpose dc control conductors shall be blue.

Cables sized No. 4 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end. The cables shall be tagged at terminations and in pull boxes, handholes and manholes.

C. **Lighting and Receptacle Branch Circuit Conductors:** Lighting conductors shall be stranded except for No. 12 AWG which shall be solid.

1. Conductors shall comply with the following characteristics:

Voltage:	600 volts.
Conductor:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	THWN/THHN, 90 degree C dry, 75 degree C wet, polyvinylchloride (PVC) per UL 83.
Jacket:	Nylon.
Flame resistance:	UL 83.

D. **Power and Control Conductors and Cable, 600 Volts:** Conductors and cable shall comply with the following:

1. **Single Conductors:** Single conductor cable shall be stranded and shall be installed in conduits for power and control circuits.

   Conductors shall comply with the following characteristics:

Voltage:	600 volts.
Conductor:	Coated, Class B, stranded, annealed copper per ASTM B8.
Insulation:	XHHW, 90 degrees C dry, 75 degrees C wet, composite of ethylene propylene rubber (EPR) and chlorosulfonated polyethylene (CSPE) per ICEA UL 44 and NEMA WC-7.
Jacket:	Chlorosulfonated polyethylene (CSPE).
Flame resistance:	IEEE 383.

2. **Multiconductor Cable:** Multiconductor cable shall be used for power and control circuits installed in cable tray. Cables shall be UL labeled, Type TC, designed for cable tray installation in accordance with NEC 340. The type of insulation, number of conductors, and size of conductor shall comply with the indicated requirements.

   Multiconductor power cable shall contain three or four conductors, as indicated, plus an equipment grounding conductor.

   Multiconductor power cables shall comply with the following:

Voltage:	600 volts.
Conductors:	Annealed copper, stranded, per ASTM B8, coated per ASTM B33.
Insulation:	THWN/THHN, 90 degrees C dry, 75 degrees C wet, ethylene propylene rubber (EPR) or a composite of EPR and chlorosulfonated polyethylene (CSPE) per ICEA S-68-516 and UL 44.
Jacket:	Polyvinylchloride (PVC).
Flame resistance:	IEEE 383.

   Unless otherwise indicated, multiconductor control cable shall be size 14 AWG and shall comply with the following:

Voltage:	600 volts.
Conductors:	Annealed copper, stranded, per ASTM B8, coated per ASTM B33.
Insulation:	THWN/THHN, 90 degrees C dry, 75 degrees C wet, ethylene propylene rubber (EPR) or a composite of EPR and chlorosulfonated polyethylene (CSPE) per ICEA S-68-516 and UL 44.
Jacket:	Polyvinylchloride (PVC).
Flame resistance:	IEEE 383.

E. **Direct Burial:** N/A.

F. **Medium Voltage Power Conductors and Cable (5 KV-15 KV):** N/A

G. **Signal Cables:** Signal cables shall comply with the following:

1. **General:** Signal cable shall be provided for instrument signal transmission, alarm, communication and any circuit operating at less than 100 volts. Cables shall be color coded black and white for pairs or black, white and red for triads. Circuit shielding shall be provided in addition to cable shielding.

2. **Single Circuit:** Cable shall consist of one pair or triad, No. 16 AWG conductors with 15 mils of 90 degree C polyvinylchloride (PVC) insulation, 4 mils nylon conduit or jacket, twisted on a 2-inch lay, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with No. 18 AWG 7-strand tinned copper drain wire and a 45 mil PVC jacket overall. Cable shall be UL listed, Type TC, rated 600 volts.

3. **Multiple Circuit:** Cable shall consist of four or more pairs or triads which are made up of No. 18 AWG conductors with 15 mils of 90 degree C PVC insulation, 4 mils nylon jacket, twisted on a staggered lay 1-1/2 to 2-1/2 inches, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with No. 22 AWG 7-strand tinned copper drain wire. Overall cable shield shall be 2.35 mil aluminum-Mylar tape with a No. 20 AWG 7-strand tinned copper drain wire. Cable shall be UL listed, Type TC, 600 volts.

4. **Thermocouple Extension:** N/A

5. **Communication, Paging and Security System:** N/A

6. **Modbus cable:** Cable shall be Belden 3106A or UV system manufacturer approved equal for the UV system. Modbus cable shall be fully compatible with the network system shown on plans and meet the requirements set forth at http://www.modbus.org/. The contractor shall coordinate and be responsible for all cable configurations, proof of proper resistance, impedance, shielding, and connections to the equipment communication ports.

H. **Portable Cord:** Portable cord shall be UL listed, Type SO for sizes No. 10 AWG and smaller. Cords with conductors larger than No. 10 AWG shall be UL listed, Type G. Cords shall contain an equipment grounding conductor.

1. Cables shall comply with the following:

Conductors:	Flexible rope stranded per ASTM B189 and B33. Conductors shall be coated except ground conductors may be uncoated.
Insulation:	Insulation shall be ethylenepropylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
Jacket:	Heavy-duty neoprene as per ICEA S-68-516.

I. **Splicing and Terminating Materials:** Splicing and terminating materials shall comply with the following:

1. 600 Volt Conductor and Cable Connectors: Connectors shall be compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8

AWG and larger shall be one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

In-line splices and taps shall be used only where indicated, or shown on the shop drawings. When used, they shall be of the same construction as other connectors. Splices shall be compression type, made with a compression tool die designed for the purpose. Splice shall be covered with a heat-shrinkable sleeve or boot.

2. 5 KV and 15 KV Cable Terminators: N/A

3. Portable Cable Fittings: Portable cable fittings for terminating the cable shall provide a watertight seal between the cord and the terminator and between the terminator and mounting hub. The cable terminator shall include neoprene liner which grips the cord jacket when the back nut on the fitting is tightened.

2.5 WIRING DEVICES

A. **General:** Wiring devices shall be UL approved for the current and voltage indicated and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captively held binding screws.

Devices shall be brown, except those located in finished areas shall be ivory.

Special purpose devices shall be the color indicated.

Receptacles and switches shall conform to Federal Specifications W-C-596E and W-S-896E, respectively, and the indicated standards.

B. **Receptacles and Plugs:** Receptacles and plugs shall comply with the following:

1. **General:** Receptacles shall be grounding type.

2. **120V Receptacles:** Receptacles indicated for indoor use in clean areas shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps.

Receptacle indicated for use outdoors or in process or corrosive areas shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacle and plug caps shall be corrosion resistant, marine duty with yellow polycarbonate weatherproof lift covers.

3. **Ground Fault Interrupter Receptacles:** Receptacles shall be NEMA 5-20R configured and shall mount in a standard outlet box. Units shall trip at 5 milliamperes of ground current and shall comply with NEMA WD-1-1.10 and UL 943. GFI receptacles shall be capable of individual as well as "downstream" operation.

C. **Switches:** Switches shall comply with the following:

1. **General Purpose (Indoor, Clean Areas):** General purpose switches shall be quiet AC type, specification grade, and shall comply with rated capacities as required. Switches shall match receptacles in color.

2. **Switches for Hazardous Areas:** Switches for control of lighting and small single-phase power loads in hazardous areas shall consist of a factory assembled and sealed combination general purpose type switch in an explosion-proof housing. The switch shall be rated in accordance with NEC for the area in which it is to be installed. The external operating mechanism shall consist of a wing-type handle having the "ON" and "OFF" positions visible from the front.

3. **Switches for Outdoor and Corrosive Areas:** Switches shall be heavy-duty industrial type 20-ampere presswitch type with weatherproof/corrosion resistant neoprene plate. CONTRACTOR shall provide abuse-resistant nylon handles, and switches with corrosion-resistant steel nickel plate bridge.

D. **Device Plates:** Device plates shall be provided with switches. In noncorrosive indoor areas, receptacle device plates shall be made of sheet steel, zinc electroplated with chrome finish.

Device plates in corrosive or outdoor areas shall be corrosion-resistant/marine-duty type. Device plates for explosionproof equipment shall be factory provided with the equipment.

Device plates shall include engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

Nameplates for switches shall identify panel and circuit number and area served.

Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

E. **Plug Strips:** N/A.

2.6 LIGHTING AND POWER DISTRIBUTION PANELBOARDS

A. **General:** Panelboards shall be flush, surface or motor control center mounted as indicated. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1 and UL circuit breakers shall be group mounted. Panelboards used for service equipment shall be UL labeled for such use.

Ground fault circuit breakers shall be provided for circuits which supply convenience outlets located outdoors or within lavatory and wash down areas indoors.

Handle lock-off devices for circuit breakers which act as motor disconnect switches shall be provided as indicated in panel schedules.

Trim and cabinets of surface-mounted panels in general purpose areas shall be phosphate treated, primed and finished with baked enamel, panels of flush mounted panels shall be finished to match surrounding wall color. Surface mounted cabinets and trim in wet and damp areas shall be galvanized. Panelboards in corrosive areas shall be encased in fiberglass enclosures. The number of circuit breakers and the ampere ratings for lighting panelboard shall be in accordance with panel schedules indicated. The panelboard circuit breakers shall be group mounted and shall be Type NQOB with 3- or 2-pole main breakers as required and branch circuit breakers with 10,000 AIC, minimum or as indicated on the Contract Drawings.

Panelboards shall comply with the following:

1. Arrangement and Construction: The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. The fronts shall not be removable with doors in the locked position. Panelboard locks shall be keyed alike.

   Gutter space shall be provided on all sides of the breaker assembly to connect and arrange incoming wiring.

   A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2. Bus: Bus shall be tin-plated copper and shall have current ratings indicated on the panelboard schedules and shall be sized in accordance with UL 67. Ratings shall be determined by temperature rise test. Minimum bus size shall be 100 amperes. Panel fault withstand rating shall be equal to the interrupting rating of the smallest circuit breaker in the panel.

   Panelboards shall include a separate ground bus.

   Neutral bar shall be full-sized and shall have one terminal screw for each branch circuit; main bus bar shall be full-sized for entire length.

   The neutral bus of instrument power panels shall be mounted on insulated stand-offs.

   Spaces shown shall have cross connections for the maximum sized device that can be fitted.

3. Circuit Breakers: Circuit breakers for power panelboard shall be molded-case type designed for the current ratings and pole configurations indicated on the panelboard schedule. Circuit breakers rated 120/208 volt and 120/240 volt alternating current shall have a minimum interrupting current rating of 18,000 amperes (symmetrical) at 240V AC. Circuit breakers rated 277/480 volt alternating current shall have a minimum interrupting current rating of 25,000 amperes (symmetrical) at 480V AC or as indicated on the panelboard schedule. Circuit breakers shall be bolt-on type and shall be listed in accordance with UL 489 for the service indicated.

4. Finish: Panelboard cabinet shall be fabricated from hot-dip

B. **Lighting Panelboards**: Except as otherwise indicated, lighting panelboards shall be rated for 120/208-volt 3-phase operation or 120/240-volt for single phase operation. Cabinets for building panels shall be 20-inch wide minimum, with 4-inch minimum side gutters and 5-inch minimum top and bottom gutters. Panelboard trim shall be the same size as cabinet on surface-mounted panels and 3/4-inch larger all around than cabinet of flush-mounted panels.

C. **Power Panelboards:** Power panelboards shall be rated for 600 volts, 3-phase operation. Cabinets for power panelboards shall comply with the following: with 225-amp mains, 30 inches wide; with 400amp, 38 inches wide; with 1200-amp mains, 42 inches wide. Minimum bottom and top gutters shall be 8-inch, minimum side gutter shall be 5-inch.

2.7 DISCONNECT SWITCHES

A. Disconnect switches shall be externally operated with quick-make/quick-break mechanisms. The handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be lockable in the "off" position. Switches shall have nameplates with manufacturer, rating, and catalog number. Heavy-duty switches shall have arc suppressors, pin hinges, and shall be horsepower rated at 600-volts. Heavy-duty switches shall be provided for all motor circuits above 3 horsepower. In smaller motor circuits switches shall be general duty. Switch enclosure shall be NEMA 4X.

2.8 ELECTRICAL IDENTIFICATION

A. **Nameplates:** Nameplates shall be fabricated from white-center, black-face laminated plastic engraving stock. Nameplates shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style of adequate size to be read easily at a distance of 6 feet with no characters smaller than 1/8-inch high.

B. **Conductor and Equipment Identification:** Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

C. **Identification Tape (Buried):** Identification tape for protection of buried installation shall be a 6-inch wide green polyethylene tape imprinted "CAUTION - ELECTRIC UTILITIES BELOW".

2.9 PUSHBUTTONS

A. Remote-mounted pushbuttons shall be NEMA rated heavy duty, oiltight type with synthetic rubber boots and any special gasketing required to make the completed station watertight. Provide NEMA Type 4 pushbutton for above ground indoor unit and NEMA Type 4X constructed of stainless steel or glass polyester for dry well area.

B. Install provisions for locking pushbuttons in the OFF position wherever lockout provisions are indicated. Locking provision shall be 316 stainless steel.

2.10 CABINETS AND ENCLOSURES

A. **General:** The WORK of this Section includes the following requirements for control compartments of motor control sections, for control cabinets of lighting panelboards, and for separate terminal and control cabinets:

1. **Terminal Cabinets:** Terminal cabinets located indoors shall be NEMA 12. Cabinets located outdoors and in corrosive areas shall be NEMA 4X. Cabinets shall be provided with hinged doors. Cabinets shall be provided with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals. Sufficient terminal blocks to terminate 25 percent more conductors than are indicated shall be provided.

2. **Components:** Compartments of motor control centers containing terminal blocks and control components shall be isolated from other compartments of the control center and shall have a separate hinged door with locking handle. Internal control components shall be mounted on a removable mounting pan.

3. **Relay and Control Cabinets:** Relay and control cabinets shall comply with NEMA 12 for enclosures. Floor-standing cabinets shall have locking handles with 3-point catches. Bottom conduit entrances shall be located accurately and cut to the conduit diameter using a circle cutter (not a torch). Interiors of relay and control compartments shall be finished white. Terminal block requirements shall comply with the requirements for Terminal Cabinets.

B. **Wiring:** Wiring of terminal cabinets and control cabinets shall be accomplished with stranded copper conductor rated for 600-volts and UL listed as Type MTW. Wires for annunciator and indication circuits shall be No. 16 AWG. Other wiring shall be No. 14 AWG. Color coding shall comply with the indicated requirements. Incoming wires to terminal or relay cabinets shall be terminated on a master set of terminal blocks. All wiring from the master terminals to internal components shall be factory-installed and shall be contained in plastic raceways with removable covers. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

C. **Engraving:** Nameplates shall comply with the indicated requirements.

2.11 ELECTROLIERS (NOT USED)

2.12 PROCESS CONTROL DEVICES (NOT USED)

2.13 MANUFACTURERS

A. Products of the type or model number indicated shall be manufactured by one of the below listed manufacturers (or equal):

1. Unions:
Appleton UNF or UNY
Crouse-Hinds UNF or UNY

2. Device Boxes:
Appleton FD
Crouse-Hinds FD

3. Sealing Compound:
Chico A

4. Watertight Seals:
O.Z. Gedney Co., Type CSMC
Thunderline Corp.
Link Seal

5. Lighting and Receptacle Branch Circuit Conductors:
Okoseal-N, Series 116-67-XXXX

6. Single Power and Control Conductors and Cable, 600V:
Okonite-Okolon, Series 112-11-XXXX
Anaconda

Durasheath EP

7. Multiconductor Cables:
   Okonite-Okolon, Series 202-11-3XXX
   Anaconda
   Durasheath EP

8. Direct Burial Cables:
   Okonite
   CLX

9. Medium Voltage Power Conductors and Cable (5-15 KV) Installed In Raceway:
   N/A Armored Cable:

10. Okoguard, Series 571-23-3XXX
    Anaconda
    Duralox Unishield EP

11. Single Circuit Signal Cable:
    Okoseal-N Type P-OS

12. Multiple Circuit Signal Cable:
    Okoseal-N Type SP-OS

13. Thermocouple Extension:
    Okonite P-OS, Type PLTC

14. Portable Cords:
    Okocord

15. Compression Tool Die For Splicing:
    Thomas and Betts Corp.

16. Heat Shrinkable Moisture Seal Caps:
    Raychem Corp. "Thermofit"

17. 120V Receptacles (Indoor, Clean Areas):
    Hubbell IG-5362
    Arrow-Hart 6766
    G.E. 4107-1 (Brown)

18. 120V Receptacles (Outdoor, Process or Corrosive Areas):
    Hubbell 53CM62/53CM21
    General Electric GE5262-C

19. 240V Duplex Receptacles (Gray):
    Hubbell 5462
    General Electric G.E. 4188-9

20. 240V Single Receptacles (Black):
    Hubbell 9308

General Electric G.E. 4138-3

21. Three Phase Receptacles (60 amps):
Crouse-Hinds Catalog No. AREA 6424
Hubbell Hubbellock

22. Three Phase Receptacles (30 amps):
Crouse-Hinds Catalogue No. AREA 3423
Bryant Cat. 7223FR
Russell Stoll No. JRFA6344

23. Switches (Hazardous Areas):
Crouse-Hinds EFSC2129
Appleton EFSC175-F1

24. Electrical Identification:
Nameplates
Formica Type ES-1

Imprinted Plastic Coated Cloth
Brady
Thomas & Betts

25. Device Plates:
Crouse-Hinds
Appleton

26. Plug Strips:
Plugmold

27. Manholes and Pullboxes:
Brooks
Quikset

28. Flexible Conduit:
American Brass
Anaconda
Electroflex

29. Cable Trays:
P-W
Cope

30. Compression Connectors:
Burndt "Hi Lug"
Thomas & Betts "Shure Stake"

31. Spring Connectors (Wire Nuts):
3M "Scotch Lok"
Ideal "Wing Nuts"

32. Insulating Tape:
Scotch No. 33
Plymouth "Slip knot"

33. High Temperature Insulating Tape (Polyvinyl):
Plymouth
3M

34. Pre-Insulated Fork Tongue Lugs:
Thomas & Betts RC Series
Burndy

35. Epoxy Resin Splicing Kits:
3M Scotchcoat 82 Series
Burndy "Hy Seal"

36. Stress Cone Material For Make-up Of Medium Voltage Shielded Cable:
G & W
3M
duPont

37. Stainless Steel Covers:
Sierra S-line
Hubbell

38. Products For Cast Boxes:
Switches at outdoor locations
    Crouse-Hinds DS 128
    Mackworth Rees Style 3845
    Joy Flexitite

Switches at damp locations
    Mackworth Rees Style 3496
    Joy Flexitite

Switches at dry locations
    Crouse-Hinds DS 32G
    Pyle National SCT-10k

Receptacles at outdoor locations
    Crouse-Hinds
    Hubbell

Receptacles at damp or dry locations
    Crouse-Hinds DS 23G
    Pyle National N-1

Receptacles at corrosive locations
    Crouse-Hinds "Ark Gard"
    Appleton DTQ
    Hubbell 52CM21 or 5221

39. Cast Boxes Required for Pull or Junction Boxes:
Floor boxes with checker plate covers
O-Z Type "YR",
Surface boxes
O-Z type "YH"

40. Floor Type Outlet Boxes:
Hubbell Catalog B-2530 with S-2530 cover plate
Steel City (Russell & Stoll) Catalog 78AL and 889

41. Power Outlet Boxes:
Hubbell Cat. No. SC-3098
Steel City Cat. No SFH40RG

42. Telephone Outlet Boxes:
Hubbell Cat. No. SS-309-T
Steel City Cat. No SFL10

43. Insulated Bushings:
O-Z Type A and B
Thomas & Betts
Steel City
Appleton
Efcor
Gedney

44. Insulated Grounding Bushings:
O-Z Type BL
Thomas & Betts
Steel City
Efcor
Gedney

45. Erickson Couplings:
Appleton Type EC
Thomas & Betts
Steel City
Efcor
Gedney

46. Liquid-tight Fittings:
Appleton Type ST
Thomas & Betts
Crouse-Hinds
Efcor
Gedney

47. Hubs:
Appleton Type HUB
Thomas & Betts
Myers Scrutite
Efcor

48. Sealing Fittings:
Appleton Type EYS
O-Z Type FSK

49. Expansion Couplings:
O-Z Type D
Crouse-Hinds Type

PART 3 -- EXECUTION

3.1 GENERAL

A. **Field Control of Location and Arrangement**: The Drawings diagrammatically indicate the location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined in the field based on the physical size and arrangement of equipment, finished elevations, and obstructions. Locations shown on the Drawings shall be adhered to as closely as possible. Omissions or conflicts on Drawings or between Drawings and Specifications shall be brought to the attention of the CONSTRUCTION MANAGER for clarification before proceeding with the WORK.

B. **Installation:** The CONTRACTOR shall make all necessary provisions throughout the site to receive the WORK as construction progresses and shall furnish and install adequate backing, supports, inserts, and anchor bolts for the hanging and support of all electrical fixtures, conduit, panelboard, and switches, and shall furnish and install sleeves through walls, floors, or foundations where electrical lines are required to penetrate.

Conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Fixtures, switches, convenience outlets, and similar items shall be located within finished rooms, as shown. Where the Drawings do not indicate exact locations, locations of concealed conductors shall be as indicated on the shop drawings.

C. **Workmanship:** Materials and equipment shall be installed in accordance with printed recommendations of the manufacturer. The installation shall be accomplished by workmen skilled in this type of WORK and installation shall be coordinated in the field with other trades so that interferences are avoided.

D. **Tests:** The WORK of this Section includes tests required by the authority having jurisdiction. Tests shall be performed in the presence of the CONSTRUCTION MANAGER. The WORK includes testing equipment, replacement parts and labor necessary to repair damage resulting from damaged equipment or from testing and correction of faulty installation. The following tests shall be performed:

Insulation resistance tests.
Operational testing of equipment.

E. **Field Quality Control**: Conduit shall be provided with a number tag at each end and in each manhole and pullbox. Trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end.

3.2 RACEWAY, FITTINGS AND SUPPORTS

A. **General**: Except as otherwise indicated, conduit installed in direct contact with earth and in concrete slabs on grade shall be corrosion-protected.

Conduit shall be left exposed until inspected by the CONSTRUCTION MANAGER.
Raceways shall be installed as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for the purpose intended. Factory elbows shall be used for all 3/4-inch conduits. Bends in larger sizes of metallic conduit shall be accomplished by field bending or by the use of factory elbows.

Non-metallic conduit may be run beneath structures or slabs on grade. In these instances conduit shall be placed at least 12 inches below the bottom of the structure or slab. Non-metallic conduit may be buried 24 inches minimum below grade, with a 3-inch concrete cover, in open areas or where otherwise not protected by concrete slab or structures. Top of concrete cover shall be colored red. Non-metallic conduit shall be permitted only in concealed locations as described above.

Where a run of concealed PVC conduit becomes exposed, a transition to rigid steel conduit is required. Such transition shall be accomplished by means of a factory elbow or a minimum 3-foot length of rigid steel conduit, either terminating at the exposed concrete surface with a flush coupling. Piercing of concrete walls by non-metallic runs shall be accomplished by means of a short steel nipple terminating with flush couplings.

Flexible conduit may be used in lengths required for the connection of recessed lighting fixtures; otherwise the maximum length of flexible conduit shall be 18 inches.

1. Application:

Embedded or encased in non-hazardous areas	Schedule 80 PVC
Exposed in corrosive areas	Plastic coated, rigid steel
Direct buried lighting and receptacle raceways in non-hazardous areas	Schedule 80 PVC
Hazardous and corrosive areas within stud walls, above suspended ceilings, and within elevator machine rooms	Plastic coated, rigid steel
Dry well/Pump room area	Plastic coated, rigid steel

Final raceway connections to lighting fixtures, equipment and pressure switches subject to vibration-DRY AREAS	Flexible non-metallic
Final raceway connections to Equipment	Liquidtight, flexible non-metallic

2. Conduit Runs Between Boxes: The number of directional changes of the conduit shall be limited to total not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction. Bends and offsets shall be avoided where possible but, where necessary, shall be made without flattening or kinking, or shall be factory preformed bends. Turns shall be made with cast metal fittings or conduit bends. Welding, brazing or otherwise heating of conduit is not acceptable.

3. Junction and Pull Boxes: Cast junction or pull boxes shall be installed where required for pulling cable and as necessary to meet the indicated requirements. Pull boxes used for multiple conduit runs shall not combine circuits of different motor control centers, switchboards, or switchgear.

4. Conduit Terminations: The WORK of this Section includes conductors required to interconnect incoming annunciator, control and instrumentation except as otherwise indicated.

   Two- and 3-conductor shielded cables installed in conduit runs which exceed 2,000 feet may be spliced in pullboxes. These cable runs shall have only one splice per conductor.

   Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment. 120/208-volt and 480-volt branch circuit conductors may be spliced in suitable fittings at locations required. 5-kV conductors shall be spliced or terminated only at equipment terminals indicated.

   Solid conductors shall be terminated at equipment terminal screws such that conductor is tightly wound around screw and does not protrude beyond screw head. Stranded conductors shall be terminated directly on equipment box lugs such that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

   Splices in 600-volt wire which are not pre-insulated shall be insulated with three layers of tape each half lapped except that splices in below grade pull boxes or in any box subject to flooding shall be made watertight using an epoxy resin splicing kit.

   Splices to motor leads in motor terminal boxes shall be taped with varnished cambric tape and with high temperature tape on the exterior.

   Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable manufacturer. The CONTRACTOR shall submit the proposed termination procedure as described for shop drawings.

Control devices, such as solenoid operated valves, that are normally supplied with conductor pigtails, shall be terminated as described for control conductors.

Conduit entering NEMA 1 type sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the box or cabinet and shall have an insulating grounding or bonding bushing installed over the conduit end. Conduit entering other boxes shall be terminated with a threaded hub. Cast boxes and nonmetallic enclosures shall have threaded hubs. Joints shall be made with standard couplings or threaded unions. Metal parts of nonmetallic boxes and plastic coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of conduit shall be cut square, reamed, and threaded with straight threads. Rigid steel conduit shall be made up tight and without thread compound. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard PVC couplings.

Conduit entering field equipment enclosures shall enter the bottom or side of the box. Where conduit comes from above, it shall be run down beside the enclosure and a tee conduit and drip leg installed.

5. Matching Existing Facilities: When new conduit is added to areas which are already painted, the conduit and its supports shall be painted to match the existing facilities. Where new conduit is used to replace existing conduit, the existing conduit and supports shall be removed, resulting blemishes shall be patched and repainted to match original conditions. Similarly, if existing conduits are to be reused and rerouted, resulting blemishes shall be corrected in the same manner. Coating system shall comply with Section 09800.

6. Conduit Support: Exposed rigid steel or plastic coated conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling. Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch, 5 feet apart for conduits 1 1/4 inches to 2 inches and 6 feet apart for conduits 2 1/2 inches and larger. No conduit shall approach closer than 6 inches to any object operating above 30 degrees C. PVC conduit shall not be provided where it will be damaged by heat.

   Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors. Individual conduit supports shall use cast-in-place anchors, die-cast, rustproof alloy or expansion shields. Wooden plugs, plastic inserts or gunpowder-driven inserts are not acceptable.

7. Conduit Penetrations: Unless otherwise indicated, conduit routed perpendicular through floors, walls or other concrete structures shall pass through cast-in-place openings wherever possible. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure's integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Unless otherwise protected, conduits that rise vertically through the floor shall be protected by a 3 1/2-inch high concrete pad with a sloping top.

Conduits entering manholes and handholes shall be horizontal. Conduits shall not enter through the concrete bottom of handholes and manholes.

Wherever conduits penetrate outdoor concrete walls or ceilings below grade, watertight seal shall be installed.

8. Conduit Separation: Signal conduits shall be separated from AC power or control conduits. The separation shall be a minimum of 12 inches for metallic conduits and 24 inches for nonmetallic conduits.

9. Conduit Seals for Hazardous or Corrosive Areas: Conduit passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.

   Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type and shall be UL listed for explosionproof sealing fittings. Sealing compound shall be nonhardening type for corrosive areas. Sealing compound shall not be poured in place until electrical installation has been otherwise accepted.

10. Plastic Coated Conduit: Plastic coated conduit shall be made up tight with strap wrenches. Conduit threads shall be covered by a plastic overlap which shall be coated and sealed in accordance with manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.

11. Liquidtight Flexible Conduit: The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.

12. Conduit Fittings: Fittings shall comply with the same requirements as the raceway with which they will be used. Fittings having a volume less than 100 cubic inches for use with rigid steel conduit, shall be cast or malleable non-ferrous metal. Fittings larger than one inch shall be "mogul size." Fittings shall be of the gland ring compression type. Covers of fittings, unless in "dry" locations, shall include gaskets. Surface-mounted cast fittings, housing wiring devices in outdoor and damp locations, shall have mounting lugs.

    Erickson couplings shall be used at all points of union between ends of rigid steel conduits which cannot be coupled. Running threads and threadless couplings shall not be used. Couplings shall be 3-piece type.

    Transition fittings to mate steel to PVC conduit, and PVC access fitting, shall be as furnished or recommended by the manufacturer of the PVC conduit.

B. **Cable Tray:** Unless otherwise indicated, cable trays shall be supported with cable tray supports at intervals not exceeding 5 feet. Corners shall be supported by two supports installed as close as possible to the corner, with one support on each side of the corner. Cable tray shall be installed straight and true.

Expansion-joint splice plates shall be used to allow 1 1/2-inch free movement between adjacent trays when crossing a building expansion joint.

A minimum clearance of 3/4 inch shall be maintained between trays and concrete surfaces. A minimum spacing of 12 inches shall be maintained between trays, measured from the top of the upper tray to the top of the lower tray. The top of the tray shall be not less than 9 inches from the ceiling.

Solid or louvered type covers shall be provided on signal trays.

Each tray shall be installed with No. 2/0 AWG minimum bare copper equipment ground conductor unless otherwise specified. Ground conductor shall be attached to the outside of each tray section using a bolted bronze or brass ground clamp.

Power cables shall not be placed in cable trays more than two layers deep. Cables shall be arranged in trays so as to provide a minimum of cable cross-overs.

3.3 UNDERGROUND DUCTS, MANHOLES AND PULL-BOXES

A. **Underground Ducts:** Where an underground distribution system is indicated, installation shall comply with the following:

1. Ducts shall be laid on a grade line of at least 4 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the concrete envelope is a minimum of 24 inches below grade. Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter. Couplings shall be staggered at least 6 inches vertically. Bottom of trench shall be of select backfill or sand. Horizontal and vertical duct separation shall be maintained by plastic spacers set every 5 feet. The duct array shall be anchored every 4 feet to prevent movement during placement of the concrete envelope. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct through which the mandrel will be drawn. After passing of the mandrel, a wire brush and swab shall be drawn through. A raceway, in the duct envelope, which does not require conductors, shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.

2. Duct bank markers shall be installed every 200 feet along run of duct bank, at changes in horizontal direction of duct bank, and at ends of duct bank. Concrete markers, 6 by 6 inches square and one foot long, shall be set flush with grade. The letter "D" and arrow set in the concrete shall be facing in the direction of the duct alignment

B. **Manholes and Pull-Boxes:** Manholes and handholes shall be set plumb to limit the depth of standing water to a maximum of 2 inches. Manhole covers, unless otherwise indicated, shall be set at grade. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 6-inch bed of gravel as recommended by the manufacturer.

3.4 CONDUCTORS, WIRE AND CABLE

A. **General:** Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the cable insulation. The cable pulling compound shall be polymer-based and UL approved. It shall be non-toxic, non-flammable, non-corrosive and compatible with all cable types. The product shall dry to a thin semi-liquid film that will not clog the conduit. The cable pulling lubricant shall be AquaGel II by Ideal Industries, or equal. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed.

Whenever a cable leaves a raceway, a cable support shall be provided.

When flat bus bar connections are made with unplated bar, the contact areas shall be "scratch-brushed" before connection. Bolts shall be torqued to the bus manufacturer's recommendations.

B. **600 Volt Conductor and Cable:** Conductors in panels and electrical equipment, No. 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is installed for wire runs, lacing is not required. Plastic panel wiring duct shall not be used in manholes and handholes.

Stranded conductors shall be terminated. Conductors shall be terminated directly on the terminal block. Compression lugs and connectors shall be installed using manufacturer's recommended tools.

Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be installed in conduits with power or control conductors.

Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

Terminations at 460 volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated and sealed with factory-engineered kits. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends. Bolt connection area shall be kept free of mastics and fillers to facilitate rapid stripping and re-entry. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations.

In-line splices and tees shall be made with tubular compression connectors and insulated as for motor terminations, except that conductors No. 10 AWG and smaller may be spliced using self-insulating connectors. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits. Terminations at devices with 120V pigtail leads, at

solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors.

Conductor and cable markers shall be provided at splice points.

C. **Signal Cable:** Circuits shall be installed as individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise indicated. Signal circuits shall be installed without splices between instruments, terminal boxes, or panels.

Shields are not acceptable as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables.

Common ground return conductors for two or more circuits are not acceptable.

Unless otherwise indicated, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be installed for running signal leads and shield drain wires through junction boxes.

Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run.

Terminal boxes shall be installed at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.

Cable for paging, telephone, and security systems shall be installed and terminated in compliance with the manufacturer's recommendations.

D. **600 Volt Conductor and Cable**: Cable shall comply with the following requirements:

1. Terminations: Terminations shall be in exact conformance with the written instructions accompanying the splicing or terminator kits. Special care shall be exercised to ensure that cable insulation is not damaged during stripping back of jacket, semiconductor layers, shields; or penciling operations. All stripping, back operations involving the cutting of nonmetallic layers of the cable shall be accomplished using a ringing tool. The usage of pocket or jack knives for stripping back or penciling operations is prohibited.

2. Installation: Cable installation shall comply with the following:

   Cable Placement: Cable shall be carefully checked as to condition, size, and length before being pulled into raceways. Cable pulled into the incorrect raceway or cut too short to rack, train, or splice shall be removed and replaced.

   Cable In Manholes: Cable shall be supported at all times during handling, without short bends or excessive sags, and shall not be permitted to lie on the manhole floor. Cable ends shall be sealed. Cable racks or trays shall be installed for permanent support. Temporary support required during placement shall be with rope slings or timbers.

Supports: Cable supports and securing devices shall have bearing surfaces oriented parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation. Adequate cable end lengths shall be provided and properly placed in electrical equipment or manholes to avoid longitudinal strains and distorting pressures on the cable at termination points and duct end bells. Final inspection shall be made after all cable is in place. Where supports, bushings, and end bells deform the cable jacket, additional supports shall be installed.

Cable Racks: Cable racks shall be installed according to the drawings and as required to provide the proper cable support. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolted to permanent wall surfaces with anchors or continuous slot concrete inserts.

3. Cable Pulling: Cable pulling shall comply with the following:

Pulling Lines: Raceway cleaning mandrels and cable pulling shall be done with manila hemp line to prevent damage to the raceway. Nylon or stranded steel pulling lines shall not be used. "Fishing" may be done with CO_2-propelled polyethylene cord.

Cable Grips: Factory-installed pulling eyes shall be used for pulling cable where they are available. Where pulling eyes are not available, woven wire cable grips shall be used to pull all single-conductor cable. When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal, plus 6 inches, shall be cut off and discarded when the pull is completed. As soon as the cable is pulled into place, the pulling eyes on cable grips shall be removed and the cable shall be resealed.

Swivels: A reliable, nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.

Reel Inspection: Before unreeling, the outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced.

Feeding Tubes: A flexible feeding tube, with a removable nozzle sized to fit the raceway shall be used in pulling all cable. The feeding tube shall be long enough to extend from the raceway entrance to the outside of the manhole and shall be arranged such that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface. Cable pulling into, through, or out of new manholes shall be done with the entire concrete manhole lid removed.

Lubricant: A cable lubricant shall be used on conductors in all pulls, and shall be of the type, and applied in the quantity, recommended by the cable manufacturer. Only lubricants recommended by the cable manufacturer shall be used.

Pulling Tension: The pulling tension of the cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both manual and power

types shall have the rated capacity (in pounds) clearly marked on the mechanism. A dynamometer shall be used to show the tension on the cable during all pulls and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected. Under no circumstances shall cable be pulled using equipment not monitored by a dynamometer. The use of motor vehicles in pulling cable is prohibited. Any cable so pulled shall be removed and replaced. The dynamometer shall have a maximum tension indicator to show the maximum tension developed during a pull. The cable play-out reel shall be equipped with a suitable brake and shall be constantly manned during all pulls.

Sidewall Pressure: To avoid insulation damage from excessive sidewall pressure at bends in raceway runs, the pulling tension in pounds exiting a bend shall not exceed 200 times the radius of the bend in feet.

Cable Bends: Extreme care shall be exercised during the placement of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. The permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations.

4. Moisture Seals: Cable shall be kept sealed except when termination and splicing WORK is being performed. The ends of all cables shall be sealed with heat-shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable outside diameter and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive, watertight seal. Before and after pulling, the leading end seal of each length of cable shall be examined and replaced if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

5. Splices: Power cable circuits may be spliced only at locations indicated. Splices shall not be made to utilize short lengths of cable, nor shall they be made to provide correct lengths on cable initially cut too short for a particular circuit.

6. Terminations: Cable shall be trained into place without bending the cable in a radius less than the manufacturer's recommended minimum bending radius. If the cable is bent at any time to a radius less than the minimum bending radius, the cable shall be terminated at a point at least 6 inches below the bend. Where the shape and configuration of terminal fittings make workmanlike insulation of the bare connection impractical, the contours of the connection shall be smoothed by filling voids and molding over irregular surfaces with a moldable filler material as recommended by the terminator kit manufacturer before application of the recommended thickness of insulating material.

E. **Portable Cord**: Portable cord feeding permanent equipment, such as pendant cords, pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with the use of terminals. In-line taps and splices shall be used only where indicated.

F. **Testing:** Testing shall comply with the requirements of Section 16030 and the following:

1. Signal Cable: Each signal pair or triad shall be tested for electrical continuity. Any pair or triad exhibiting a loop resistance of less than or equal to 50 ohms shall be deemed

satisfactory without further test. For pairs with greater than 50 ohm loop resistance, the expected loop resistance shall be calculated considering loop length and intrinsic safety barriers if present. Loop resistance shall not exceed the calculated value by more than 5 percent.

Each shield drain conductor shall be tested for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.
Each conductor (signal and shield drain) shall be tested for insulation resistance with all other conductors in the cable grounded.

Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500 volt megohmmeter shall be used for insulation resistance measurements.

2. 5-15 KV Cable: N/A

3.5 WIRING DEVICES

A. **General**: Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

Unless otherwise indicated, receptacles and switches installed in sheet steel boxes shall be flush mounted and shall be located 18 inches above the floor unless otherwise indicated.

Switch boxes and receptacles installed in cast device boxes shall be mounted 48 inches above the floor.

B. **Application of Boxes and Covers**: Boxes and covers shall be installed as follows:

1. Outlet, switch, and junction boxes for flush-mounting in general purpose locations shall be sheet metal.

2. Outlet, switch, and junction boxes where surface mounted in exposed locations shall be cast alloy ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish. Surface mounted boxes in concealed locations may be welded sheet steel boxes.

3. Outlet, control station, and junction boxes, including covers, for installation in corrosive locations shall be fiberglass-reinforced polyester and shall include mounting lugs.

4. Sheet metal boxes for flush-mounting in concrete shall include with cast, malleable box covers and gaskets. Covers for pressed steel boxes shall be one-piece pressed steel, cadmium plated, except that boxes for installation in plastered areas shall be stainless steel over plaster rings.

5. Outlet boxes shall be used as junction boxes wherever possible. Where separate pullboxes are indicated, they shall include screw covers. Outdoor boxes shall be galvanized and shall be provided with gasketed covers and threaded hubs. Indoor boxes shall be painted.

3.6 LIGHTING AND POWER DISTRIBUTION PANELBOARDS

A. **General:** The circuit description as indicated on the record drawings or panelboard schedule shall be typed on the circuit directory.

B. **Testing:** Panelboards shall be tested for proper operation and function.

3.7 CABINETS AND ENCLOSURES

A. The installation of cabinets and enclosures shall comply with the following:

1. Cabinets: Cabinets shall be set plumb at an elevation such that the maximum circuit breaker height shall be less than 5 ft 6 inches. Top edge of trim of adjacent panels shall be at the same height. Panels which are indicated as flush mounted shall be set so cabinet is flush and serves as a "ground" for plaster application.

2. Connections: Factory bus and wire connections shall be made at shipping splits, and all field wiring and grounding connections shall be made after the assemblies are anchored.

3. Finishes: Enclosures smaller in volume than 500 cubic inches shall be finished in accordance with the manufacturer's standard procedures. Finish color shall be No. 61 complying with ANSI Z55.1.

   Enclosures larger in volume than 500 cubic inches shall comply with Section 09800.

3.8 EQUIPMENT ANCHORING

A. Freestanding or wall-hung equipment shall be anchored in place by methods that will meet seismic requirement in the area where project is located. Wall-mounted panels that weigh more than 500 pounds or which are within 18 inches of the floor shall be provided with fabricated steel support pedestal(s). Pedestals shall be of welded steel angle sections. If the supported equipment is a panel or cabinet and enclosed with removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds, shall have auxiliary floor supports.

B. Anchoring methods and leveling shall comply with the printed recommendations of the equipment manufacturers.

3.9 CONDUCTOR AND EQUIPMENT IDENTIFICATION

A. The completed electrical installation shall include adequate identification to facilitate proper control of circuits and equipment and to reduce maintenance effort.

B. Control and instrumentation wire and cable shall be assigned a unique identification number. Numbers shall be assigned to conductors having common terminals. Identification numbers shall appear within 3 inches of conductor terminals. "Control" shall be defined as any conductor used for alarm, annunciator, or signal purposes or any connect switch or relay contacts or any relay coils.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is

expected that the cable number will form a part of the individual wire number. All individual control conductors and instrumentation cable shall be identified at pull points as described above.

2. The instrumentation cable numbers shall incorporate the loop numbers shown.

3. Refer to Section 13300 for numbering details.

C. Spare conductors shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

D. Nameplates shall be provided for panelboards, panels, starters, switches, and pushbutton stations. In addition to the name plates indicated, control devices shall be equipped with standard collar-type legend plates, as required.

E. Terminal strips shall be identified by imprinted, varnished, marker strips attached under the terminal strip.

F. Three-phase receptacles shall be consistent with respect to phase connection of receptacle terminals. Errors in phasing shall be corrected at the bus, not at the receptacle.

G. Toggle switches which control loads out of sight of switch, and all multi-switch locations of more than 2 switches, shall have suitable inscribed finish plates.

H. Empty conduits shall be tagged at both ends to indicate the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by marking an adjacent surface.

I. Identification tape shall be installed directly above buried raceway. Tape shall be installed 8 inches below grade and parallel with raceway. Identification tape shall be installed for buried raceway not under buildings or equipment pads except identification tape is not required for protection of street lighting raceway.

**** END OF SECTION ****

SECTION 16170 – GROUNDING SYSTEM

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing grounding for electrical systems, exposed non-energized metal surfaces of equipment and metal structures.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03300 Cast-In-Place Structural Concrete
2. Section 05500 Miscellaneous Metalwork
3. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	IEEE 81	Measuring Earth Resistivity, Ground Impedance, and
2	UL 467	Earth Surface Potentials of a Ground System, Guide for Standard for Grounding and Bonding Equipment

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Shop drawings showing details of grounding system.
2. Product data for grounding electrodes and connections.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's instructions including instructions for storage, handing, protection, examination, preparation and installation of exothermic welded connectors.

2. Test reports indicating overall resistance to ground and resistance of each electrode.

1.7 PROJECT RECORD DRAWINGS

A. The following shall be included in the PROJECT RECORD DRAWINGS:

1. Accurate record of actual locations of grounding electrodes.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The WORK of this Section includes the following:

1. Products listed and classified by Underwriters Laboratories, Inc. or the testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

2. Except as otherwise indicated, grounding products and systems shall comply with the NEC.

2.2 ROD ELECTRODE

A. Rod electrodes shall be 3/4 inch copper-clad steel, sectional type, joined by threaded copper alloy couplings. Length of rods forming an individual ground array shall be equal in length and shall be of the length required to obtain a minimum ground resistance of 5 ohms. Top of ground rod shall be fitted with a coupling and steel driving stud. Rods shall be of sufficient length to ensure contact with ground water and shall be not less than 10 feet.

2.3 CABLE

A. Ground cable shall be annealed bare copper, concentric stranded wire. If cable sizes are not indicated, the minimum sizes shall be as follows:

1.	5 and 15 kV switchgear	4/0 AWG
2.	5 kV motor starters	4/0 AWG
3.	15 kV-5 kV transformers	4/0 AWG
4.	5 kV-480V transformers	4/0 AWG
5.	480V switchgear	4/0 AWG

6.	480V MCC and Switchboards	2/0 AWG
7.	Cable tray	2/0 AWG
8.	Lighting panels	2 AWG
9.	Exposed metal	2 AWG

2.4 MECHANICAL CONNECTORS

A. Compression connectors shall comply with the following:

1. Material: Cast Copper

2.5 GROUNDING WELL COMPONENTS

A. Grounding well components shall comply with the following:

1. Well Pipe: 8 inch diameter by 24 inch long concrete pipe with belled end.
2. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.6 MANUFACTURERS

A. Products indicated shall be manufactured by one of the following (or equal):

1. Rods and Fittings:

   Copperweld
   Blackburn
   Weaver

2. Compression Connectors:

   Thomas and Bett

PART 3 -- EXECUTION

3.1 GENERAL

A. Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Compression connections shall be prepared in accordance with the manufacturer's instructions. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise indicated. Solder shall not be used in any part of the ground circuits.

B. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement. As each part of the grounding system which is laid below finished grade is completed, the CONSTRUCTION MANAGER shall be notified 2 hours prior to backfilling.

C. Grounding conductors which are extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals maximum. Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate.

D. Grounding conductor shall not be used as a system neutral.

E. Lightning arresters shall be directly connected to the ground system using copper conductors.

3.2 FACILITY GROUNDING

A. Ground continuity throughout the facility shall be maintained by installing an electrically-continuous metallic raceway system, or a non-metallic raceway with a grounding conductor.

B. Metallic raceway shall be installed with double lock nuts or hubs at enclosures. Metallic conduits shall be assembled to provide a continuous ground path. Metallic conduits shall be bonded using insulated grounding bushings and shall be connected to the grounding system. Cable trays shall have No. 2/0 AWG bare copper ground conductor run on the outside of each tray. Conductor shall be connected to each section or fitting using a carriage bolt and clamp.

C. Non-metallic raceway containing dc conductors operating at more than 50 volts to ground, or any ac conductors, shall contain a copper grounding conductor either bare, or green if insulated. Such conductor shall be bonded to terminal and intermediate metallic enclosures.

3.3 EQUIPMENT AND ENCLOSURE GROUND

A. Electrical and distribution equipment and metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the indicated raceway grounding.

B. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed and shall be bolted pressure type where exposed. Bolted connectors shall be assembled wrench-tight.

C. Insulated grounding bushings shall be employed for all grounding connections to steel conduits in switchboards, in motor control centers, in pullboxes, and elsewhere where conduits do not terminate at a hub or a sheet metal enclosure.

D. Where insulated bushings are required, they shall be installed in addition to double lock nuts.

E. Shielded power cable shall have its shield grounded at each termination in a manner recommended by the cable manufacturer. Shielded instrumentation cable shall be grounded at one end only; this shall be at the Motor Control Board or otherwise at the "receiving" end of the signal carried by the cable except as otherwise indicated. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be connected with No. 16 solid tinned bare copper wire jumper; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

F. Nonelectrical equipment with metallic enclosures shall be connected to the grounding system.

3.4 ISOLATED GROUNDING

A. Where the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, an additional isolated ground conductor from the equipment through the instrument power panel for connection to a single point ground bus in the automatic transfer switch enclosure shall be provided. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors.

B. The neutral conductor from the ultra-isolation transformers shall be grounded only at the single point ground bus in the automatic transfer switch.

3.5 EXAMINATION

A. The WORK of this Section includes verification that final backfill and compaction has been completed before driving rod electrodes.

3.6 INSTALLATION

A. Rod electrodes and additional rod electrodes as required to achieve specified resistance to ground shall be installed at locations indicated.

B. Grounding well pipes with cover shall be installed at each rod location where indicated with well pipe top flush with finished grade.

C. Number 4 AWG bare copper wire shall be installed in foundation footing where indicated.

D. Grounding electrode conductor shall be installed and connected to reinforcing steel in foundation footing where indicated.

E. Metal siding not attached to grounded structure shall be bonded together and to ground.

F Reinforcing steel and metal accessories shall be bonded to structures.

G. Transient suppression plates shall be installed where indicated

H. Ground grid shall be installed under access floors where indicated. Grid shall be constructed of 2 AWG bare copper wire installed on 24 inch centers both ways. Each access floor pedestal shall be bonded to grid.

I. Metallic raceway, pipe, duct and other metal object entering space under access floors shall be bonded together and to underfloor ground grid using 2 AWG bare copper conductor.

J. Isolated grounding conductors shall be installed for circuits supplying personal computers.

K. Where equipment grounding conductors are indicated, separate insulated conductors shall be installed within each feeder and branch circuit raceway. Ends shall be terminated on suitable lug, bus, or bushing.

3.7 FIELD QUALITY CONTROL

A. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.

3.8 GROUNDING SYSTEM TESTS

A. Suitable test instruments shall be used to measure resistance to ground of system. Testing shall be performed in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

B. The grounding test shall comply with IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be submitted on 8-1/2 x 11 inch size graph paper. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. Additional parallel connected ground rods and/or deeper driven rods shall be provided until the ground resistance measurements complies with the indicated requirements. Use of salts, water or compounds to attain the specified ground resistance is not acceptable.

**** END OF SECTION ****

SECTION 16400 –
LOW VOLTAGE ELECTRICAL SERVICE AND DISTRIBUTION

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing all electrical service sections, distribution switchboards, special control panels, control and terminal cabinets, control devices, circuit breakers, and all appurtenant WORK, complete and operable.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 16030 Electrical Tests
2. Section 16050 Basic Electrical Materials and Methods
3. Section 16480 Motor Control

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. National Electrical Code (NEC) NFPA 70

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	ANSI/IEEE C37.20	Switchgear Assemblies, including Metal-Enclosed Bus
2.	ANSI/NEMA ICS-2	Devices, Controllers, and Assemblies for Industrial Control
3.	ANSI/UL 1008	Automatic Transfer Switches, Safety Standard for
4.	NEMA PB2	Dead Front Distribution Switchboard

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Shop drawings of the service section and switchboards. After review of shop drawings of the service section by the CONSTRUCTION MANAGER, said drawings shall also be submitted to the utility company for approval prior to fabrication.
2. Design test reports conducted for similar assemblies at the factory.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL.

1. Operating procedures.
2. Maintenance procedures.
3. Manufacturer's parts list, illustrations, assemblies and diagrams.

1.7 WARRANTY

A. The CONTRACTOR shall provide a 1-year warranty. Should the equipment fail during the 1-year period after acceptance by OWNER, the CONTRACTOR, at its own expense, shall repair the equipment.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Materials:** All materials and equipment furnished under this Specification shall be new and shall bear the Underwriters' Laboratories label where such service is regularly available.

B. **Equipment:** All equipment for the same purpose shall be of the same make.

C. **Enclosure Requirements:** All outdoor equipment, fixtures, and wiring devices shall be of weatherproof construction.

D. **Standard Products:** Materials and equipment shall be catalogue products of companies regularly engaged in the manufacture of such items, shall be the latest standard design that conforms to the specification requirements, and shall essentially duplicate material and equipment that has history of satisfactory use.

2.2 SWITCHBOARDS (N/A)

2.3 MAIN SERVICE SWITCHBOARD (N/A)

2.4 SWITCHBOARD INSTRUMENTS (N/A)

2.5 AUTOMATIC TRANSFER SWITCH

A. Automatic Transfer Switch: The automatic transfer (AT) switch shall be a 4-pole, double-throw, with a definite neutral position rated at 480 V, with the continuous current rating shown. The AT switch shall be able to withstand the short circuit currents indicated or shall have the same withstand rating as the switchboard in which it is installed. The load terminals of the AT switch shall be de-energized when the AT switch is in the neutral position; the duration of the neutral position shall be adjustable from zero to 30 seconds. The AT switch shall comply with requirements of ANSI/UL 1008-Safety Standard for Automatic Transfer Switches and ANSI/NEMA ICS-2-Devices, Controllers, and Assemblies for Industrial Control.

B. Manual Operation: The AT switch shall be manually operable but the manual operating mechanism shall be declutched when the electric operator becomes energized. Mechanical and

electrical interlocks shall be provided to prevent simultaneous closure of the normal and emergency positions.

C. Protective Features: The AT switch shall include integrated controls featuring solid state timing and sensing relays. Protective features and indicators shall include:

1. Three-phase, close-differential undervoltage protection on the Normal source; drop-out shall be adjustable from 80 to 85 percent; pick-up shall be adjustable from 90 to 95 percent.

2. Circuitry shall be provided to prevent transfer to the Emergency source until Emergency source voltage and frequency are within 90 percent of nominal values.

3. Adjustable time delay of retransfer of up to 10 minutes after the voltage of the Normal source has attained the pick-up setting indicated in the foregoing Item No. 1 on all phases.

4. The AT switch shall be equipped with indicator lamps for the Normal and Emergency positions. Two "dry" contacts shall be provided for the Emergency position and one "dry" contact for the Normal position; said contacts shall be wired to identified terminals.

5. Three-position selector switch: TEST-OFF-AUTO ; the AUTO position shall cause transfer and retransfer of the load on failure and subsequent restoration of the Normal source. The TEST position shall simulate failure of the Normal source for however long the switch is in the Test position.

2.6 TRANSFORMERS

A. All indoor transformers shall be dry-type and shall conform to or exceed the requirements of the latest applicable IEEE, NEMA, and ANSI standards. Transformers rated 3 kva and below shall be designed not to exceed 80-degree C temperature rise; 5 kva and greater shall be designed not to exceed 115-degree C temperature rise. All transformer windings shall be copper.

B. Transformers rated 15 kVA and above shall have four 2-1/2 percent taps, two above and two below 480 volts. Transformers shall be floor type.

C. **Isolation Transformers**: Isolation transformers shall be designed to lessen effects of transient generation into the supply power and shall act as a buffer for SCR current surges. Transformers shall have full capacity taps, four 2.5 percent taps, two above and two below primary windings. Transformers shall have a 150 degree C insulation and shall be UL listed.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Circuit breakers having a frame size of 150-amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units. Breaker contact material shall be a non-weldable silver alloy. Breakers shall have arc-extinguishing chutes. Ground fault tripping, where required, shall be as indicated below.

B. Circuit breakers with a frame size of 225 amperes to 600 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip elements. Ground fault protection shall be provided by means of a core balance transformer encircling all feeder leads. The transformer shall energize a surface-mounted, solid-state relay, adjustable from 10-20 percent of phase current

with an adjustable time delay of zero to 36 cycles. Ground fault protection shall include a test panel containing indication and test tripping circuits.

C. Circuit breakers with a frame size more than 600 amperes shall be molded case as described in the foregoing paragraph, except if power circuit breakers are indicated. Molded case circuit breakers shall have an integral, solid state over-current trip unit and line current sensors. Trip units shall have adjustable long time tripping in the range of 60 to 100 percent of continuous rating, instantaneous tripping adjustable in the range of 300 to 1000 percent of continuous rating, and ground fault tripping adjustable in the range of 20 to 60 percent of continuous rating with adjustable delay of approximately 5 to 40 cycles.

D. Power circuit breakers shall be draw-out; power circuit breakers shall be air break units or insulated case units. Draw-out mechanism shall be 4-position: connected, test, disconnect and remove. The circuit breaker element shall be able to assume the connected, test, and disconnected positions with the circuit breaker cubicle door closed.

E. Interlocks shall be provided to assure that the circuit breaker element is open before movement from a position is possible; stored energy mechanism shall be discharged automatically upon removal of the circuit breaker element from its cubicle. Charging of stored energy springs shall be motorized; closing of the main power contacts shall automatically charge the tripping springs. A manual trip button, position indicators, and status of stored energy mechanism shall be fitted to the front panel.

F. Power circuit breakers shall be equipped with an integral solid-state 3-phase tripping unit as described above.

G. Circuit breaker interlocking shall include an anti-pumping circuit.

H. An external power source shall not be required for circuit breaker tripping. A bell alarm switch shall be provided to close only on circuit breaker overload.

I. Circuit breaker accessories shall include switchgear mounted traveling lift-out hoist.

2.8 MOTOR STARTERS (N/A)

2.9 MANUFACTURERS

A. Products of the type indicated shall be manufactured by the following (or equal):

1. Solid state programmers for circuit breakers:

General Electric Micro-Versatrip
Square D Micrologic Trip System

2. Indicating meters:

Voltmeter

Westinghouse Type KA-251
General Electric Type AB-40

Voltmeter transfer switch

Westinghouse Type W
General Electric Type SB-1

AC indicating ammeter

Westinghouse Type KA-241
General Electric Type AB-40

Ammeter transfer switch

Westinghouse Type W
General Electric Type SB-1

Water-hour demand meter

Westinghouse Type CB
General Electric Type DSM 63

Varmeter

Westinghouse Type KP-261
General Electric Type AB-40

3. Automatic transfer switch

ASCO
Russelectric
Westinghouse
Zenith

4. Transformers

General Electric
Westinghouse
Square D

5. Molded case, insulated case and power circuit breakers

Westinghouse Pow-R-Gear
General Electric Power Break
Square D

6. Switchboard

General Electric, AV-Line
Westinghouse, Pow-R-Line C

7. Motor Starters

General Electric
Westinghouse
Square D

PART 3 -- EXECUTION

3.1 INSTALLATION - GENERAL

A. All electrical equipment materials shall be installed securely in place. Equipment shall be mounted parallel and perpendicular to the walls, floors, and ceilings.

B. All anchors and fasteners shall be types designed for the intended purpose and shall be capable of adequately, safely, and permanently securing the material in place. Screws shall be used on wood surfaces, masonry anchors in concrete or brick, toggle bolts on hollow walls, machine screws, bolts, or welded studs on steel. Nails shall be used only for temporary attachment or support.

C. Omissions or conflicts on Drawings or between Drawings and Specifications shall be brought to the attention of the CONSTRUCTION MANAGER for clarification before proceeding with the WORK.

D. The CONTRACTOR shall make all necessary provisions throughout the site to receive all equipment as construction progresses and shall provide adequate backing, supports, inserts, and anchor bolts for the hanging and support of all electrical cabinets, enclosures, conduit, panelboards, and switches, and shall provide sleeves through walls, floors, or foundations where electrical lines are required to penetrate.

E. Floor standing equipment shall be leveled with shims as required to maintain horizontal surfaces within 1/32-inch per horizontal foot; after leveling, equipment shall be anchored, then grouted so that no space is existing between concrete and equipment support beams.

3.2 PREPARATION AND FINISH

A. All equipment cabinets or enclosures furnished under this Section shall have a finish which conforms to Section 16480.

3.3 TESTING

A. All WORK shall be tested per Section 16030.

**** END OF SECTION ****

SECTION 16431 - SHORT CIRCUIT AND COORDINATION REPORT

PART 1 -- GENERAL

1.1. WORK OF THIS SECTION

A. The WORK of this Section includes providing a short circuit and protective device coordination study and harmonic measurement for the electrical power system.

B. The studies shall include the electrical distribution system for normal and standby power sources distribution system.

C. The studies shall include protection studies for motors supplied with factory-installed solid state overload and overcurrent protection devices.

D. The WORK of this Section includes measurement of harmonic current and the installation of filters required for harmonic suppression.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 16050 Basic Electrical Materials and Methods
2. Section 16400 Low Voltage Electrical Service and Distribution

1.3 CODES

A. The WORK of the Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. ANSI/IEEE 141Recommended Practice for Electrical Power Distribution for Industrial Plants
2. ANSI/IEEE 242Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. ANSI C 37.010Standard Application Guide for AC High-Voltage Circuit Breakers
4. ANSI C 37.5Calculation of Fault Currents for Application of Power Circuit Breakers
5. ANSI C 37.13Low-Voltage AC Power Circuit Breaker (600-Volt Insulation Class)
6. IEEE 519 Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Studies related to distribution system protection and coordination shall be submitted to the CONSTRUCTION MANAGER prior to submittal of distribution equipment shop drawings and/or release of equipment for manufacture. A preliminary submittal shall be made with sufficient detail to review the adequacy of products and to indicate the computer program selected for use in performing the WORK of this Section.

2. Studies for harmonic current, voltage and line notching test results shall be forwarded to the CONSTRUCTION MANAGER prior to acceptance of the project and after installation of harmonic generating and harmonic sensitive equipment.

3. Submittals for solid state motor protective devices shall be forwarded to the CONSTRUCTION MANAGER prior to loading the motor.

4. Protective device and coordination evaluation studies must be approved by the CONSTRUCTION MANAGER prior to acceptance testing.

5. Submittals shall indicate proposed changes to the protection scheme and equipment selection which will result in improved system reliability and safety.

6. Documentation of at least one successful study of comparable size and complexity completed in the recent past, including contact names, addresses, and telephone numbers.

1.6 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, and protective coordination studies shall be performed by the medium voltage switchgear manufacturer or an electrical testing service regularly engaged in short circuit and protective device coordination studies, having at least one successful study of comparable size and complexity completed in the recent past.

1.7 STUDY REPORTS

A. The results of the power system study and harmonic current, voltage and line notching measurements shall be summarized in a final report, signed by the professional electrical engineer, registered in the State of California responsible for the studies. Six bound copies of the final report shall be submitted and shall include the following:

1. Single-line diagram
2. Impedance diagram
3. Tabulation and identification of protective devices on a single-line diagram.
4. Time/current coordination curves
5. Computerized fault current calculations
6. Test instrumentation, condition and connections, as applicable, for each study
7. Harmonic measurement results
8. Specific recommendations (if any)

PART 2 -- PRODUCTS

2.1 GENERAL

A. **General:** The report shall include a single-line and an impedance diagram of the power system. This diagram shall identify components included in the study and the ratings of power devices including transformers, circuit breakers, relays, fuses, busses, and cables. The resistances and reactance of cables shall be indicated in the impedance diagram. The study shall include written data regarding maximum available short circuit current, voltage, and X/R ratio of San Diego Gas and Electric Co.

2.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a computer program complying with ANSI C 37.5, IEEE Standard 242, and IEEE Standard 141.

2.3 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the CONSTRUCTION MANAGER's attention in writing but in no case more than 7 days after discovery.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective device coordination study shall be performed including calculations required to review the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

2.5 TIME/CURRENT COORDINATION CURVES

A. The time/current coordination curves for the power distribution system shall include, on 5-cycle log-log graph paper, at least the following:

1. Time/current curves for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and tap and time dial settings shall be shown.

2. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the CONSTRUCTION MANAGER shall be promptly notified of the cause in writing but in no case more than 7 days after discovery.

3. Time/current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Maximum fault values.

6. Sketch of bus and breaker arrangement.

7. Magnetizing inrush points of transformers.

8. Compliance with Code requirements and proper coordination intervals and separation of characteristics curves.

9. Thermal limits of motors 250 hp and above.

2.6 HARMONIC MEASUREMENT

A. The report of the distribution system, at all voltage levels, shall indicate the harmonic currents anticipated at each voltage level. The report shall indicate sources of harmonic currents, voltages, and line notching of equipment. The report shall state the tolerance of sensitive equipment to harmonics.

B. The report shall include measurement of harmonics present in the output of harmonic-generating equipment at the input terminals of sensitive equipment. Filters required to prevent equipment malfunction due to harmonics shall be installed. Harmonic measurements shall be performed and documented after the filter installation.

C. Equipment which is required to conform with IEEE 519 shall be measured to determine output harmonic content. Corrective action necessary for compliance with IEEE 519, Tables 2 and 4 General System Class shall be made. Measurements and documentation shall be performed to demonstrate compliance with 5 percent voltage distortion limitation.

2.7 MOTOR PROTECTION

A. Where overload protection as phase overcurrent for medium voltage motors is specified to be solid state protective modules, modules shall be adjusted for actual installed motor torque, current and thermal characteristics. Protective settings shall be submitted, and reviewed, before motors are run under load.

PART 3 -- EXECUTION

3.1 TESTING, CALIBRATION, AND ADJUSTMENT

A. The medium voltage equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system study for 2 days.

**** END OF SECTION ****

SECTION 16480 - MOTOR CONTROL

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing group-mounted and unit motor control as required for motors provided.

B. If motors furnished are different from those indicated, then starters, overload elements, and branch circuit protection shall be adjusted and coordinated as required to control and protect the motors provided.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 16030 Electrical Tests
2. Section 16050 Basic Electrical Materials and Methods
3. Section 16400 Low Voltage Electrical Service and Distribution
4. Section 16431 Short-Circuit and Coordination Report

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. National Electrical Code (NEC) NFPA 70

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	NEMA ICS-1	General Standards for Industrial Controls
2.	NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies
3.	UL 845, 489, 508	Electric Motor Control Centers, Molded Case Circuit Breakers, and Industrial Control Equipment

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Shop drawings of all motor control centers and components.

a. Shop drawing submittals shall comply with the "Shop Drawings and Samples" paragraph of Section 16050. The submittal shall also include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase and ground; electrical characteristics including voltage, frame size and trip ratings of overcurrent devices, short circuit withstand ratings, and protective device time-current curves of all equipment and components.

2. Product data on motor starters and combination motor starters, relays, pilot devices and switching and overcurrent protective devices.
3. A wiring diagram and an elementary control diagram for each motor control center cubicle. An identifying number shall be assigned to each wire.
4. Seismic design certification and anchorage sketches in accordance with Section 16050.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Spare parts data listing.
2. Source and current prices of replacement parts.
3. Recommended maintenance procedures and intervals.
4. Factory test reports.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Motor control centers shall be stored in a clean, dry space. Maintain factory wrapping or provide an additional heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Motor control centers shall be handled carefully to avoid damage to motor control center components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 GENERAL

A. All similar products of the same type shall be furnished by a single manufacturer.

B. Motor control assemblies (motor control centers) shall conform to the standards for NEMA Class II, type B assemblies.

C. Components and assemblies shall comply with NEMA ICS 2.

2.2 DESIGN, CONSTRUCTION AND MATERIAL REQUIREMENTS (N/A)

2.3 MOTOR STARTERS -- GROUP MOUNTED (N/A)

2.4 MAIN AND FEEDER CIRCUIT BREAKERS

A. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units. Breaker contact material shall be a non-

weldable silver alloy. Breakers shall have arc-extinguishing chutes.

B. Circuit breakers with a frame size of 225 amperes to 800 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip elements. Main circuit breakers with a frame size of 1000 amperes and larger shall be insulated case type fully rated circuit breakers.

C. The interrupting capacity of all main and feeder circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes.

2.5 MOTOR CONTROL CENTERS (N/A)

2.6 PREPARATION AND FINISH

A. The CONTRACTOR shall have the manufacturer of the motor control center enclosures prepare them in strict accordance with the following requirements:

1. NEMA 1 gasketed indoor assemblies shall be prepared and finished using materials and methods of the manufacturer's standard finish and colors, except that at least 2 coats of the final finish shall be applied by the manufacturer.

2.7 CONTROL DEVICES

A. **Selector Switches:** Selector switches shall be rated 10 amperes at 600 volts, shall be heavy-duty, oil-tight, shall have the number of positions and poles indicated. Each shall have a factory-engraved legend plate, as indicated.

B. **Pushbutton Switches:** The pushbutton stations shall be heavy-duty type with NEMA enclosures of the type indicated. When required, provisions shall be made for padlocking the "Stop" button. Pushbutton devices in damp or outdoor locations shall be fitted with appropriate neoprene boots.

C. **Indicating Lights:** Indicating lights shall be full-voltage, push-to-test type, and shall be heavy-duty, oil-tight as specified above for selector switches. Each shall be nickel-plated with a screwed-on glass prismatic lens approximately one-inch in diameter.

D. **Magnetic Relays:** Magnetic relays shall be machine tool type with 115-volt ac coils and 10-amp contacts, unless otherwise shown. Contacts shall be field convertible. Relays shall be base-mounted to a common mounting channel. Mounting dimensions and drilling for AC and DC relays shall be identical.

E. **Time Delay Relay:** Time delay relays shall be pneumatic on-delay or off-delay with calibrated time range dials, adjustable as indicated.

F. **Timers:** Timers shall be synchronous motor driven with a solenoid operated clutch. Timer shall be on-delay or off-delay for semi-flush panel-mounting. The timers shall be rated 120-volt, 60-Hz, with 10-amp rated contacts and with time range as indicated.

G. **Elapsed Time Meter:** Elapsed time meter (ETM) shall be non-reset type; shall register hours and tenths of an hour; shall have flush panel-mount case not less than 3 inches square; shall be suitable for operation at 120 volts, 60-Hz, AC.

H. **Terminal Blocks:** Terminal blocks for control wiring shall be molded type with barriers, rated not less than 600 volts. Crimped eyelets or approved equal shall be used on all stranded control wire wherever wires are terminated on screw terminals. White or other light-colored marking strips, fastened by screws to the molded sections at each block, shall be provided for circuit designation. Each connected terminal of each block shall have the circuit designation or wire number imprinted on the marking strip with permanent marking fluid. Provide at least 20 percent spare terminals.

2.8 FACTORY TESTS

A. The motor control centers and components shall be given manufacturer's standard electrical and mechanical production tests and inspections with complete test reports submitted to the CONSTRUCTION MANAGER for approval. The tests shall include, but not be limited to, electrical continuity check, dielectric tests for each circuit and inspection for proper functioning of all components, including controls, protective devices, metering and alarm devices.

B. Motor control centers shall be tested in accordance with NEMA ICS-2.

2.9 NAMEPLATES, TOOLS AND SPARE PARTS

A. **Spare Parts**: The WORK includes the following spare parts:

1. 1 unit control transformer for each size of magnetic starter
2. 3 bezels of each color installed in pilot indicators
3. 1 dozen panel lamps
4. 1 dozen control fuses of each size provided in the WORK

B. Spare parts shall be stored in tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

2.10 MANUFACTURERS

A. Products of the type indicated shall be manufactured by one of the following (or equal):

1. Motor Control Centers

Westinghouse
General Electric
Allen Bradley

PART 3 - EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall install the motor control center in accordance with manufacturer's published instructions. Conduit installation shall be coordinated with manufacturer's as-built drawings so that all conduit stub-ups are within the area allotted for conduit. Conduit shall be stubbed up in the section which contains the devices to which conductors are terminated.

3.2 INSTALLATION

A. The motor control center shall be set level within 1/32-inch per horizontal foot. After leveling and shimming, the CONTRACTOR shall anchor motor control center to concrete pad and shall grout in place so that no space exists between the pad and support beams.

B. The CONTRACTOR shall:

1. Torque all bus bar bolts to manufacturer's recommendations; tighten all sheet metal and structure assembly bolts.

2. Adjust all MCP devices to lowest setting consistent with reliable operation under normal conditions. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.

3. After equipment is installed, touch up scratches and verify that nameplate and other identification is accurate and in compliance with these Specifications.

C. The CONTRACTOR shall install pushbutton stations that are remote from the motor control centers, as shown on the drawings.

3.3 FIELD TESTING

A. The CONTRACTOR shall test all pilot lamp indicators and test all controls prior to plant startup.

B. The CONTRACTOR shall perform all the testing required by Section 16030.

**** END OF SECTION ****

SECTION 16485 - LOCAL CONTROL PANELS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing local control panels including enclosures, wiring and control devices.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 13300 Instrumentation and Control
2. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	JIC EGP-1	Electrical Standards for General Purpose Machine Tools
2.	NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
3.	UL	Underwriters' Laboratories

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's product data including catalogue cut sheets showing classifications.
2. Arrangement drawings of the local control panel enclosure indicating the front door and rear panel equipment arrangement and dimensions.
3. List of materials and components.
4. Connection diagrams.
5. Shop drawings indicating mounting of devices, discrete inputs and outputs, and termination points.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL:

1. Manufacturer's installation instructions.
2. Manufacturer's maintenance procedures.
3. Manufacturer's certification that products comply with the indicated requirements.

1.7 FACTORY TESTING

A. **Product Testing**: Panels shall be tested at the factory for sequence of operation.

B. **Witnesses**: The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness factory tests.

1.8 FIELD TESTING

A. **Testing**: Panels shall be field-tested for functional operation after connection of external conductors and prior to equipment startup.

PART 2 -- PRODUCTS

2.1 LABELING

A. Products shall bear the UL label.

2.2 CLASSIFICATION

A. Unless otherwise indicated, enclosures installed indoors shall be NEMA 12 with gasketed doors. Enclosures installed outdoors or in corrosive areas shall be NEMA 4X. Enclosures installed in the indicated hazardous areas shall comply with the NEC requirements for that area.

2.3 SIZE

A. Unless otherwise indicated, the minimum enclosure area, height by width, shall be twice the sum of the areas of the individual components mounted on the back panel. The enclosure depth shall not be less than 6 inches.

2.4 LOCAL CONTROL PANELS (LCP)

A. The LCP shall be designed to provide the indicated sequence of operations. The LCP controls shall be 120 VAC. Control conductors shall comply with the requirements of Section 16050.

B. Each LCP shall include terminal strips identified for the connection of external conductors. The LCP shall include sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with shop drawings. The LCP shall be the source of power for 120 VAC solenoid valves interconnected with the LCP. Equipment associated with the LCP shall be ready for service after connection of conductors to equipment, controls, and LCP.

C. Internal wiring shall be factory-installed and shall be enclosed in plastic raceways with removable covers. Wiring to door-mounted devices shall be extra flexible and shall be anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent contact.

D. Enclosures shall be either freestanding, or designed to be mounted on pedestals or equipment skids or as indicated. Internal control components shall be mounted on a removable mounting pan. Interior of enclosure and mounting pan shall be finished white. Enclosure shall include 100-watt incandescent light (min.) designed to be controlled by a hand-operated switch and a circuit breaker and 15-amp duplex receptacle.

E. The main feeder disconnect shall be flange-mounted unless otherwise indicated.

F. Each source of voltage and motor control shall include a means for disconnecting by disconnecting or pull-apart terminal blocks or a disconnect operable from the panel front.

G. Motor starters: Motor starters, where indicated, shall comply with Section 16400. Each motor starter shall include contact closures for motor overload local indication and remote alarm.

H. Discrete outputs from the LCP shall be provided by electrically isolated dry contacts rated for 5 amps at 120 VAC. Analog inputs and outputs shall be isolated 4-20 mA two-wire signal with power supply complying with Section 13300.

I. Identification of panel-mounted devices, conductors, and electrical components shall comply with Section 13300.

J. LCPs shall include programmable logic controllers (PLCs) in accordance with Section 13300.

K. Indicating lights shall be "Push-to-Test" type.

2.5 COLOR CODING

A. Wiring shall be color coded complying with Section 16050.

2.6 LABELING AND NAMEPLATES

A. **Labeling**: Local control panel components shall be labeled to match the description on the elementary diagram. Internal components of the local control panel on the back side of the door shall be labeled with the same description as provided on the front side. Labeling shall be permanently marked on or near each component. Plastic embossed labels such as "Dymo" tape will not be accepted.

B. **Nameplates**: External door-mounted components and the local control panel description shall be identified with plastic nameplates.

2.7 GROUNDING

A. Neutrals of locally derived control circuits shall be grounded to the mounting plate using a copper bus or grounding lug. A grounding lug for a size No. 2 AWG bare copper conductor shall be included to ground the panel to the plant's grounding system.

2.8 MANUFACTURERS

A. Products of the type or model (if any) indicated shall be manufactured by one of the following (or equal):

Hoffmann Engineering Co., Bulletin A
E.M. Wiegman and Co., Inc.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Products, equipment, conduit, conductors and terminations shall be installed in accordance with the manufacturer's written installation instructions and Section 16050.

B. LCP interior and exteriors shall be cleaned and coatings shall be touched up to match original finish upon completion of the WORK.

C. Alternating current control circuits shall be grounded. One terminal of each load device shall be connected to the grounded conductor. Control contracts shall be installed in the ungrounded side of the circuit.

D. Signal and control wiring shall be separated and installed in separate wireways.

E. The panel shall be grounded to the plant grounding system as indicated.

F. Local control panel centers shall be mounted at 36 inches minimum above the finished floor.

G. A copy of the wiring diagrams shall be placed on the inner panel door. Drawings shall be enclosed in a transparent, protective jacket. A metal pocket measuring not less than 10 inches wide by 8 inches high by 3/4-inch deep shall be provided on the inside of the door for the drawings.

**** END OF SECTION ****

SECTION 16612 – MULTIFUNCTION ELECTRICAL POWER QUALITY METER

PART 1 – GENERAL

1.1. WORK OF THIS SECTION

A. The WORK of this Section includes providing electrical power quality meter, which shall provide continuous monitoring of a three-phase system as required. Meter shall measure current, voltage, real and reactive power, energy use, cost of power, power factor and frequency. Programmable setpoints and 4 assignable output relays shall be provided for control functions for specific applications. Meter shall be capable of basic alarm on over/under current or voltage, unbalance, demand-based load shedding, and capacitor power factor correction control. More complex control shall be possible using the 4 switch inputs which also can be used for status such as breaker open/closed, flow information etc.

1.2. RELATED WORK SPECIFIED ELSEWHERE

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 16030 Electrical Tests
2. Section 16050 Basic Electrical Materials and Methods

1.3. CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. National Electrical Code (NEC) NFPA 70

PART 2 -- PRODUCTS

2.1 SAFETY CERTIFICATE AND TESTING

A. Meter shall be manufactured under an ISO9001 registered program.

B. The meter shall be UL listed and conform to CE EN 55011/CSPIR 11, EN50082-2, IEC 947-1 and IEC 1010-1 standards.

C. Meter shall conform to environment standard IEC 68-2-38 for temperature and humidity cycle.

D. Meter shall have a dielectric strength of 2.0 kV for 1 minute to relays, CTs, PTs and Power supply. Meter shall be able to withstand impulse rated at .5 Joules at 5kV.

2.2 METERING AND MONITORING

A. Meter shall be panel mount design with integrated display. Display shall be a Liquid Crystal

Display (LCD), minimum 40-character display capable of clearly displaying alphanumeric characters.

B. Meter shall provide separate LED indicators for Alarms, Relay Activation, Auxiliary and Communication (Rx,Tx) status.

C. Set-point keys shall be provided on the front panel of the meter to program the meter. Meter shall be able to display all measured value on demand using the keys on meters front panel.

D. For testing purposes meter shall be able to run in self-test and simulation mode. The meter shall simulate values for current, voltage, analog input, switches and analog outputs.

E. Meter shall provide a true RMS monitoring of Ia, Ib, Ic, In, Van, Vbn, Vcn, Vab, Vbc, Vca, voltage/current unbalance, power factor, line frequency, watts, vars, VA, Wh, varh, VAh, and demand readings for A, W, vars, and VA. Maximum and minimum values of measured quantities shall also be recorded and date/time stamped.

F. Meter shall be able to provide demand metering for energy and power. Demand shall be programmable for Thermal or Rolling demand with the demand interval of 5-60 minutes in step of 1.

G. Meter shall be capable of calculating energy costs. User shall be able to program up to 3 different tariff rates for cost calculations.

H. Following minimum accuracy for the monitored parameters shall be provided:

1. Voltage: ±0.2% of full-scale
2. Current: ±0.2% of full-scale
3. Voltage unbalance: ±1% of full-scale
4. Current unbalance: ±1% of full-scale
5. kW: per curves ±1 digit on display
6. kvar: per curves ±1 digit on display
7. kVA: per curves ±1 digit on display
8. kWh: per curves ±1 digit on display
9. kvarh: per curves ±1 digit on display
10. kVAh: per curves ±1 digit on display
11. Power factor: ±1% of full-scale
12. Frequency: ±0.02 Hz
13. kW demand: ±0.4% of full-scale

14. kvar demand:±0.4% of full-scale

15. kVA demand: ±0.4% of full-scale

16. Current demand: ±0.4% of full-scale

17. Current THD: ±2.0% of full-scale

18. Voltage THD: ±2.0% of full-scale

19. Crest factor: ±0.4% of full-scale

I. User shall be able to set Alarm conditions for all measured quantities. These include over-current, under-current, neutral current, current unbalance, voltage unbalance, phase reversal, over-frequency, under-frequency, power factor, switch inputs, etc. The alarm messages shall be displayed on the meter LCD display in a simple and easy to understand English format.

2.3 POWER QUALITY

A. Power analysis features shall include an event recorder, waveform capture, trace memory, harmonic spectrum display (through the 62nd harmonic with total harmonic distortion) and a data logger function. Meter shall be able to sample harmonic spectrum at 256 samples per cycle. All analysis data shall be non-volatile.

B. Meter shall have a Voltage Disturbance Recorder (VDR) function to monitor and record sag and swell disturbances. It shall record up to 500 sag/swell events for all voltages simultaneously and log them with a time stamp.

C. Meter shall be able to capture waveform for voltage and current channels. Meter shall simultaneously sample all channels at minimum 16 samples per cycle. Meter shall be able to automatically capture waveforms based on user-defined set-points.

D. Meter shall automatically generate log for alarms, triggers and input/output events. 150 events records with time stamp shall be stored in the meter.

2.4 INPUT/OUTPUTS

A. Meter shall have built in input and output modules for control and transducer functions:

1. Four switch inputs (digital inputs) shall be provided which can be programmed for relay activation, counters, logic, demand sync, reset and alarms.

2. Four output relays shall be provided which can be programmed to activate on alarms, setpoints, switch inputs, kWh pulse, trace memory triggers or KYZ communications control. These output relays shall also be able to use demand-metering values of A, VAR, W and VA to control load shedding.

3. Four isolated 4-20mA analog outputs assignable to all measured and calculated parameters for output to PLC and other such external devices.

2.5 COMMUNICATION

A. Meter shall be able to communicate using Modbus and DNP 3.0 protocols over assignable RS 485 communication ports at minimum rate baud rate of 19200. Through the use of communication user shall be able to read/write set-points, read actual values, execute commands and read device status loop-back test.

1. Meter shall have a RS232 9-pin computer interface port accessible from the front of the meters for interface with local computer.

2. Two RS485 ports shall be provided for communication with SCADA and other systems. Each port shall be able to communicate independently to different systems using Modbus or DNP protocols.

3. Through the use of external Ethernet module meter shall be able to communicate over Local Area Network (LAN) using TCP/IP. The module shall support both 10BaseT (copper) and 10BaseF (fiber optic) connections. The module shall allow up to thirty additional RS-485/Modbus RTU devices to be connect to the Ethernet.

2.6 MANUFACTURERS

A. Products of the type and model indicated shall be manufactured by the following (or approved equal):

1. Multifunction Electrical Power Quality Meter

General Electric Company (PQM II-T20-C-A)

PART 3 – EXECUTION

3.1 INSTALLATION

A. Meters shall be installed as per manufacturer's recommendations.

*** *END OF SECTION * ***

SECTION 16781 - OUTDOOR FIBER OPTIC CABLE SYSTEMS

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing and installing a fiber optic conduit system including fiber optic cable (FOC), conduit, pullboxes, splices, terminations and testing.

B. The Work includes splicing and testing individual fiber cables installed under this CONTRACT and testing a completed fiber link as shown on the Contract Drawings.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11300 Ultra-Violet Disinfection System
2. Section 13300 Instrumentation and Control
3. Section 16050 Basic Electrical Materials and Methods

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC), commonly known as the "Greenbook"; and the City Supplement to the SSPWC, commonly known as the "Whitebook".

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. **Catalog Data:** Catalog data on conduit system, pullboxes, conduit fittings, conduit plugs, pull rope, identification tape, warning signs.

2. Detailed bill of materials.

3. Drawings indicating the locations of all pullboxes with station numbers.

4. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.

5. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pullboxes that are required, including station number and a written description of the location.

6. A cable pulling and splicing work plan shall be submitted a minimum of 45 days prior to the planned initiation of cable pulling. The pulling plan and pull tension calculations may be prepared by using a software program such as Pull-Planner 2000 by American Polywater Corporation, **or equal**. The cable pulling and splicing work plan must be approved a minimum of 15 days prior to pulling cable. Work plan shall include the following:

    a. Pull tension calculations
    b. Calculated amount of lubrication required
    c. Detailed description of pull operation methods for all conduit runs
    d. Tools and equipment to be used for cable installation and testing
    e. Physical location of equipment setup and type
    f. Exact location of splice points
    g. Safety and manual assist cable pulling operations
    h. Detailed schedule for pulling and testing cables

7. Information on at least one successfully performing fiber optic cable installation of comparable size and complexity installed in the recent past with name, address, and telephone number of facility owner, name of project and completion date, and type of conduit system and length of cable pulled.

8. The name and qualifications of the supervisory personnel that will be directly responsible for the installation of the conduit system.

1.5 STANDARDS

A. **Cable Certification:** The cable manufacturer shall certify that the cable is suitable for direct installation in 2-inch to 4-inch conduit in an underground environment. The CONTRACTOR shall submit a sample and its certification to the CONSTRUCTION MANAGER for approval prior to installation. The CONTRACTOR shall submit laboratory test reports on representative samples of similar cable design to demonstrate compliance with the following requirements prior to cable installation:

    1. Tensile Strength per EIA-RS-455-33A and EIA-RS-455-28A
    2. Jacket Shrinkage per EIA-RS-455-86
    3. Cable Twist per EIA-RS-455-85
    4. Environmental Temperature Cycling per EIA-RS-455-3A
    5. Flexing per EIA-RS-455-104
    6. Impact Resistance per EIA-RS-455-25A
    7. Compressive Strength per EIA-RS-455-41
    8. Freezing Test per EIA-RS-455-98A
    9. Mechanical Bend Test per EIA-RS-455-37

B. The cable manufacturer shall be ISO 9001 registered.

1.6 APPLICABLE DOCUMENTS

A. The optical fiber cable shall conform to the latest issue of the following standards documents which are incorporated by reference into this specification:

1. EIA-455 Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
2. EIA-359 Standard Colors for Color Identification and Coding.
3. MIL-202 Test Methods for Electronic and Electrical Component Parts.
4. MIL-454 Standard General Requirements for Electronic Equipment.
5. MIL-810 Environmental Test Methods and Engineering Guidelines.

B. All fiber optical cables shall be constructed in accordance with EIA-455 and one hundred percent (100%) of all optical fibers and jacketing shall meet or exceed the requirements contained in this specification.

1.7 QUALITY ASSURANCE

A. All work described in this Section shall meet or exceed the applicable provisions of the following documents:

1. ANSI, C8.471983, American National Standard Institute for Polyolefin insulated Thermoplastic Jacketed Communication Cables.

2. EIA-455 (addendum 1 through 5) Standard Test Procedures for Fiber Optics, Cables, Transducers, Connecting and Terminating Devices.

3. EIA-455-27A, Method of Measuring (Uncoated) Diameter of Optical Waveguide Fibers.

4. EIA-455-28A, Method For Measuring Tensile Failure Point of Optical Waveguide Fibers.

5. EIA-455-34, Interconnection Device Insertion Loss Test.

6. EIA-455-89, Fiber Optic Cable Jacket Elongation and Tensile Strength.

7. Underwriters Laboratories (UL) Standard 651 (Conduit)

8. Underwriters Laboratories (UL) Standard 514 (Accessories)

9. National Electrical Manufacturers Association (NEMA) TC-2 (Conduit)

10. National Electrical Manufacturers Association (NEMA) TC-3 (Accessories)

1.8 WARRANTY

A. The Contractor shall provide an unconditional warranty on all installed cable for a minimum period of two (2) years.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Conduit:** See specification 16050 Basic Electrical Materials and Methods.

B. **Cabinets:** N/A

C. **Pullboxes:** N/A

D. **Conduit Duct Plugs:** Jackmoon Simplex Duct Plugs with bushing sleeves **or equal**.

E. **Pull Rope:** Low friction, polyethylene jacketed polypropylene rope with 1800 psi tensile strength. Provide Vikamatic "Fiber Glide" **or equal**.

F. **Fiber Optic Cable**

1. **Cable type:** All-dielectric outdoor plant stranded loose-tube, gel-filled fiber optic cable, Corning Altos or Lucent Lightpack.

2. **Number of fibers and Mode (Single or Multi):** per Contract Drawings.

3. **Buffer Tubes:** All optical fibers shall be grouped and placed inside a loose buffer tube. The tubes shall be color coded and arranged symmetrically around the central member.

4. Each fiber shall be numbered and color-coded.

5. The colors of the individual fibers shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

6. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.

7. Filler may be included in the cable core composition to lend symmetry to the cable cross-section where needed.

8. A central anti-buckling member shall be included into the cable to prevent buckling of the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.

9. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

10. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.

11. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

12. Binders shall be applied with sufficient tension to secure the buffer tubes to the member

without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dialectic with low shrinkage.

13. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

14. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.

15. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

G. **Fan-Out Termination for Loose Tube Cables**

1. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.

2. The tight-buffered pigtails shall be terminated with ST™ connectors as specified.

H. **Fan-out Pigtail Cable Specifications**

1. Single mode fiber (Corning SMF-28™ **or equal**) shall be used in the pigtails. Optical characteristics shall comply with the optical fiber performance specifications.

Buffer material	Thermoplastic
Buffer O.D.	900 um
Strength Member	Kevlar
Jacket Material	PVC
Jacket O.D.	3.0 mm
Temperature Range	-20 to + 70 C

I. **Fiber Optic Termination Patch Panels**

1. Where shown on the plans, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the cable shall be terminated with ST™ compatible connectors. The patch panel shall have a

fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected. Patch panels shall be designed for either rack mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain ST™ type bayonet couplings. All unused couplings shall have protective dust covers. All panels shall be furnished with locking doors. Factory-terminated, tight-buffered, agamid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0 mm O.D., shall connect the optical cable terminations to the patch panel couplings. Panels shall be equal to the following manufactured by Secure:

Mounting	Fiber Capacity	Model Number
Rack	48	C.H.-02U
Rack	72	C.H.-03U
Wall	48	AC-048L with lock
Wall	72	AC-072L with lock

2. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors, to prevent damage to fibers and connectors during all regular operation and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be greater than four (4) inches at all times to ensure optical and mechanical integrity of the optical fibers.

J. **Optical Connectors**

1. All connectors shall be field-install able and perfectly matched to the cable used. The connectors shall provide tight fitting termination to the cladding and buffer coating. Epoxy based or "hot-melt" adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination or "quick crimp" connectors are allowed.

2. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If any irregularities found cannot be removed by further polishing, the entire process must be redone by cutting off and disposing the connector body.

3. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EA.-455-34. No index-matching gel is to be used, dry interfaces only. Single mode connectors shall be capable of field installation on 9/125micron fibers with 900 micron buffers (OD).

4. Each connector shall be of the industry standard ST type compatible, designed for single mode tolerances, and shall meet or exceed the applicable provisions of EA.-455-5, 455-2A, and 455-34, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials, such as nickel-plated zinc, designed to

operate in humid environments without degradation of surface finishes.

K. **Splice Closures**

1. Splice closures shall be of the re-enterable type, with an external moisture-proof shell, inner closure and encapsulant.

2. Closure shall have removable interior splice trays.

3. Closures shall be Corning Cable Systems (Secure) type SCN **or equal**.

2.2 TRENCH BACKFILL MATERIALS: N/A

PART 3 -- EXECUTION

3.1 CONDUIT INSTALLATION

A. **General**

1. Conduit sections shall be joined in accordance with the Manufacturers' recommendations. All joints shall be watertight.

2. All conduit shall be cleaned and tested prior to installation of cables.

3. CONTRACTOR shall install pull rope in the conduit.

4. Conduits entering pullboxes shall be sealed with Jackmoon Simplex duct plugs.

5. The conduit shall gradually and smoothly slope up to the elevation of the pullbox entrance. Use of manufactured bends shall be limited to an absolute minimum. Factory bends, if required, shall be no more than 22½ degrees.

3.2 FIBER OPTIC CABLE INSTALLATION

A. **General**

1. The Contractor shall determine a suitable cable installation method to ensure that all cable installation requirements shall be met in all conduit sections. All work shall be carried out in accordance and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; as well as the accuracy and completeness of the documentation.

2. The Contractor shall make a physical survey of the project site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any work or committing any materials.

3. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately, and the CONSTRUCTION MANAGER notified.

4. Fiber optic cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the manufacturer's recommended procedures including, but not limited to the following:

   a. Proper attachment to the cable strength elements for pulling during installation. Depending on cable design, this will involve direct attachment to internal strength members or attaching an external "Kellums" or split mesh grip using a 600 lb breakaway swivel.

   b. Cable tensile limitations and tension monitoring procedures.

   c. Cable bending radius limitations.

   d. Cable twisting limitations.

B. **Cable Protection During Installation**

1. All fiber optic cable shall be pulled in conduit except as specified on the plans. Care shall be exercised during cable pulls through conduit bends and looping in pullboxes.

2. The Contractor shall comply with the cable manufacturer's recommended installation procedures at all times. Cable installation procedures shall conform to Belcore guidelines.

3. To reduce the possibility of damage to the outer jacket of the fiber optic cable, protective measures shall be used when the cable is installed. The requirements herein shall be followed, but does not limit the installation to only those identified. The purpose of the installation specifications is to ensure protection of the fiber optic cable when it is installed. Other protective measures not specified herein may be taken during installation if it will ensure protection of the cable.

4. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the CONSTRUCTION MANAGER notified.

5. Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end and be used to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall be lubricated with a lubricant that shall be of the water- based type and approved by the cable manufacturer.

6. Crushed or kinked cable shall be replaced with new cable.

7. Dynamometers or break away pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during installation shall be less than 0.75 %.

C. **Lubrication:** As the cable is pulled into the conduit system, it shall be sufficiently lubricated with a lubricant that shall be the water-based type and approved by the cable manufacturer. Lubricant shall be applied at a rate to provide a continuous 10-mil coating, as recommended by the manufacturer. Lubricant shall be Polywater F® manufactured by American Polywater **or equal**.

D. To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling of the fiber optic cable is acceptable and shall be implemented as follows:

1. From the midpoint, pull the fiber optic cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.

2. When this portion of the pull is complete, the remainder of the cable must be removed from the reel to make the inside end available for pulling in the opposite direction.

3. This is accomplished by hand pulling the cable from the reel and laying into large "figure eight" loops on the ground.

4. The purpose of the figure eight pattern is to avoid cable tangling and kinking.

5. The loops shall be laid carefully one upon the other (to prevent subsequent tangling) and shall be in a protected area.

6. The inside reel end of the cable is then available for installation.

7. In some cases, it may be necessary to set up a winch at an intermediate cable vault.

8. The required length of cable shall be pulled to that point, and brought out of the cable vault and coiled into a figure eight.

9. The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next section.

E. When power equipment is used to install fiber optic cables, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius and twist limitation for fiber optic cable shall not be exceeded under any circumstances.

F. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load- cell instruments.

G. The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks.

H. All pulls shall be documented by a graph which is annotated with the following information:

1. Reel number
2. Station from and station to
3. Date and time
4. Explanations of abnormalities in readings or interruptions
5. Sign-off by CONTRACTOR and CONSTRUCTION MANAGER.

I. Under no conditions shall the FOC be left exposed or unattended.

J. **Repairs:** Repair of cable jacket shall not be permitted. Jacket damage shall require removal and re-installation of a new cable run at the Contractor's expense.

K. **Installation at Pullboxes**

1. The pulling of the cable shall be hand assisted at each handhole or pullbox. The cable shall not be crushed, kinked or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination.

2. The cable shall be looped in all pullboxes as noted on the plans to provide approximately fifteen (15) feet of extra cable in the pullbox. At termination points, such as at cabinets or computers, a fifteen (15)-foot loop shall also be provided wherever space permits. The fiber optic cable shall be coiled and secured with cable ties in the pullbox. The Contractor shall ensure that the minimum bending radius of the fiber optic cable is not compromised when preparing this stored cable slack.

3. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by Brady or Thomas & Betts.

4. When all cables at each pullbox are securely racked, unused conduits and void areas around conduit containing cables shall be sealed.

5. **Cable Marking:** At each pullbox and at each cabinet, the cable shall be visibly marked with yellow warning tape as follows:

"CAUTION - FIBER OPTIC CABLE"

L. **Splicing**

1. Splicing of fiber optic cable shall <u>not</u> be permitted except in emergency conditions or as specified on the plans or in the special conditions for a specified project. Fiber optic cable runs and required looping of the cable shall be provided in one continuous length. When splicing is authorized by the CONSTRUCTION MANAGER, splicing shall be by trained, authorized persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only, no mechanical splices are permitted.

2. All fusion splicing equipment shall be in good working order, properly calibrated, and

meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

3. Spices shall be made in pullboxes and shall use re-enterable splice closures.

4. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice, divided by two. No individual splice loss measured in a single direction shall exceed 0.15 dB.

5. Upon completion of the splicing operation, all waste material shall be deposited in suitable containers, removed from the job site, and disposed of in an environmentally acceptable manner.

3.3 PULLBOXES

A. Field Location of Pullboxes

1. The drawings diagrammatically indicate the desired location of pullboxes, conduit runs and other items. Exact locations shall be determined by the CONTRACTOR based on physical size and arrangement of equipment, finished elevations, calculated cable pulling tensions, field obstructions, and the criteria below. Locations shown on the drawings should be followed as closely as possible, however, pullboxes shall be located according to the following criteria:

    a. At no point shall the cable pulling tension exceed 600 pounds. If cable pulling tension is calculated to exceed 600 pounds, additional pullboxes shall be provided at no extra cost to the OWNER.

    b. The maximum distance between any two pullboxes shall not exceed 1,200 feet.

    c. Within the 1,200-feet distance, the CONTRACTOR shall install pullboxes at locations wherever the cumulative change of direction of the conduit exceeds 180 degrees.

    d. The minimum bending radius for conduit shall be 3 feet.

    e. A pullbox shall be installed on one side of a tunneled crossing. However, for any crossing which requires more than 180 degrees of conduit bends to account for elevation differences or route adjustments, a pullbox shall be provided on both sides of the crossing.

    f. Pullboxes shall be installed a minimum of 12 inches from all structures.

B. Construction

1. Pullbox conduit entries shall be sealed with duct plugs to prevent the intrusion of water

and debris into the pullboxes.

2. Upon final acceptance of the conduit system all pullboxes shall be free of debris and water, and be ready for cable installation.

3.4 MODIFICATIONS

A. All dimensions and exact locations of underground substructures shall be field verified. Minor changes in locations of pullboxes which result in no additional costs for material or labor shall be made at no additional cost to the OWNER. However, the CONTRACTOR shall prepare proposals consisting of detailed material lists, cost estimates, and schedules for rerouting the conduit around existing unforeseen underground utilities and structures which result in additional cost. The CONSTRUCTION MANAGER will consider the proposals in accordance with the provisions of the General Conditions.

B. The CONTRACTOR shall consider the following when preparing proposals:

1. Manufactured bends shall be minimized

2. Required bends shall be less than 22½ degrees
3. Clearances between conduits and other structures shall be:

Power or other foreign conduit: 12 inches

Pipe for gas, oil, water, sewage: 6 inches when crossing; 12 inches when parallel

3.5 CONDUIT SYSTEM CLEANING AND TESTING

A. Following the backfill placement and compaction, all conduits shall be cleared of loose material by brush and compressed air.

B. Conduit shall be tested for leakage by air testing at 5 psi, maintaining the pressure for one hour without showing any leakage.

C. Following the leakage test, a test mandrel **d** inch smaller than the inside diameter shall be passed through all conduits to detect alignment and deformation problems. Mandrel shall be passed in both directions.

D. Cleaning and testing of the conduit shall be performed by the CONTRACTOR and witnessed by the CONSTRUCTION MANAGER. The cleaning and testing operation shall be conducted for each conduit section between adjacent pullboxes, a section at a time, for the entire route. The results of tests shall be documented by the CONTRACTOR and signed by the CONSTRUCTION MANAGER and the CONTRACTOR.

E. The CONTRACTOR shall provide a five-day advance notice of the schedule and location of test to the CONSTRUCTION MANAGER.

F. The CONTRACTOR shall remove and replace conduit which fails either test and shall repeat the test.

3.6 FIBER OPTIC CABLE TESTING

A. **General:** The CONTRACTOR shall perform pre-installation and post-installation FOC tests. The CONSTRUCTION MANAGER shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to LIST standards.

B. **Test equipment:** The CONTRACTOR shall use the following to perform pre-installation and post installation FOC tests:

1. **Optical Time Domain Reflectometer (OTDR):** The OTDR shall be laser precision, ALT Inc MODEL 5200 LRFL, **or equal**.

C. **Pre-Installation Tests**

1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes.

2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the CONTRACTOR using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.

3. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the contractor and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.

4. The CONTRACTOR shall perform tests on all reels of cable. The CONSTRUCTION MANAGER shall be notified a minimum of 15 days prior to any test.

5. The CONTRACTOR shall document each test and submit the report to the CONSTRUCTION MANAGER for review. Documentation shall consist of both hard copy and 3½-inch electronic disk complete with all application software.

6. Cable shall not be installed until the CONSTRUCTION MANAGER has reviewed the test report.

7. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.

D. **Post-Installation Tests:** After FOC has been installed the following tests shall be performed:

1. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1310 nm and 1550 nm light source

for the single mode fiber (SMF). The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.

2. The maximum permissible end-to-end loss shall be 0.5 dB/km. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.

3. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

4. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

5. Hard and electronic copy of test documentation shall be submitted to the CONSTRUCTION MANAGER. The documentation shall include the trace plot, index, dB/km loss, cable length, date and time of test, wavelength, pulse width, the test site, cable ID, fiber number and type, and operator's initials. The CONTRACTOR shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the CONSTRUCTION MANAGER shall be notified in writing by the CONTRACTOR, and the cable shall be removed and replaced at no additional cost to the OWNER.

6. Upon completion of the previous tests all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

E. **Required OTDR Trace Information**

1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace: away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length of the fiber under test.

2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the 5-point splice loss measurement technique.

3. The OTDR trace shall also include the following information:

   a. The date and time of the test

b. The cable ID number
c. The cable segment ID number
d. The fiber color or sub-cable number
e. Launch point connector number
f. The optical wavelength used for the test
g. The refractive index setting of the OTDR
h. The pulse width setting of the OTDR
I. The averaging interval of the test

3.7 RECORD DRAWINGS

A. The CONTRACTOR shall upon completing the construction of the fiber optic system, shall submit to the CITY Record Drawings showing the following:

1. Horizontal alignment of fiber optic conduit.

2. Vertical alignment of fiber optic conduit.

3. Location of all pullboxes.

****END OF SECTION****

SUPPLEMENTARY SPECIAL PROVISIONS

APPENDICES

APPENDIX A

NOTICE OF EXEMPTION AND NOTICE OF RIGHT TO APPEAL ENVIRONMENTAL DETERMINATION

NOTICE OF EXEMPTION

(Check one or both)

TO: __X__ Recorder/County Clerk
P.O. Box 1750, MS A-33
1600 Pacific Hwy, Room 260
San Diego, CA 92101-2400

_____ Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

FROM: City of San Diego
Public Works Department
525 B Street, Suite 750, MS 908A
San Diego, CA 92101

Project Name: SBWRP Ultraviolet (UV) Disinfection System Replacement

Project No. / WBS No.: B-18031.02.06

Project Location-Specific: The South Bay Water Reclamation Plant (SBWRP) is located at 2411 Dairy Mart Road, San Diego, CA 92154 and within the Tijuana River Valley Community Planning Area (Council District 8).

Project Location-City/County: San Diego/San Diego

Description of nature and purpose of the Project: The project involves the replacement and upgrade of the existing UV light disinfection system with a more technologically advanced energy-efficient system. All work will occur within or around the existing UV mechanical concrete channel. Work will include:

- minor modifications to the existing UV concrete channel;
- removal and replacement of UV disinfection equipment and appurtenances;
- updating the existing electrical system;
- updating the existing controls system; and
- if necessary for constructability, removal, storage, and re-installation of an existing shade structure.

Name of Public Agency Approving Project: City of San Diego

Name of Person or Agency Carrying Out Project: City of San Diego Public Works Department,
Contact: Jerry Jakubauskas; Phone: (619) 533-3755
525 B Street, Suite 750 (MS 908A), San Diego, CA

Exempt Status: (CHECK ONE)

( ) Ministerial (Sec. 21080(b)(1); 15268);
( ) Declared Emergency (Sec. 21080(b)(3); 15269(a));
( ) Emergency Project (Sec. 21080(b)(4); 15269 (b)(c))
(X) Categorical Exemption: 15301 (Existing Facilities) and 15302 (Replacement or Reconstruction)

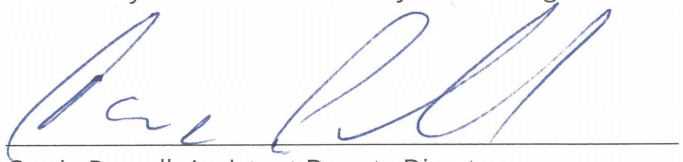
Reasons why project is exempt: The City of San Diego conducted an environmental review which determined that the project meets the categorical exemption criteria set forth in CEQA State Guidelines, Section 15301 (Existing Facilities) which allows for restoration or rehabilitation of deteriorated or damaged structures, facilities, or mechanical equipment to meet current standards for public health and safety and 15302 (Replacement or Reconstruction) which allows for the replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity; and where the exceptions listed in Section 15300.2 would not apply.

Lead Agency Contact Person: Jerry Jakubauskas Telephone: (619) 533-3755

If filed by applicant:

1. Attach certified document of exemption finding.
2. Has a notice of exemption been filed by the public agency approving the project? ( ) Yes ( ) No

It is hereby certified that the City of San Diego has determined the above activity to be exempt from CEQA



Carrie Purcell, Assistant Deputy Director

August 27, 2018
Date

Check One:
(X) Signed By Lead Agency
( ) Signed by Applicant

Date Received for Filing with County Clerk or OPR:

THE CITY OF SAN DIEGO

Date of Notice: August 10, 2018

NOTICE OF RIGHT TO APPEAL ENVIRONMENTAL DETERMINATION

PUBLIC WORKS DEPARTMENT

WBS No. B-18031.02.06

PROJECT NAME: SBWRP Ultraviolet (UV) Disinfection System Replacement

COMMUNITY PLAN AREA: Tijuana River Valley Community Planning Area

COUNCIL DISTRICT: 8

LOCATION: The South Bay Water Reclamation Plant (SBWRP) is located at 2411 Dairy Mart Road, San Diego, CA 92154.

PROJECT DESCRIPTION: The project involves the replacement and upgrade of the existing UV light disinfection system with a more technologically advanced energy-efficient system. All work will occur within or around the existing UV mechanical concrete channel. Work will include:

- minor modifications to the existing UV concrete channel;
- removal and replacement of UV disinfection equipment and appurtenances;
- updating the existing electrical system;
- updating the existing controls system; and
- if necessary for constructability, removal, storage, and re-installation of an existing shade structure.

ENTITY CONSIDERING PROJECT APPROVAL: City of San Diego

ENVIRONMENTAL DETERMINATION: Categorical Exemption: 15301 (Existing Facilities) and 15302 (Replacement or Reconstruction)

ENTITY MAKING ENVIRONMENTAL DETERMINATION: City of San Diego Public Works Department

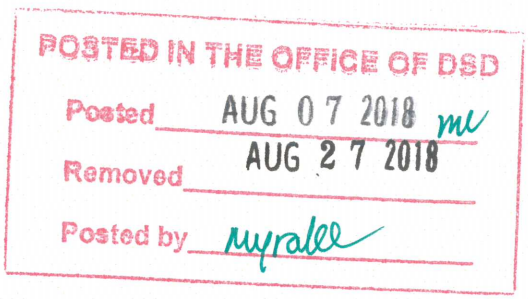
STATEMENT SUPPORTING REASON FOR ENVIRONMENTAL DETERMINATION: The City of San Diego conducted an environmental review which determined that the project meets the categorical exemption criteria set forth in CEQA State Guidelines, Section 15301 (Existing Facilities), which allows for restoration or rehabilitation of deteriorated or damaged structures, facilities, or mechanical equipment to meet current standards for public health and safety, or 15302 (Replacement or Reconstruction), which allows for the replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity; and where the exceptions listed in Section 15300.2 would not apply.

CITY PROJECT MANAGER:	Jerry Jakubauskas
MAILING ADDRESS:	525 B Street, Suite 750 (MS 908A), San Diego, CA 92101
PHONE NUMBER:	(619) 533-3755

On August 10, 2018 the City of San Diego made the above-referenced environmental determination pursuant to the California Environmental Quality Act (CEQA). This determination is appealable to the City Council. If you have any questions about this determination, contact the City Project Manager listed above.

Applications to appeal CEQA determination made by staff (including the City Manager) to the City Council must be filed in the office of the City Clerk within 10 business days from the date of the posting of this Notice (August 24, 2018). The appeal application can be obtained from the City Clerk, 202 'C' Street, Second Floor, San Diego, CA 92101.

This information will be made available in alternative formats upon request.



APPENDIX B

FIRE HYDRANT METER PROGRAM

CITY OF SAN DIEGO CALIFORNIA DEPARTMENT INSTRUCTIONS	NUMBER **DI** 55.27	DEPARTMENT Water Department
SUBJECT **FIRE HYDRANT METER PROGRAM (FORMERLY: CONSTRUCTION METER PROGRAM)**	**PAGE** 1**OF** 10	**EFFECTIVE DATE** October 15, 2002
	SUPERSEDES **DI** 55.27	**DATED** April 21, 2000

1. **PURPOSE**

1.1 To establish a Departmental policy and procedure for issuance, proper usage and charges for fire hydrant meters.

2. **AUTHORITY**

2.1 All authorities and references shall be current versions and revisions.

2.2 San Diego Municipal Code (NC) Chapter VI, Article 7, Sections 67.14 and 67.15

2.3 Code of Federal Regulations, Safe Drinking Water Act of 1986

2.4 California Code of Regulations, Titles 17 and 22

2.5 California State Penal Code, Section 498B.0

2.6 State of California Water Code, Section 110, 500-6, and 520-23

2.7 Water Department Director

Reference

2.8 State of California Guidance Manual for Cross Connection Programs

2.9 American Water Works Association Manual M-14, Recommended Practice for Backflow Prevention

2.10 American Water Works Association Standards for Water Meters

2.11 U.S.C. Foundation for Cross Connection Control and Hydraulic Research Manual

3. **DEFINITIONS**

3.1 **Fire Hydrant Meter:** A portable water meter which is connected to a fire hydrant for the purpose of temporary use. (These meters are sometimes referred to as Construction Meters.)

3.2 **Temporary Water Use:** Water provided to the customer for no longer than twelve (12) months.

3.3 **Backflow Preventor:** A Reduced Pressure Principal Assembly connected to the outlet side of a Fire Hydrant Meter.

4. POLICY

4.1 The Water Department shall collect a deposit from every customer requiring a fire hydrant meter and appurtenances prior to providing the meter and appurtenances (see Section 7.1 regarding the Fees and Deposit Schedule). The deposit is refundable upon the termination of use and return of equipment and appurtenances in good working condition.

4.2 Fire hydrant meters will have a 2 ½" swivel connection between the meter and fire hydrant. The meter shall not be connected to the 4" port on the hydrant. All Fire Hydrant Meters issued shall have a Reduced Pressure Principle Assembly (RP) as part of the installation. Spanner wrenches are the only tool allowed to turn on water at the fire hydrant.

4.3 The use of private hydrant meters on City hydrants is prohibited, with exceptions as noted below. All private fire hydrant meters are to be phased out of the City of San Diego. All customers who wish to continue to use their own fire hydrant meters must adhere to the following conditions:

a. Meters shall meet all City specifications and American Water Works Association (AWWA) standards.

b. Customers currently using private fire hydrant meters in the City of San Diego water system will be allowed to continue using the meter under the following conditions:

1. The customer must submit a current certificate of accuracy and calibration results for private meters and private backflows annually to the City of San Diego, Water Department, Meter Shop.

2. The meter must be properly identifiable with a clearly labeled serial number on the body of the fire hydrant meter. The serial number shall be plainly stamped on the register lid and the main casing. Serial numbers shall be visible from the top of the meter casing and the numbers shall be stamped on the top of the inlet casing flange.

3. All meters shall be locked to the fire hydrant by the Water Department, Meter Section (see Section 4.7).

4. All meters shall be read by the Water Department, Meter Section (see Section 4.7).

5. All meters shall be relocated by the Water Department, Meter Section (see Section 4.7).

6. These meters shall be tested on the anniversary of the original test date and proof of testing will be submitted to the Water Department, Meter Shop, on a yearly basis. If not tested, the meter will not be allowed for use in the City of San Diego.

7. All private fire hydrant meters shall have backflow devices attached when installed.

8. The customer must maintain and repair their own private meters and private backflows.

9. The customer must provide current test and calibration results to the Water Department, Meter Shop after any repairs.

10. When private meters are damaged beyond repair, these private meters will be replaced by City owned fire hydrant meters.

11. When a private meter malfunctions, the customer will be notified and the meter will be removed by the City and returned to the customer for repairs. Testing and calibration results shall be given to the City prior to any re-installation.

12. The register shall be hermetically sealed straight reading and shall be readable from the inlet side. Registration shall be in hundred cubic feet.

13. The outlet shall have a 2 ½ "National Standards Tested (NST) fire hydrant male coupling.

14. Private fire hydrant meters shall not be transferable from one contracting company to another (i.e. if a company goes out of business or is bought out by another company).

4.4 All fire hydrant meters and appurtenances shall be installed, relocated and removed by the City of San Diego, Water Department. All City owned fire hydrant meters and appurtenances shall be maintained by the City of San Diego, Water Department, Meter Services.

4.5 If any fire hydrant meter is used in violation of this Department Instruction, the violation will be reported to the Code Compliance Section for investigation and appropriate action. Any customer using a fire hydrant meter in violation of the requirements set forth above is subject to fines or penalties pursuant to the Municipal Code, Section 67.15 and Section 67.37.

4.6 **Conditions and Processes for Issuance of a Fire Hydrant Meter**

Process for Issuance

a. Fire hydrant meters shall only be used for the following purposes:

1. Temporary irrigation purposes not to exceed one year.

2. Construction and maintenance related activities (see Tab 2).

b. No customer inside or outside the boundaries of the City of San Diego Water Department shall resell any portion of the water delivered through a fire hydrant by the City of San Diego Water Department.

c. The City of San Diego allows for the issuance of a temporary fire hydrant meter for a period not to exceed 12 months (365 days). An extension can only be granted in writing from the Water Department Director for up to 90 additional days. A written request for an extension by the consumer must be submitted at least 30 days prior to the 12 month period ending. No extension shall be granted to any customer with a delinquent account with the Water Department. No further extensions shall be granted.

d. Any customer requesting the issuance of a fire hydrant meter shall file an application with the Meter Section. The customer must complete a "Fire Hydrant Meter Application" (Tab 1) which includes the name of the company, the party responsible for payment, Social Security number and/or California ID, requested location of the meter (a detailed map signifying an exact location), local contact person, local phone number, a contractor's license (or a business license), description of specific water use, duration of use at the site and full name and address of the person responsible for payment.

e. At the time of the application the customer will pay their fees according to the schedule set forth in the Rate Book of Fees and Charges, located in the City Clerk's Office. All fees must be paid by check, money order or cashiers check, made payable to the City Treasurer. Cash will not be accepted.

f. No fire hydrant meters shall be furnished or relocated for any customer with a delinquent account with the Water Department.

g. After the fees have been paid and an account has been created, the

meter shall be installed within 48 hours (by the second business day). For an additional fee, at overtime rates, meters can be installed within 24 hours (within one business day).

4.7 **Relocation of Existing Fire Hydrant Meters**

a. The customer shall call the Fire Hydrant Meter Hotline (herein referred to as "Hotline"), a minimum of 24 hours in advance, to request the relocation of a meter. A fee will be charged to the existing account, which must be current before a work order is generated for the meter's relocation.

b. The customer will supply in writing the address where the meter is to be relocated (map page, cross street, etc). The customer must update the original Fire Hydrant Meter Application with any changes as it applies to the new location.

c. Fire hydrant meters shall be read on a monthly basis. While fire hydrant meters and backflow devices are in service, commodity, base fee and damage charges, if applicable, will be billed to the customer on a monthly basis. If the account becomes delinquent, the meter will be removed.

4.8 **Disconnection of Fire Hydrant Meter**

a. After ten (10) months a "Notice of Discontinuation of Service" (Tab 3) will be issued to the site and the address of record to notify the customer of the date of discontinuance of service. An extension can only be granted in writing from the Water Department Director for up to 90 additional days (as stated in Section 4.6C) and a copy of the extension shall be forwarded to the Meter Shop Supervisor. If an extension has not been approved, the meter will be removed after twelve (12) months of use.

b. Upon completion of the project the customer will notify the Meter Services office via the Hotline to request the removal of the fire hydrant meter and appurtenances. A work order will be generated

for removal of the meter.

c. Meter Section staff will remove the meter and backflow prevention assembly and return it to the Meter Shop. Once returned to the Meter Shop the meter and backflow will be tested for accuracy and functionality.

d. Meter Section Staff will contact and notify Customer Services of the final read and any charges resulting from damages to the meter and backflow or its appurtenance. These charges will be added on the customer's final bill and will be sent to the address of record. Any customer who has an outstanding balance will not receive additional meters.

e. Outstanding balances due may be deducted from deposits and any balances refunded to the customer. Any outstanding balances will be turned over to the City Treasurer for collection. Outstanding balances may also be transferred to any other existing accounts.

5. EXCEPTIONS

5.1 Any request for exceptions to this policy shall be presented, in writing, to the Customer Support Deputy Director, or his/her designee for consideration.

6. MOBILE METER

6.1 Mobile meters will be allowed on a case by case basis. All mobile meters will be protected by an approved backflow assembly and the minimum requirement will be a Reduced Pressure Principal Assembly. The two types of Mobile Meters are vehicle mounted and floating meters. Each style of meters has separate guidelines that shall be followed for the customer to retain service and are described below:

a) **Vehicle Mounted Meters**: Customer applies for and receives a City owned Fire Hydrant Meter from the Meter Shop. The customer mounts the meter on the vehicle and brings it to the Meter Shop for

inspection. After installation is approved by the Meter Shop the vehicle and meter shall be brought to the Meter Shop on a monthly basis for meter reading and on a quarterly basis for testing of the backflow assembly. Meters mounted at the owner's expense shall have the one year contract expiration waived and shall have meter or backflow changed if either fails.

b) **Floating Meters**: Floating Meters are meters that are not mounted to a vehicle. **(Note: All floating meters shall have an approved backflow assembly attached.)** The customer shall submit an application and a letter explaining the need for a floating meter to the Meter Shop. The Fire Hydrant Meter Administrator, after a thorough review of the needs of the customer, (i.e. number of jobsites per day, City contract work, lack of mounting area on work vehicle, etc.), may issue a floating meter. At the time of issue, it will be necessary for the customer to complete and sign the "Floating Fire Hydrant Meter Agreement" which states the following:

    1) The meter will be brought to the Meter Shop at 2797 Caminito Chollas, San Diego on the third week of each month for the monthly read by Meter Shop personnel.

    2) Every other month the meter will be read and the backflow will be tested. This date will be determined by the start date of the agreement.

If any of the conditions stated above are not met the Meter Shop has the right to cancel the contract for floating meter use and close the account associated with the meter. The Meter Shop will also exercise the right to refuse the issuance of another floating meter to the company in question.

Any Fire Hydrant Meter using reclaimed water shall not be allowed use again with any potable water supply. The customer shall incur the cost of replacing the meter and backflow device in this instance.

7. FEE AND DEPOSIT SCHEDULES

7.1 **Fees and Deposit Schedules:** The fees and deposits, as listed in the Rate Book of Fees and Charges, on file with the Office of the City Clerk, are based on actual reimbursement of costs of services performed, equipment and materials. Theses deposits and fees will be amended, as needed, based on actual costs. Deposits, will be refunded at the end of the use of the fire hydrant meter, upon return of equipment in good working condition and all outstanding balances on account are paid. Deposits can also be used to cover outstanding balances.

All fees for equipment, installation, testing, relocation and other costs related to this program are subject to change without prior notification. The Mayor and Council will be notified of any future changes.

8. UNAUTHORIZED USE OF WATER FROM A HYDRANT

8.1 Use of water from any fire hydrant without a properly issued and installed fire hydrant meter is theft of City property. Customers who use water for unauthorized purposes or without a City of San Diego issued meter will be prosecuted.

8.2 If any unauthorized connection, disconnection or relocation of a fire hydrant meter, or other connection device is made by anyone other than authorized Water Department personnel, the person making the connection will be prosecuted for a violation of San Diego Municipal Code, Section 67.15. In the case of a second offense, the customer's fire hydrant meter shall be confiscated and/or the deposit will be forfeited.

8.3 Unauthorized water use shall be billed to the responsible party. Water use charges shall be based on meter readings, or estimates when meter readings are not available.

8.4 In case of unauthorized water use, the customer shall be billed for all applicable charges as if proper authorization for the water use had been obtained, including but not limited to bi-monthly service charges, installation charges and removal charges.

8.5 If damage occurs to Water Department property (i.e. fire hydrant meter, backflow, various appurtenances), the cost of repairs or replacements will be charged to the customer of record (applicant).

Water Department Director

Tabs: 1. Fire Hydrant Meter Application
2. Construction & Maintenance Related Activities With No Return To Sewer
3. Notice of Discontinuation of Service

APPENDIX

Administering Division: Customer Support Division

Subject Index:
Construction Meters
Fire Hydrant
Fire Hydrant Meter Program
Meters, Floating or Vehicle Mounted
Mobile Meter
Program, Fire Hydrant Meter

Distribution: DI Manual Holders

City of San Diego
PUBLIC UTILITIES
Water & Wastewater

Application for Fire Hydrant Meter (EXHIBIT A)

(For Office Use Only)

NS REQ	FAC#
DATE	BY

METER SHOP (619) 527-7449

Application Date	Requested Install Date:

Meter Information

Fire Hydrant Location: (Attach Detailed Map//Thomas Bros. Map Location or Construction drawing.) Zip:	T.B.	G.B. (CITY USE)
Specific Use of Water:		
Any Return to Sewer or Storm Drain, If so , explain:		
Estimated Duration of Meter Use: ☐ Check Box if Reclaimed Water		

Company Information

Company Name:			
Mailing Address:			
City:	State:	Zip:	Phone: ( )
*Business license#	*Contractor license#		
A Copy of the Contractor's license OR Business License is required at the time of meter issuance.			
Name and Title of Billing Agent: (PERSON IN ACCOUNTS PAYABLE)			Phone: ( )
Site Contact Name and Title:			Phone: ( )
Responsible Party Name:			Title:
Cal ID#			Phone: ( )
Signature:		Date:	

Guarantees Payment of all Charges Resulting from the use of this Meter. Insures that employees of this Organization understand the proper use of Fire Hydrant Meter

☐ Fire Hydrant Meter Removal Request		Requested Removal Date:
Provide Current Meter Location if Different from Above:		
Signature:	Title:	Date:
Phone: ( )	Pager: ( )	

☐ City Meter	☐ Private Meter	
Contract Acct #:	Deposit Amount: $ 936.00	Fees Amount: $ 62.00
Meter Serial #	Meter Size: 05	Meter Make and Style: 6-7
Backflow #	Backflow Size:	Backflow Make and Style:
Name:	Signature:	Date:

WATER USES WITHOUT ANTICIPATED CHARGES FOR RETURN TO SEWER

Auto Detailing
Backfilling
Combination Cleaners (Vactors)
Compaction
Concrete Cutters
Construction Trailers
Cross Connection Testing
Dust Control
Flushing Water Mains
Hydro Blasting
Hydro Seeing
Irrigation (for establishing irrigation only; not continuing irrigation)
Mixing Concrete
Mobile Car Washing
Special Events
Street Sweeping
Water Tanks
Water Trucks
Window Washing

Note:

1. If there is any return to sewer or storm drain, then sewer and/or storm drain fees will be charges.

Date

Name of Responsible Party
Company Name and Address
Account Number:_____

Subject: Discontinuation of Fire Hydrant Meter Service

Dear Water Department Customer:

The authorization for use of Fire Hydrant Meter #_____, located at *(Meter Location Address)* ends in 60 days and will be removed on or after *(Date Authorization Expires)*. Extension requests for an additional 90 days must be submitted in writing for consideration 30 days prior to the discontinuation date. If you require an extension, please contact the Water Department, or mail your request for an extension to:

City of San Diego
Water Department
Attention: Meter Services
2797 Caminito Chollas
San Diego, CA 92105-5097

Should you have any questions regarding this matter, please call the Fire Hydrant Hotline at (619)_____-_____.

Sincerely,

Water Department

APPENDIX C

MATERIALS TYPICALLY ACCEPTED BY CERTIFICATE OF COMPLIANCE

MATERIALS TYPICALLY ACCEPTED BY CERTIFICATE OF COMPLIANCE

1. Soil amendment
2. Fiber mulch
3. PVC or PE pipe up to 16 inch diameter
4. Stabilizing emulsion
5. Lime
6. Preformed elastomeric joint seal
7. Plain and fabric reinforced elastomeric bearing pads
8. Steel reinforced elastomeric bearing pads
9. Waterstops (Special Condition)
10. Epoxy coated bar reinforcement
11. Plain and reinforcing steel
12. Structural steel
13. Structural timber and lumber
14. Treated timber and lumber
15. Lumber and timber
16. Aluminum pipe and aluminum pipe arch
17. Corrugated steel pipe and corrugated steel pipe arch
18. Structural metal plate pipe arches and pipe arches
19. Perforated steel pipe
20. Aluminum underdrain pipe
21. Aluminum or steel entrance tapers, pipe downdrains, reducers, coupling bands and slip joints
22. Metal target plates
23. Paint (traffic striping)
24. Conductors
25. Painting of electrical equipment
26. Electrical components
27. Engineering fabric
28. Portland Cement
29. PCC admixtures
30. Minor concrete, asphalt
31. Asphalt (oil)
32. Liquid asphalt emulsion
33. Epoxy

APPENDIX D

SAMPLE CITY INVOICE WITH CASH FLOW FORECAST

City of San Diego, CM&FS Div., 9753 Chesapeake Drive, SD CA 92123

Project Name:

Work Order No or Job Order No.

City Purchase Order No.

Resident Engineer (RE):

RE Phone#: Fax#:

Contractor's Name:

Contractor's Address:

Contractor's Phone #:

Contractor's fax #:

Contact Name:

Invoice No.

Invoice Date:

Billing Period: (To)

Item #	Item Description	Contract Authorization				Previous Totals To Date		This Estimate		Totals to Date	
		Unit	Price	Qty	Extension	%/QTY	Amount	% / QTY	Amount	% / QTY	Amount
1					$ -		$ -		$ -	0.00	$ -
2					$ -		$ -		$ -	0.00%	$ -
3					$ -		$ -		$ -	0.00%	$ -
4					$ -		$ -		$ -	0.00%	$ -
5					$ -		$ -		$ -	0.00%	$ -
6					$ -		$ -		$ -	0.00%	$ -
7					$ -		$ -		$ -	0.00%	$ -
8					$ -		$ -		$ -	0.00%	$ -
5					$ -		$ -		$ -	0.00%	$ -
6					$ -		$ -		$ -	0.00%	$ -
7					$ -		$ -		$ -	0.00%	$ -
8					$ -		$ -		$ -	0.00%	$ -
9					$ -		$ -		$ -	0.00%	$ -
10					$ -		$ -		$ -	0.00%	$ -
11					$ -		$ -		$ -	0.00%	$ -
12					$ -		$ -		$ -	0.00%	$ -
13					$ -		$ -		$ -	0.00%	$ -
14					$ -		$ -		$ -	0.00%	$ -
15					$ -		$ -		$ -	0.00%	$ -
16					$ -		$ -		$ -	0.00%	$ -
17	**Field Orders**				$ -		$ -		$ -	0.00%	$ -
					$ -		$ -		$ -	0.00%	$ -
	CHANGE ORDER No.				$ -		$ -		$ -	0.00%	$ -
					$ -		$ -		$ -	0.00%	$ -
	Total Authorized Amount (including approved Change Order)				**$ -**		**$ -**		$ -	**Total Billed**	$ -

SUMMARY

A. Original Contract Amount	$ -
B. Approved Change Order #00 Thru #00	$ -
C. Total Authorized Amount (A+B)	$ -
D. Total Billed to Date	$ -
E. Less Total Retention (5% of D)	$ -
F. Less Total Previous Payments	$ -
G. Payment Due Less Retention	**$0.00**
H. Remaining Authorized Amount	$0.00

I certify that the materials have been received by me in the quality and quantity specified

_____

Resident Engineer

_____

Construction Engineer

Retention and/or Escrow Payment Schedule

Total Retention Required as of this billing (Item E)	$0.00
Previous Retention Withheld in PO or in Escrow	$0.00
Add'l Amt to Withhold in PO/Transfer in Escrow:	***$0.00***
Amt to Release to Contractor from PO/Escrow:	

Contractor Signature and Date: _____

NOTE: CONTRACTOR TO CALCULATE TO THE 2ND DECIMAL PLACE.

WBS #:	B18108
Date Submitted:	10/10/2018
NTP Date:	3/23/2018
Final Statement of WD Date:	5/23/2020
Contract #:	K-XX-XXXX-XXX-X
Contract Amount:	$5,617,000

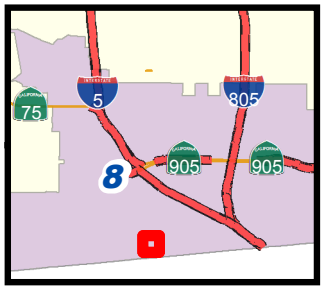
Construction Cash Flow Forecast

"Sewer and Water Group Job 965 (W)"

Year	January	February	March	April	May	June	July	August	September	October	November	December
2018				15,000	25,000	52,000	52,000	100,000	10,000	100,000	100,000	100,000
2019	10,000	10,000	85,000	58,000	100,000	100,000	100,000	100,000	100,000	100,000	1,000,000	1,000,000
2020	100,000	100,000	100,000	1,000,000	1,000,000							
2021												
2022												
2023												
2024												
2025												

APPENDIX E

LOCATION MAP



The City of SAN DIEGO Public Works

SBWRP UV DISINFECTION SYSTEM REPLACEMENT

SENIOR ENGINEER	PROJECT MANAGER	PROJECT ENGINEER	FOR QUESTIONS ABOUT THIS PROJECT
Brian Vitalle	Idalmiro Manuel da Rosa	Jorge A Larriva	Call: 619-533-4207
619-533-5105	619-533-4629	619-533-7405	Email: engineering@sandiego.gov

Legend ● **Project Location**

N
W E

Ultraviolet Disinfection System Replacement Appendix E - Location Map

COMMUNITY NAME: Tijuana River Valley

COUNCIL DISTRICT: 08

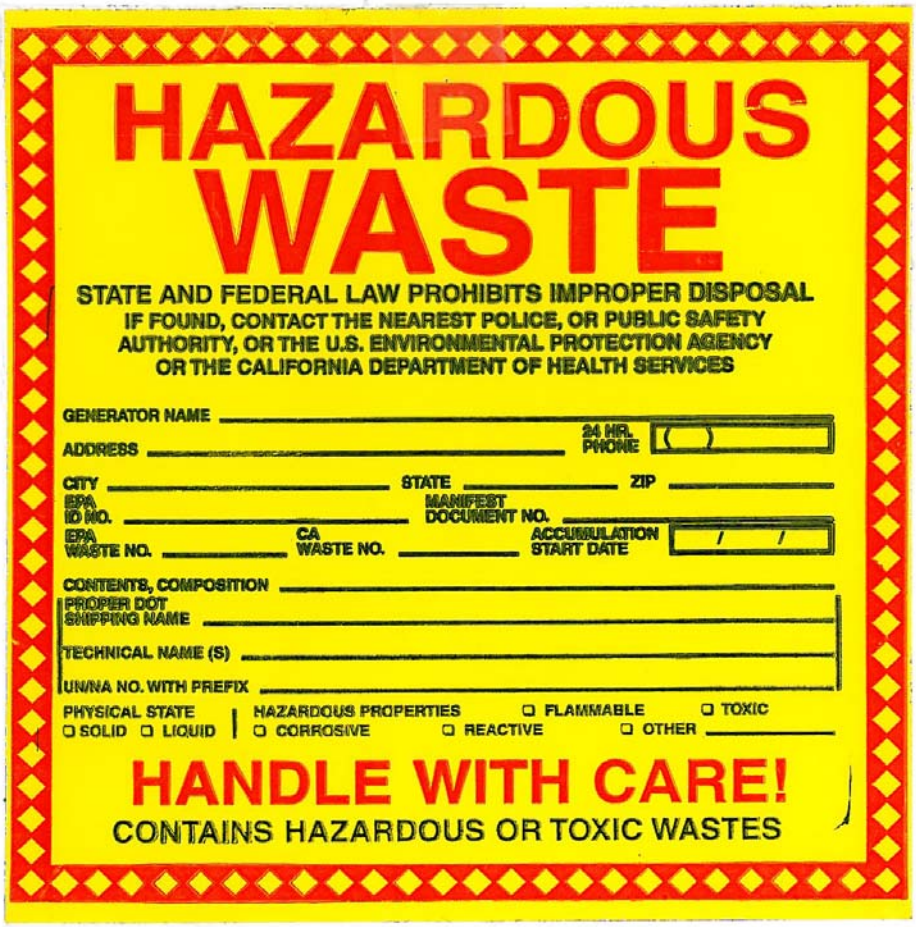
SAP ID: B-18031

Date: December 01, 2017

SanGIS

APPENDIX F

HAZARDOUS LABEL/FORMS


HAZARDOUS
WASTE
STATE AND FEDERAL LAW PROHIBITS IMPROPER DISPOSAL
IF FOUND, CONTACT THE NEAREST POLICE, OR PUBLIC SAFETY
AUTHORITY, OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY
OR THE CALIFORNIA DEPARTMENT OF HEALTH SERVICES
GENERATOR NAME
ADDRESS
24 HR. PHONE
CITY
STATE
ZIP
EPA ID NO.
MANIFEST DOCUMENT NO.
EPA WASTE NO.
CA WASTE NO.
ACCUMULATION START DATE
CONTENTS, COMPOSITION
PROPER DOT SHIPPING NAME
TECHNICAL NAME (S)
UN/NA NO. WITH PREFIX
PHYSICAL STATE
SOLID
LIQUID
HAZARDOUS PROPERTIES
CORROSIVE
FLAMMABLE
REACTIVE
TOXIC
OTHER
HANDLE WITH CARE!
CONTAINS HAZARDOUS OR TOXIC WASTES

INCIDENT/RELEASE ASSESSMENT FORM [1]

If you have an emergency, Call 911

Handlers of hazardous materials are required to report releases. The following is a tool to be used for assessing if a release is reportable. Additionally, a non-reportable release incident form is provided to document why a release is not reported (see back).

Questions for Incident Assessment:	YES	NO
1. Was anyone killed or injured, or did they require medical care or admitted to a hospital for observation?	❒	❒
2. Did anyone, other than employees in the immediate area of the release, evacuate?	❒	❒
3. Did the release cause off-site damage to public or private property?	❒	❒
4. Is the release greater than or equal to a reportable quantity (RQ)?	❒	❒
5. Was there an uncontrolled or unpermitted release to the air?	❒	❒
6. Did an uncontrolled or unpermitted release escape secondary containment, or extend into any sewers, storm water conveyance systems, utility vaults and conduits, wetlands, waterways, public roads, or off site?	❒	❒
7. Will control, containment, decontamination, and/or clean up require the assistance of federal, state, county, or municipal response elements?	❒	❒
8. Was the release or threatened release involving an unknown material or contains an unknown hazardous constituent?	❒	❒
9. Is the incident a threatened release (a condition creating a substantial probability of harm that requires immediate action to prevent, reduce, or mitigate damages to persons, property, or the environment)?	❒	❒
10. Is there an increased potential for secondary effects including fire, explosion, line rupture, equipment failure, or other outcomes that may endanger or cause exposure to employees, the general public, or the environment?	❒	❒

If the answer is YES to any of the above questions – report the release to the California Office of Emergency Services at 800-852-7550 and the local CUPA daytime: (619) 338-2284, after hours: (858) 565-5255. Note: other state and federal agencies may require notification depending on the circumstances.

Call 911 in an emergency

If all answers are NO, complete a Non Reportable Release Incident Form (page 2 of 2) and keep readily available. Documenting why a "no" response was made to each question will serve useful in the event questions are asked in the future, and to justify not reporting to an outside regulatory agency.

If in doubt, report the release.

[1] This document is a guide for accessing when hazardous materials release reporting is required by Chapter 6.95 of the California Health and Safety Code. It does not replace good judgment, Chapter 6.95, or other state or federal release reporting requirements.

NON REPORTABLE RELEASE INCIDENT FORM

1. RELEASE AND RESPONSE DESCRIPTION Incident #_____

Date/Time Discovered	Date/Time Discharge	Discharge Stopped ☐ Yes ☐ No
Incident Date / Time:		
Incident Business / Site Name:		
Incident Address:		
Other Locators (Bldg, Room, Oil Field, Lease, Well #, GIS)		
Please describe the incident and indicate specific causes and area affected. Photos Attached?: ☐Yes ☐No		
Indicate actions to be taken to prevent similar releases from occurring in the future.		

2. ADMINISTRATIVE INFORMATION

Supervisor in charge at time of incident:	Phone:
Contact Person:	Phone:

3. CHEMICAL INFORMATION

Chemical	Quantity ☐ GAL ☐ LBS ☐ FT^3
Chemical	Quantity ☐ GAL ☐ LBS ☐ FT^3
Chemical	Quantity ☐ GAL ☐ LBS ☐ FT^3
Clean-Up Procedures & Timeline:	
Completed By:	Phone:
Print Name:	Title:

EMERGENCY RELEASE FOLLOW - UP NOTICE REPORTING FORM

A

BUSINESS NAME	FACILITY EMERGENCY CONTACT & PHONE NUMBER ( ) -

B

INCIDENT DATE MO DAY YR	TIME OES NOTIFIED (use 24 hr time)	OES CONTROL NO.

C

INCIDENT ADDRESS LOCATION	CITY / COMMUNITY	COUNTY ZIP

D

CHEMICAL OR TRADE NAME (print or type)	CAS Number

CHECK IF CHEMICAL IS LISTED IN 40 CFR 355, APPENDIX A ☐	CHECK IF RELEASE REQUIRES NOTIFI - CATION UNDER 42 U.S.C. Section 9603 (a) ☐

PHYSICAL STATE CONTAINED ☐ SOLID ☐ LIQUID ☐ GAS	PHYSICAL STATE RELEASED ☐ SOLID ☐ LIQUID ☐ GAS	QUANTITY RELEASED

ENVIRONMENTAL CONTAMINATION ☐ AIR ☐ WATER ☐ GROUND ☐ OTHER	TIME OF RELEASE	DURATION OF RELEASE ___DAYS ___HOURS ___MINUTES

E

ACTIONS TAKEN

F

KNOWN OR ANTICIPATED HEALTH EFFECTS (Use the comments section for addition information)

☐ ACUTE OR IMMEDIATE (explain) _____

☐ CHRONIC OR DELAYED (explain) _____

☐ NOTKNOWN (explain)

G

ADVICE REGARDING MEDICAL ATTENTION NECESSARY FOR EXPOSED INDIVIDUALS

H

COMMENTS (INDICATE SECTION (A - G) AND ITEM WITH COMMENTS OR ADDITIONAL INFORMATION)

I

CERTIFICATION: I certify under penalty of law that I have personally examined and I am familiar with the information submitted and believe the submitted information is true, accurate, and complete.

REPORTING FACILITY REPRESENTATIVE (print or type) _____

SIGNATURE OF REPORTING FACILITY REPRESENTATIVE _____ DATE: _____

EMERGENCY RELEASE FOLLOW-UP NOTICE
REPORTING FORM INSTRUCTIONS

GENERAL INFORMATION:

Chapter 6.95 of Division 20 of the California Health and Safety Code requires that written emergency release follow-up notices prepared pursuant to 42 U.S.C. § 11004, be submitted using this reporting form. Non-permitted releases of reportable quantities of Extremely Hazardous Substances (listed in 40 CFR 355, appendix A) or of chemicals that require release reporting under section 103(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [42 U.S.C. § 9603(a)] must be reported on the form, as soon as practicable, but no later than 30 days, following a release. The written follow-up report is required in addition to the verbal notification.

BASIC INSTRUCTIONS:

- The form, when filled out, reports follow-up information required by 42 U.S.C § 11004. Ensure that all information requested by the form is provided as completely as possible.
- If the incident involves reportable releases of more than one chemical, prepare one report form for each chemical released.
- If the incident involves a series of separate releases of chemical(s) at different times, the releases should be reported on separate reporting forms.

SPECIFIC INSTRUCTIONS:

Block A: Enter the name of the business and the name and phone number of a contact person who can provide detailed facility information concerning the release.

Block B: Enter the date of the incident and the time that verbal notification was made to OES. The OES control number is provided to the caller by OES at the time verbal notification is made. Enter this control number in the space provided.

Block C: Provide information pertaining to the location where the release occurred. Include the street address, the city or community, the county and the zip code.

Block D: Provide information concerning the specific chemical that was released. Include the chemical or trade name and the Chemical Abstract Service (CAS) number. Check all categories that apply. Provide best available information on quantity, time and duration of the release.

Block E: Indicate all actions taken to respond to and contain the release as specified in 42 U.S.C. § 11004(c).

Block F: Check the categories that apply to the health effects that occurred or could result from the release. Provide an explanation or description of the effects in the space provided. Use Block H for additional comments/information if necessary to meet requirements specified in 42 U.S.C. § 11004(c).

Block G: Include information on the type of medical attention required for exposure to the chemical released. Indicate when and how this information was made available to individuals exposed and to medical personnel, if appropriate for the incident, as specified in 42 U.S.C. § 11004(c).

Block H: List any additional pertinent information.

Block I: Print or type the name of the facility representative submitting the report. Include the official signature and the date that the form was prepared.

MAIL THE COMPLETED REPORT TO:

State Emergency Response Commission (SERC)
Attn: Section 304 Reports
Hazardous Materials Unit
3650 Schriever Avenue
Mather, CA 95655

NOTE: Authority cited: Sections 25503, 25503.1 and 25507.1, Health and Safety Code. Reference: Sections 25503(b)(4), 25503.1, 25507.1, 25518 and 25520, Health and Safety Code.

ATTACHMENT F

RESERVED

ATTACHMENT G

CONTRACT AGREEMENT

CONTRACT AGREEMENT

CONSTRUCTION CONTRACT

This contract is made and entered into between THE CITY OF SAN DIEGO, a municipal corporation, herein called "City", and J.R. Filanc Construction Company, Inc., herein called "Contractor" for construction of **Ultraviolet Disinfection System Replacement**; **Bid No. K-19-1809-DBB-3**; in the amount of Three Million Three Hundred Ninety-One Thousand Six Hundred Thirty-Six Dollars and Zero Cents ($3,391,636.00), which is comprised of the Base Bid.

IN CONSIDERATION of the payments to be made hereunder and the mutual undertakings of the parties hereto, City and Contractor agree as follows:

1. The following are incorporated into this contract as though fully set forth herein:

   (a) The attached Faithful Performance and Payment Bonds.

   (b) The attached Proposal included in the Bid documents by the Contractor.

   (c) Reference Standards listed in the Instruction to Bidders and the Supplementary Special Provisions (SSP).

   (d) Phased Funding Schedule Agreement.

   (e) That certain documents entitled **Ultraviolet Disinfection System Replacement**, on file in the office of the Public Works Department as Document No. **B-18031**, as well as all matters referenced therein.

2. The Contractor shall perform and be bound by all the terms and conditions of this contract and in strict conformity therewith shall perform and complete in a good and workmanlike manner **Ultraviolet Disinfection System Replacement**, Bid Number **K-19-1809-DBB-3,** San Diego, California.

3. For such performances, the City shall pay to Contractor the amounts set forth at the times and in the manner and with such additions or deductions as are provided for in this contract, and the Contractor shall accept such payment in full satisfaction of all claims incident to such performances.

4. No claim or suit whatsoever shall be made or brought by Contractor against any officer, agent, or employee of the City for or on account of anything done or omitted to be done in connection with this contract, nor shall any such officer, agent, or employee be liable hereunder.

5. This contract is effective as of the date that the Mayor or designee signs the agreement.

CONTRACT AGREEMENT (continued)

IN WITNESS WHEREOF, this Agreement is signed by the City of San Diego, acting by and through its Mayor or designee, pursuant to Municipal Code §22.3102 authorizing such execution.

THE CITY OF SAN DIEGO

By _____

Print Name: Stephen Samara
Principal Contract Specialist
Public Works Department

Date: 7/12/2019

APPROVED AS TO FORM

Mara W. Elliott, City Attorney

By _____

Print Name: Mark M. Mercer
Deputy City Attorney

Date: 7/16/19

CONTRACTOR

By _____

Print Name: David J. Kiess

Title: Vice President

Date: 5/16/2019

City of San Diego License No.: B1194000641

State Contractor's License No.: 134877

DEPARTMENT OF INDUSTRIAL RELATIONS (DIR) REGISTRATION NUMBER: 1000001631

CERTIFICATIONS AND FORMS

The Bidder, by submitting its electronic bid, agrees to and certifies under penalty of perjury under the laws of the State of California, that the certifications, forms and affidavits submitted as part of this bid are true and correct.

BIDDER'S GENERAL INFORMATION

To the City of San Diego:

Pursuant to "Notice Inviting Bids", specifications, and requirements on file with the City Clerk, and subject to all provisions of the Charter and Ordinances of the City of San Diego and applicable laws and regulations of the United States and the State of California, the undersigned hereby proposes to furnish to the City of San Diego, complete at the prices stated herein, the items or services hereinafter mentioned. The undersigned further warrants that this 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 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 or 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.

The undersigned bidder(s) further warrants that bidder(s) has thoroughly examined and understands the entire Contract Documents (plans and specifications) and the Bidding Documents therefore, and that by submitting said Bidding Documents as its bid proposal, bidder(s) acknowledges and is bound by the entire Contract Documents, including any addenda issued thereto, as such Contract Documents incorporated by reference in the Bidding Documents.

NON-COLLUSION AFFIDAVIT TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID UNDER 23 UNITED STATES CODE 112 AND PUBLIC CONTRACT CODE 7106

State of California

County of San Diego

The bidder, being first duly sworn, deposes and says that he or she is authorized by 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 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 or 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.

CONTRACTOR CERTIFICATION

DRUG-FREE WORKPLACE

I hereby certify that I am familiar with the requirements of San Diego City Council Policy No. 100-17 regarding Drug-Free Workplace as outlined in the WHITEBOOK, Section 5-1.3, "Drug-Free Workplace", of the project specifications, and that;

This company has in place a drug-free workplace program that complies with said policy. I further certify that each subcontract agreement for this project contains language which indicates the subcontractor's agreement to abide by the provisions of subdivisions a) through c) of the policy as outlined.

CONTRACTOR CERTIFICATION

AMERICANS WITH DISABILITIES ACT (ADA) COMPLIANCE CERTIFICATION

I hereby certify that I am familiar with the requirements of San Diego City Council Policy No. 100-4 regarding the American With Disabilities Act (ADA) outlined in the WHITEBOOK, Section 5-1.2, "American With Disabilities Act", of the project specifications, and that:

This company has in place workplace program that complies with said policy. I further certify that each subcontract agreement for this project contains language which indicates the subcontractor's agreement to abide by the provisions of the policy as outlined.

CONTRACTOR CERTIFICATION

CONTRACTOR STANDARDS – PLEDGE OF COMPLIANCE

I declare under penalty of perjury that I am authorized to make this certification on behalf of the company submitting this bid/proposal, that as Contractor, I am familiar with the requirements of City of San Diego Municipal Code § 22.3004 regarding Contractor Standards as outlined in the WHITEBOOK, Section 5-1.4, ("Contractor Standards"), of the project specifications, and that Contractor has complied with those requirements.

I further certify that each of the Contractor's subcontractors has completed a Pledge of Compliance attesting under penalty of perjury of having complied with City of San Diego Municipal Code § 22.3004.

CONTRACTOR CERTIFICATION

EQUAL BENEFITS ORDINANCE CERTIFICATION

I declare under penalty of perjury that I am familiar with the requirements of and in compliance with the City of San Diego Municipal Code § 22.4300 regarding Equal Benefits Ordinance.

CONTRACTOR CERTIFICATION

EQUAL PAY ORDINANCE CERTIFICATION

Contractor shall comply with the Equal Pay Ordinance (EPO) codified in the San Diego Municipal Code (SDMC) at section 22.4801 through 22.4809, unless compliance is not required based on an exception listed in SDMC section 22.4804.

Contractor shall require all of its subcontractors to certify compliance with the EPO in their written subcontracts.

Contractor must post a notice informing its employees of their rights under the EPO in the workplace or job site.

By signing this Contract with the City of San Diego, Contractor acknowledges the EPO requirements and pledges ongoing compliance with the requirements of SDMC Division 48, section 22.4801 et seq., throughout the duration of this Contract.

AFFIDAVIT OF DISPOSAL

(To be submitted upon completion of Construction pursuant to the contracts Certificate of Completion)

WHEREAS, on the _____ DAY OF _____, 2_____ the undersigned entered into and executed a contract with the City of San Diego, a municipal corporation, for:

ULTRAVIOLET DISINFECTION SYSTEM REPLACEMENT
(Project Title)

as particularly described in said contract and identified as Bid No. **K-19-1809-DBB-3**; SAP No. (WBS/IO/CC) **B-18031**; and **WHEREAS**, the specification of said contract requires the Contractor to affirm that "all brush, trash, debris, and surplus materials resulting from this project have been disposed of in a legal manner"; and **WHEREAS**, said contract has been completed and all surplus materials disposed of:

_____

_____

NOW, THEREFORE, in consideration of the final payment by the City of San Diego to said Contractor under the terms of said contract, the undersigned Contractor, does hereby affirm that all surplus materials as described in said contract have been disposed of at the following location(s)

_____

_____

and that they have been disposed of according to all applicable laws and regulations.

Dated this _____ DAY OF _____, _____.

By:_____
Contractor

ATTEST:

State of _____ County of _____

On this_____ DAY OF _____, 2_____, before the undersigned, a Notary Public in and for said County and State, duly commissioned and sworn, personally appeared_____ known to me to be the _____ Contractor named in the foregoing Release, and whose name is subscribed thereto, and acknowledged to me that said Contractor executed the said Release.

Notary Public in and for said County and State

LIST OF SUBCONTRACTORS

***** PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY *** TO BE SUBMITTED IN ELECTRONIC FORMAT ONLY *** SEE INSTRUCTIONS TO BIDDERS FOR FURTHER INFORMATION**

In accordance with the requirements of the "Subletting and Subcontracting Fair Practices Act", Section 4100, of the California Public Contract Code (PCC), the Bidder is to list below the name, address and license number of each Subcontractor who will perform work, labor, render services or specially fabricate and install a portion [type] of the work or improvement, in an amount of or in excess of 0.5% of the Contractor's total Bid. Failure to comply with this requirement may result in the Bid being rejected as non-responsive. The Contractor is to list only one Subcontractor for each portion of the Work. The Bidder's attention is directed to the Special Provisions - General; Paragraph 2-3 Subcontracts, which stipulates the percentage of the Work to be performed with the Bidder's own forces. The Bidder is to also list all SLBE, ELBE, DBE, DVBE, MBE, WBE, OBE, SDB, WoSB, HUBZone, and SDVOSB Subcontractors for which the Bidders are seeking recognition towards achieving any mandatory, voluntary, or both subcontracting participation percentages.

NAME, ADDRESS AND TELEPHONE NUMBER OF SUBCONTRACTOR	CONSTRUCTOR OR DESIGNER	DIR Registration Number	SUBCONTRACTOR LICENSE NUMBER	TYPE OF WORK	DOLLAR VALUE OF SUBCONTRACT	MBE, WBE, DBE, DVBE, OBE, ELBE, SLBE, SDB, WoSB, HUBZone, OR SDVOSB①	WHERE CERTIFIED ②	CHECK IF JOINT VENTURE PARTNERSHIP
Name:_____ Address:_____ City:_____ State:_____ Zip:_____ Phone:_____ Email:_____								
Name:_____ Address:_____ City:_____ State:_____ Zip:_____ Phone:_____ Email:_____								

① As appropriate, Bidder shall identify Subcontractor as one of the following and shall include a valid proof of certification (except for OBE, SLBE and ELBE):

Certified Minority Business Enterprise	MBE	Certified Woman Business Enterprise	WBE
Certified Disadvantaged Business Enterprise	DBE	Certified Disabled Veteran Business Enterprise	DVBE
Other Business Enterprise	OBE	Certified Emerging Local Business Enterprise	ELBE
Certified Small Local Business Enterprise	SLBE	Small Disadvantaged Business	SDB
Woman-Owned Small Business	WoSB	HUBZone Business	HUBZone
Service-Disabled Veteran Owned Small Business	SDVOSB		

② As appropriate, Bidder shall indicate if Subcontractor is certified by:

City of San Diego	CITY	State of California Department of Transportation	CALTRANS
California Public Utilities Commission	CPUC		
State of California's Department of General Services	CADoGS	City of Los Angeles	LA
State of California	CA	U.S. Small Business Administration	SBA

The Bidder will not receive any subcontracting participation percentages if the Bidder fails to submit the required proof of certification.

NAMED EQUIPMENT/MATERIAL SUPPLIER LIST

***** PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY *** TO BE SUBMITTED IN ELECTRONIC FORMAT ONLY *** SEE INSTRUCTIONS TO BIDDERS FOR FURTHER INFORMATION**

NAME, ADDRESS AND TELEPHONE NUMBER OF VENDOR/SUPPLIER	MATERIALS OR SUPPLIES	DIR Registration Number	DOLLAR VALUE OF MATERIAL OR SUPPLIES	SUPPLIER (Yes/No)	MANUFACTURER (Yes/No)	MBE, WBE, DBE, DVBE, OBE, ELBE, SLBE, SDB, WoSB, HUBZone, OR SDVOSB①	WHERE CERTIFIED②
Name:_____ Address:_____ City:_____ State:_____ Zip:_____ Phone:_____ Email:_____							
Name:_____ Address:_____ City:_____ State:_____ Zip:_____ Phone:_____ Email:_____							

① As appropriate, Bidder shall identify Vendor/Supplier as one of the following and shall include a valid proof of certification (except for OBE,SLBE and ELBE):

Certified Minority Business Enterprise	MBE	Certified Woman Business Enterprise	WBE
Certified Disadvantaged Business Enterprise	DBE	Certified Disabled Veteran Business Enterprise	DVBE
Other Business Enterprise	OBE	Certified Emerging Local Business Enterprise	ELBE
Certified Small Local Business Enterprise	SLBE	Small Disadvantaged Business	SDB
Woman-Owned Small Business	WoSB	HUBZone Business	HUBZone
Service-Disabled Veteran Owned Small Business	SDVOSB		

② As appropriate, Bidder shall indicate if Vendor/Supplier is certified by:

City of San Diego	CITY	State of California Department of Transportation	CALTRANS
California Public Utilities Commission	CPUC		
State of California's Department of General Services	CADoGS	City of Los Angeles	LA
State of California	CA	U.S. Small Business Administration	SBA

The Bidder will not receive any subcontracting participation percentages if the Bidder fails to submit the required proof of certification.

ELECTRONICALLY SUBMITTED FORMS

THE FOLLOWING FORMS MUST BE SUBMITTED IN PDF FORMAT WITH BID SUBMISSION

The following forms are to be completed by the bidder and submitted (uploaded) electronically with the bid in PlanetBids.

A. **BID BOND – See Instructions to Bidders, Bidders Guarantee of Good Faith (Bid Security) for further instructions**

B. **CONTRACTOR'S CERTIFICATION OF PENDING ACTIONS**

C. **MANDATORY DISCLOSURE OF BUSINESS INTERESTS FORM**

D. **SUBCONTRACTOR LISTING (OTHER THAN FIRST TIER)**

Bids will not be accepted until ALL the above-named forms are submitted as part of the bid submittal

BID BOND

See Instructions to Bidders, Bidder Guarantee of Good Faith
(Bid Security)

KNOW ALL MEN BY THESE PRESENTS,

That J.R. Filanc Construction Company, Inc. as Principal, and Everest Reinsurance Company as Surety, are held and firmly bound unto The City of San Diego hereinafter called "OWNER," in the sum of **10% OF THE TOTAL BID AMOUNT** for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, said Principal has submitted a Bid to said OWNER to perform the WORK required under the bidding schedule(s) of the OWNER's Contract Documents entitled

ULTRAVIOLET DISINFECTION SYSTEM REPLACEMENT, BID NO. K-19-1809-DBB-3

NOW THEREFORE, if said Principal is awarded a contract by said OWNER and, within the time and in the manner required in the "Notice Inviting Bids" enters into a written Agreement on the form of agreement bound with said Contract Documents, furnishes the required certificates of insurance, and furnishes the required Performance Bond and Payment Bond, then this obligation shall be null and void, otherwise it shall remain in full force and effect. In the event suit is brought upon this bond by said OWNER and OWNER prevails, said Surety shall pay all costs incurred by said OWNER in such suit, including a reasonable attorney's fee to be fixed by the court.

SIGNED AND SEALED, this 25th day of April, 20 19

J.R. Filanc Construction Company, Inc. (SEAL)
(Principal)

By: _____
(Signature)

Everest Reinsurance Company (SEAL)
(Surety)

By: _____
(Signature)
Lawrence F. McMahon, Attorney-in-Fact

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

Civil Code § 1189

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document, to which this certificate is attached, and not the truthfulness, accuracy or validity of that document.

STATE OF CALIFORNIA

County of San Diego }

On APR 25 2019 (Date) before me, Rachel A. Mullen (Insert Name of Notary exactly as it appears on the official seal), Notary Public,

personally appeared Lawrence F. McMahon (Name(s) of Signer(s))

,

who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

Witness my hand and official seal.

Signature Rachel A. Mullen (Signature of Notary Public) Rachel A. Mullen

RACHEL A. MULLEN
Notary Public - California
San Diego County
Commission # 2181212
My Comm. Expires Jan 23, 2021

Place Notary Seal Above

OPTIONAL

Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of the form to another document.

Description of Attached Document

Title or Type of Document: _____

Document Date: _____ Number of Pages: _____

Signer(s) Other Than Named Above: _____

Capacity(ies) Claimed by Signer(s)

Signer's Name: _____
- ☐ Individual
- ☐ Corporate Officer — Title(s): _____
- ☐ Partner ☐ Limited ☐ General
- ☑ Attorney in Fact
- ☐ Trustee
- ☐ Guardian or Conservator
- ☐ Other: _____

Signer is Representing:
Surety Company

RIGHT THUMBPRINT OF SIGNER
Top of thumb here

Signer's Name: _____
- ☐ Individual
- ☐ Corporate Officer — Title(s): _____
- ☐ Partner ☐ Limited ☐ General
- ☐ Attorney in Fact
- ☐ Trustee
- ☐ Guardian or Conservator
- ☐ Other: _____

Signer is Representing:

RIGHT THUMBPRINT OF SIGNER
Top of thumb here

EVEREST.

ES046R10170

POWER OF ATTORNEY
EVEREST REINSURANCE COMPANY
DELAWARE

KNOW ALL PERSONS BY THESE PRESENTS: That Everest Reinsurance Company, a corporation of the State of Delaware ("Company") having its principal office located at 477 Martinsville Road, Liberty Corner, New Jersey 07938, do hereby nominate, constitute, and appoint:

Lawrence F. McMahon, Ryan E. Warnock, Christopher Conte, Sarah Myers, Rachel A. Mullen, Janice Martin

its true and lawful Attorney(s)-in-fact to make, execute, attest, seal and deliver for and on its behalf, as surety, and as its act and deed, where required, any and all bonds and undertakings in the nature thereof, for the penal sum of no one of which is in any event to exceed UNLIMITED, reserving for itself the full power of substitution and revocation.

Such bonds and undertakings, when duly executed by the aforesaid Attorney(s)-in-fact shall be binding upon the Company as fully and to the same extent as if such bonds and undertakings were signed by the President and Secretary of the Company and sealed with its corporate seal.

This Power of Attorney is granted and is signed by facsimile under and by the authority of the following Resolutions adopted by the Board of Directors of Company ("Board") on the 28th day of July 2016:

***RESOLVED**, that the President, any Executive Vice President, and any Senior Vice President and Anthony Romano are hereby appointed by the Board as authorized to make, execute, seal and deliver for and on behalf of the Company, any and all bonds, undertakings, contracts or obligations in surety or co-surety with others and that the Secretary or any Assistant Secretary of the Company be and that each of them hereby is authorized to attest to the execution of any such bonds, undertakings, contracts or obligations in surety or co-surety and attach thereto the corporate seal of the Company.*

***RESOLVED, FURTHER**, that the President, any Executive Vice President, and any Senior Vice President and Anthony Romano are hereby authorized to execute powers of attorney qualifying the attorney named in the given power of attorney to execute, on behalf of the Company, bonds and undertakings in surety or co-surety with others, and that the Secretary or any Assistant Secretary of the Company be, and that each of them is hereby authorized to attest the execution of any such power of attorney, and to attach thereto the corporate seal of the Company.*

***RESOLVED, FURTHER**, that the signature of such officers named in the preceding resolutions and the corporate seal of the Company may be affixed to such powers of attorney or to any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signatures or facsimile seal shall be thereafter valid and binding upon the Company with respect to any bond, undertaking, contract or obligation in surety or co-surety with others to which it is attached.*

IN WITNESS WHEREOF, Everest Reinsurance Company has caused their corporate seals to be affixed hereto, and these presents to be signed by their duly authorized officers this 28th day of July 2016.

Everest Reinsurance Company

Attest: Nicole Chase, Assistant Secretary

By: Anthony Romano, Vice President

On this 28th day of July 2016, before me personally came Anthony Romano, known to me, who, being duly sworn, did execute the above instrument; that he knows the seal of said Company; that the seal affixed to the aforesaid instrument is such corporate seal and was affixed thereto; and that he executed said instrument by like order.

LINDA ROBINS
Notary Public, State of New York
No 01R06239736
Qualified in Queens County
Term Expires April 25, 2023

Linda Robins, Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Company, at the Liberty Corner, this _____ day of _____ 20____.

APR 25 2019

ES 00 01 04 16

Bond #04546 contains a security pantograph, blue background, heat-sensitive ink, coin-reactive watermark, and microtext printing on border.

HEAT SENSITIVE SHIELD • FADES WITH HEAT OR TOUCH

CONTRACTOR'S CERTIFICATION OF PENDING ACTIONS

As part of its bid or proposal (Non-Price Proposal in the case of Design-Build contracts), the Bidder shall provide to the City a list of all instances within the past 10 years where a complaint was filed or pending against the Bidder in a legal or administrative proceeding alleging that Bidder discriminated against its employees, subcontractors, vendors or suppliers, and a description of the status or resolution of that complaint, including any remedial action taken.

CHECK ONE BOX ONLY.

☑ The undersigned certifies that within the past 10 years the Bidder has NOT been the subject of a complaint or pending action in a legal administrative proceeding alleging that Bidder discriminated against its employees, subcontractors, vendors or suppliers.

☐ The undersigned certifies that within the past 10 years the Bidder has been the subject of a complaint or pending action in a legal administrative proceeding alleging that Bidder discriminated against its employees, subcontractors, vendors or suppliers. A description of the status or resolution of that complaint, including any remedial action taken and the applicable dates is as follows:

DATE OF CLAIM	LOCATION	DESCRIPTION OF CLAIM	LITIGATION (Y/N)	STATUS	RESOLUTION/REMEDIAL ACTION TAKEN

Contractor Name: J.R. FILANC CONSTRUCTION CO., INC.

Certified By DAVID J. KIESS (Name) Title VICE PRESIDENT

(Signature) Date 4/30/2019

USE ADDITIONAL FORMS AS NECESSARY

Mandatory Disclosure of Business Interests Form

BIDDER/PROPOSER INFORMATION

Legal Name J.R. FILANC CONSTRUCTION CO., INC. DBA

Street Address 740 N. ANDREASEN DR. City ESCONDIDO State CA. Zip 92029

Contact Person, Title DAVID J. KIESS, VICE PRES. Phone 760-941-7130 Fax 760-466-0470

Provide the name, identity, and precise nature of the interest* of all persons who are directly or indirectly involved** in this proposed transaction (SDMC § 21.0103).

* The precise nature of the interest includes:

- the percentage ownership interest in a party to the transaction,
- the percentage ownership interest in any firm, corporation, or partnership that will receive funds from the transaction,
- the value of any financial interest in the transaction,
- any contingent interest in the transaction and the value of such interest should the contingency be satisfied, and
- any philanthropic, scientific, artistic, or property interest in the transaction.

** Directly or indirectly involved means pursuing the transaction by:

- communicating or negotiating with City officers or employees,
- submitting or preparing applications, bids, proposals or other documents for purposes of contracting with the City, or
- directing or supervising the actions of persons engaged in the above activity.

Name SEE ATTACHMENT "A" Title/Position

City and State of Residence Employer (if different than Bidder/Proposer)

Interest in the transaction

Name Title/Position

City and State of Residence Employer (if different than Bidder/Proposer)

Interest in the transaction

*** Use Additional Pages if Necessary ***

Under penalty of perjury under the laws of the State of California, I certify that I am responsible for the completeness and accuracy of the responses contained herein, and that all information provided is true, full and complete to the best of my knowledge and belief. I agree to provide written notice to the Mayor or Designee within five (5) business days if, at any time, I learn that any portion of this Mandatory Disclosure of Business Interests Form requires an updated response. Failure to timely provide the Purchasing Agent with written notice is grounds for Contract termination.

DAVID J. KIESS, VICE PRES. (Print Name, Title) — Signature — 4/30/2019 (Date)

Failure to sign and submit this form with the bid/proposal shall make the bid/proposal non-responsive. In the case of an informal solicitation, the contract will not be awarded unless a signed and completed Mandatory Disclosure of Business Interests Form is submitted.

J.R. Filanc Construction Company, Inc.

Attachment A

Name(s) of Member of Firm or Office of Corporation directly or indirectly involved in this transaction	City and State of Residence	Employer (if different than Bidder/Proposer)	Interest in Transaction
Mark E. Filanc - Chief Executive Officer	Del Mar, CA	n/a	Executive Officer
Omar Rodea - President	Carlsbad, CA	n/a	Executive Officer
Vincent L. Diaz - Vice President	Fallbrook, CA	n/a	Executive Officer
Norbert J. Schulz - Vice President	Del Mar, CA	n/a	Executive Officer
Robert W. Zaiser - Vice President	Cardiff, CA	n/a	Executive Officer
Gary Silverman – Vice President	Del Mar, CA	n/a	Executive Officer
Linda Stangel - Secretary	Escondido, CA	n/a	Executive Officer
David J. Kiess - Assistant Secretary and Vice President	Carlsbad, CA	n/a	Executive Officer

SUBCONTRACTOR LISTING
(OTHER THAN FIRST TIER)

Pursuant to California Senate Bill 96 and in accordance with the requirements of Labor Code sections 1771.1 and 1725.5, by submitting a bid or proposal to the City, Contractor is certifying that he or she has verified that all subcontractors used on this public work project are registered with the California Department of Industrial Relations (DIR). **The Bidder is to list below the name, address, license number, DIR registration number of any (known tiered subcontractor)** - who will perform work, labor, render services or specially fabricate and install a portion [type] of the work or improvement pursuant to the contract. **If none are known at this time, mark the table below with non-applicable (N/A).**

NAME, ADDRESS AND TELEPHONE NUMBER OF SUBCONTRACTOR	CONSTRUCTOR OR DESIGNER	DIR REGISTRATION NUMBER	SUBCONTRACTOR LICENSE NUMBER	TYPE OF WORK
Name: N/A Address: City: State: Zip: Phone: Email:	N/A	N/A	N/A	N/A
Name: Address: City: State: Zip: Phone: Email:				
Name: Address: City: State: Zip: Phone: Email:				
Name: Address: City: State: Zip: Phone: Email:				

**** USE ADDITIONAL FORMS AS NECESSARY ****

City of San Diego

CITY CONTACT: Antoinette Sanfilippo, **Contract Specialist**, **Email:** ASanfilippo@sandiego.gov
Phone No. (619) 533-3439

ADDENDUM A

e - Bidding

FOR

ULTRAVIOLET DISINFECTION SYSTEM REPLACEMENT

BID NO.:	**K-19-1809-DBB-3**
SAP NO. (WBS/IO/CC):	**B-18031**
CLIENT DEPARTMENT:	**2000**
COUNCIL DISTRICT:	**8**
PROJECT TYPE:	**BO**

BID DUE DATE:

2:00 PM
MAY 2, 2019

CITY OF SAN DIEGO'S ELECTRONIC BIDDING SITE, PLANETBIDS

http://www.sandiego.gov/cip/bidopps/index.shtml

ENGINEER OF WORK

The engineering Specifications and Special Provisions contained herein have been prepared by or under the direction of the following Registered Engineer:

Amritendu Maji 4/23/2019
1) Registered Engineer Date Seal:

Brian Vitelle 4/23/19
2) For City Engineer Date Seal:

A. CHANGES TO CONTRACT DOCUMENTS

The following changes to the Contract Documents are hereby made effective as though originally issued with the bid package. Bidders are reminded that all previous requirements to this solicitation remain in full force and effect.

B. BIDDER's QUESTIONS

Q1. **Specification Section 11300, Paragraph 2.2K 8 and 9**. Electrical supplely for the water level sensor shall be provided by the Level Control Panel and be 12VDC. The electrical supply to the Level Control Panel shall be 120V, 1 phase, 2 wire + GND, 60Hz, 0.12kVA. Please adjust spec to account for this.

A1. It will be addressed during shop drawing review.

Q2. **Specification Section 11300, Paragraph 3.2A.** Does this mean onsite assistance is required? If onsite assistance is required, please clarify so the UV Vendor can account for it.

A2. ADD: to **Specification Section 11300*, Paragraph 3.2A.*** For bidding purposes, a minimum of two days for a total of twenty hours of field help shall be considered.

Q3. **Specification Section 11293, Paragraph 2.2.** Please confirm we can use the downward opening gate configuration (flow over weir).

A3. ADD: to **Specification Section 11293, Paragraph 2.2, 10.** For this project a downward opening gate configuration (flow over weir) shall be used.

Q4. **Specification Section 16050, Paragraph 2.3.B2.** Do specified wire colors apply to internal wiring on the UV vendor panels?

A4. ADD: to **Specification Section 16050, Paragraph 2.4, B2.** After the last sentence of the last paragraph "The specified wire colors do not apply to internal wiring on the UV vendor panels."

Q5. **Drawings M-2.** MWG Low Setpoint to be 52.94'. The Regulated water level should be 55.29'.

A5. This item will be addressed during shop drawing review when the vendor will fine-tune their hydraulic calculations and submit it with the shop drawing.

C. ATTACHMENTS

1. To Attachment A, Scope of Work, Item 3, Contract Time, page 21, **DELETE** in its entirety and **SUBSTITUTE** with the following:

   3. CONTRACT TIME: The Contract Time for completion of the Work shall be **366 Calendar Days.**

D. SUPPLEMENTARY SPECIAL PROVISIONS

1. To Technicals, SECTION 02100 – SITE PREPARATION, PART 3 – EXECUTION, Section 3.1, GENERAL, Sub-section A, Existing Conditions, **DELETE** in its entirety and **ADD** the following:

   A. **Existing Conditions:** The site shall be examined and the CONSTRUCTION MANAGER notified of any conditions which affect the WORK of this Section. Access to the existing trailer located west of the roadway adjacent to the UV tertiary basin shall be maintained at all times. The CONTRACTOR shall not place any items close to the trailers, which will impede the City personnel from opening the trailer gates and accessing the trailers.

E. PLANS

1. To the Sheet Drawings 40775-01-D and 40775-04-D, **DELETE** in their entirety and **REPLACE** with pages 5 and 6 of this Addendum.

James Nagelvoort, Director
Public Works Department

Dated: *April 24, 2019*
San Diego, California

JN/JB/lji

CONSTRUCTION DRAWINGS FOR

PW/ENGINEERING & CAPITAL PROJECTS DEPARTMENT

CITY OF SAN DIEGO

SBWRP ULTRAVIOLET (UV) DISINFECTION SYSTEM REPLACEMENT

SCOPE OF WORK

1. BUILDING, ELECTRICAL, MECHANICAL & PLUMBING PERMITS FOR UPGRADES TO A CITY OWNED WASTEWATER TREATMENT PLANT.

WORK TO BE DONE

THE WORK IN THIS CONTRACT COMPRISES OF THE FOLLOWING BUT IS NOT LIMITED TO:

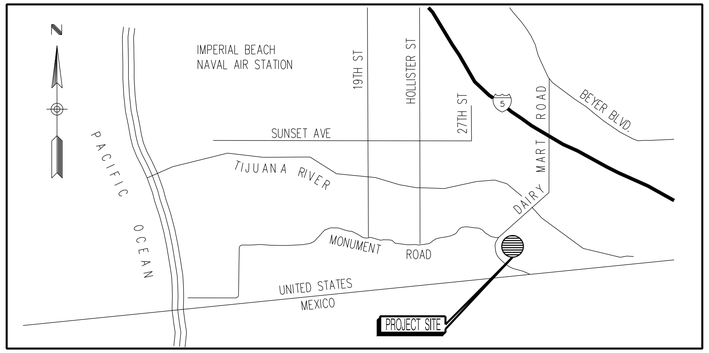
1. DEMOLITION OF EXISTING UV UNITS IN THE TERTIARY UV BASIN, UV CONTROL PANELS, AND RELATED CONDUITS AND SUPPORTS FROM UV CONTROL BUILDING TO THE TERTIARY UV BASIN.
2. FURNISHING AND INSTALLATION OF TWO NEW UV SYSTEM UNITS AND BALLASTS TO TREAT 15 MGD OF RECLAIMED WATER. REQUIRES POWER AND CONTROL FROM UV CONTROL BUILDING.
3. MODIFICATION TO EXISTING TERTIARY UV BASIN FOR THE INSTALLATION OF NEW UV UNITS PER MANUFACTURER'S RECOMMENDATIONS.
4. INSTALLATION OF POWER DISTRIBUTION UNITS, CONTROL PANELS, AND OTHER ELECTRICAL AND I&C WORK.
5. MAINTAIN SBWRP PLANT OPERATIONS IN SECONDARY UV BASIN DURING CONSTRUCTION OR AS REQUIRED BY THE CITY.

CONSTRUCTION STORM WATER PROTECTION NOTES

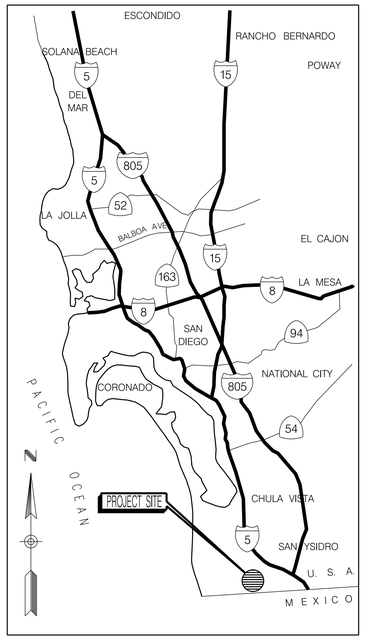
1. TOTAL SITE DISTURBANCE AREA (ACRES) 0.11
   HYDROLOGIC UNIT/ WATERSHED TIJUANA HU/TIJUANA RIVER WMA
   HYDROLOGIC SUBAREA NAME & NO. SAN YSIDRO HAS-911.11
2. THE CONTRACTOR SHALL COMPLY WITH THE REQUIREMENTS OF THE

   ☒ WPCP
   THE PROJECT IS SUBJECT TO MUNICIPAL STORM WATER PERMIT NO. R9-2013-001 AS AMENDED BY R9-2015-0001 AND R9-2015-0100

   ☐ SWPPP
   THE PROJECT IS SUBJECT TO MUNICIPAL STORM WATER PERMIT NO. R9-2013-001 AS AMENDED BY R9-2015-0001 AND R9-2015-0100 AND CONSTRUCTION GENERAL PERMIT ORDER 2009-0009-DWQ AS AMENDED BY ORDER 2010-0014-DWQ AND 2012-006-DWQ
   TRADITIONAL: RISK LEVEL 1 ☐ 2 ☐ 3 ☐
   LUP: RISK TYPE 1 ☐ 2 ☐ 3 ☐
3. CONSTRUCTION SITE PRIORITY
   ☐ ASBS ☐ HIGH ☐ MEDIUM ☒ LOW



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

DSD DEFERRED SUBMITTALS

DSD (DEVELOPMENT SERVICES DEPARTMENT) DEFERRED SUBMITTALS WILL BE REQUIRED FOR THE FOLLOWING ITEMS:

1. ANCHORS FOR UV DISINFECTION EQUIPMENT;
2. ANCHORS FOR FABRICATED WEIR GATE;
3. ALUMINUM EXTRUDED FLAT COVERS;
4. STAIRWAYS AND ASSOCIATED ANCHORAGE;
5. LADDER AND ASSOCIATED ANCHORAGE;
6. GUARD POST, TOP RAIL AND ASSOCIATED ANCHORAGE.

THE DEFERRED SUBMITTAL ITEMS LISTED ON THIS SHEET SHALL BE SUBMITTED ON DRAWINGS STAMPED AND SIGNED BY CA LICENSED CIVIL/STRUCTURAL ENGINEER. ALSO, THE DRAWINGS SHALL BE ASSOCIATED WITH STRUCTURAL CALCULATIONS STAMPED AND SIGNED BY CA LICENSED CIVIL/STRUCTURAL ENGINEER.

BASIS OF DESIGN

2016 CALIFORNIA BUILDING CODE
2016 CALIFORNIA ELECTRICAL CODE
2016 CALIFORNIA PLUMBING CODE

* I HEREBY DECLARE THAT I AM THE ENGINEER OF WORK FOR THIS PROJECT. THAT I HAVE EXERCISED RESPONSIBLE CHARGE OVER THE DESIGN OF THE PROJECT AS DEFINED IN SECTION 6703 OF THE BUSINESS AND PROFESSIONS CODE AND THAT THE DESIGN IS CONSISTENT WITH CURRENT STANDARDS. I UNDERSTAND THAT THE CHECK OF PROJECT DRAWINGS AND SPECIFICATIONS BY THE CITY OF SAN DIEGO IS CONFINED TO A REVIEW ONLY AND DOES NOT RELIEVE ME, AS ENGINEER OF WORK, OF MY RESPONSIBILITIES FOR PROJECT DESIGN.

Amritendu Maji 12/26/2018
AMRITENDU MAJI DATE

CONTRACTOR'S RESPONSIBILITIES, GENERAL NOTES

1. PURSUANT TO SECTION 4216 OF THE GOVERNMENT CODE, AT LEAST 2 WORKING DAYS PRIOR TO EXCAVATION, YOU MUST CONTACT THE REGIONAL NOTIFICATION CENTER (E.G. UNDERGROUND SERVICE ALERT OF SOUTHERN CALIFORNIA) AND OBTAIN AN INQUIRY IDENTIFICATION NUMBER.
2. NOTIFY SDG&E AT LEAST 10 WORKING DAYS PRIOR TO EXCAVATING WITHIN 10' OF SDG&E UNDERGROUND HIGH VOLTAGE TRANSMISSION POWER LINES. (I.E., 69 KV & HIGHER.
3. EXCAVATE AROUND WATER METER BOX (CITY PROPERTY SIDE) TO DETERMINE IN ADVANCE, THE SIZE OF EACH SERVICE BEFORE TAPPING MAIN.
4. CITY FORCES, WHEN SPECIFIED OR SHOWN ON THE PLANS, WILL MAKE PERMANENT CUTS & PLUGS AND CONNECTIONS.
5. KEEP EXISTING MAINS IN SERVICE IN LIEU OF HIGH-LINING, UNLESS OTHERWISE SPECIFIED SHOWN ON PLANS.
6. THE LOCATIONS OF EXISTING BUILDINGS AS SHOWN ON THE PLAN ARE APPROXIMATE.
7. STORM DRAIN INLETS SHALL REMAIN FUNCTIONAL AT ALL TIMES DURING CONSTRUCTION.
8. UNLESS OTHERWISE NOTED AS PREVIOUSLY POTHOLED (PH), ELEVATIONS SHOWN ON THE PROFILE FOR EXISTING UTILITIES ARE BASED ON A SEARCH OF THE AVAILABLE RECORD INFORMATION ONLY AND ARE SOLELY FOR THE CONTRACTOR'S CONVENIENCE. THE CITY DOES NOT GUARANTEE THAT IT HAS REVIEWED ALL AVAILABLE DATA. THE CONTRACTOR SHALL POTHOLE ALL EXISTING UTILITIES EITHER SHOWN ON THE PLANS OR MARKED IN THE FIELD IN ACCORDANCE WITH THE SPECIFICATIONS SECTION 5-UTILITIES.
9. EXISTING UTILITY CROSSING AS SHOWN ON THE PLANS ARE APPROXIMATE AND ARE NOT REPRESENTATIVE OF ACTUAL LENGTH AND LOCATION OF CONFLICT AREAS. SEE PLAN VIEW.
10. ALL ADVANCE METERING INFRASTRUCTURE (AMI) DEVICES ATTACHED TO THE WATER METER OR LOCATED IN OR NEAR WATER METER BOXES, COFFINS, OR VAULTS SHALL BE PROTECTED AT ALL TIMES IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

DSD FIRE NOTES

1. DURING CONSTRUCTION, AT LEAST ONE EXTINGUISHER SHALL BE PROVIDED ON EACH FLOOR LEVEL AT EACH STAIRWAY, IN ALL STORAGE AND CONSTRUCTION SHEDS, IN LOCATIONS WHERE FLAMMABLE OR COMBUSTIBLE LIQUIDS ARE STORED OR USED, AND WHERE OTHER SPECIAL HAZARDS ARE PRESENT PER CFC SECTION 3315.1.
2. BUILDINGS UNDERGOING CONSTRUCTION, ALTERATION, OR DEMOLITION SHALL CONFORM TO CFC CHAPTER 33. WELDING, CUTTING, AND OTHER HOT WORK SHALL BE IN CONFORMANCE WITH CFC CHAPTER 35.
3. OPEN FLAMES, FIRE, AND BURNING ON ALL PREMISES IS PROHIBITED EXCEPT AS SPECIFICALLY PERMITTED BY THE CITY OF SAN DIEGO AND CFC 308.

COVER SHEET

CONSTRUCTION CHANGE / ADDENDUM			
CHANGE	DATE	AFFECTED OR ADDED SHEET NUMBERS	APPROVAL NO.
A	4/18/2019	4	

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

The City of SAN DIEGO Public Works

CONSULTANT

LEE & RO, Inc.
10640 Scripps Ranch Blvd. Suite 150
San Diego, California 92131
Ph: (858) 558-4411 Fax: (858) 558-9522
https://www.lee-ro.com/

BID SET

G-1

SBWRP ULTRAVIOLET (UV) DISINFECTION SYSTEM REPLACEMENT

COVER SHEET

SPEC. NO.

REGISTERED PROFESSIONAL ENGINEER — MAJI, AMRITENDU — No. C87036 — 10/22/2018 — CIVIL — STATE OF CALIFORNIA

CITY OF SAN DIEGO, CALIFORNIA
PUBLIC WORKS DEPARTMENT
SHEET 01 OF 37 SHEETS

WBS B-18031

APPROVED: 11/2/18
FOR CITY ENGINEER — DATE
BRIAN VITELLE — 73039
PRINT DCE NAME — RCE#

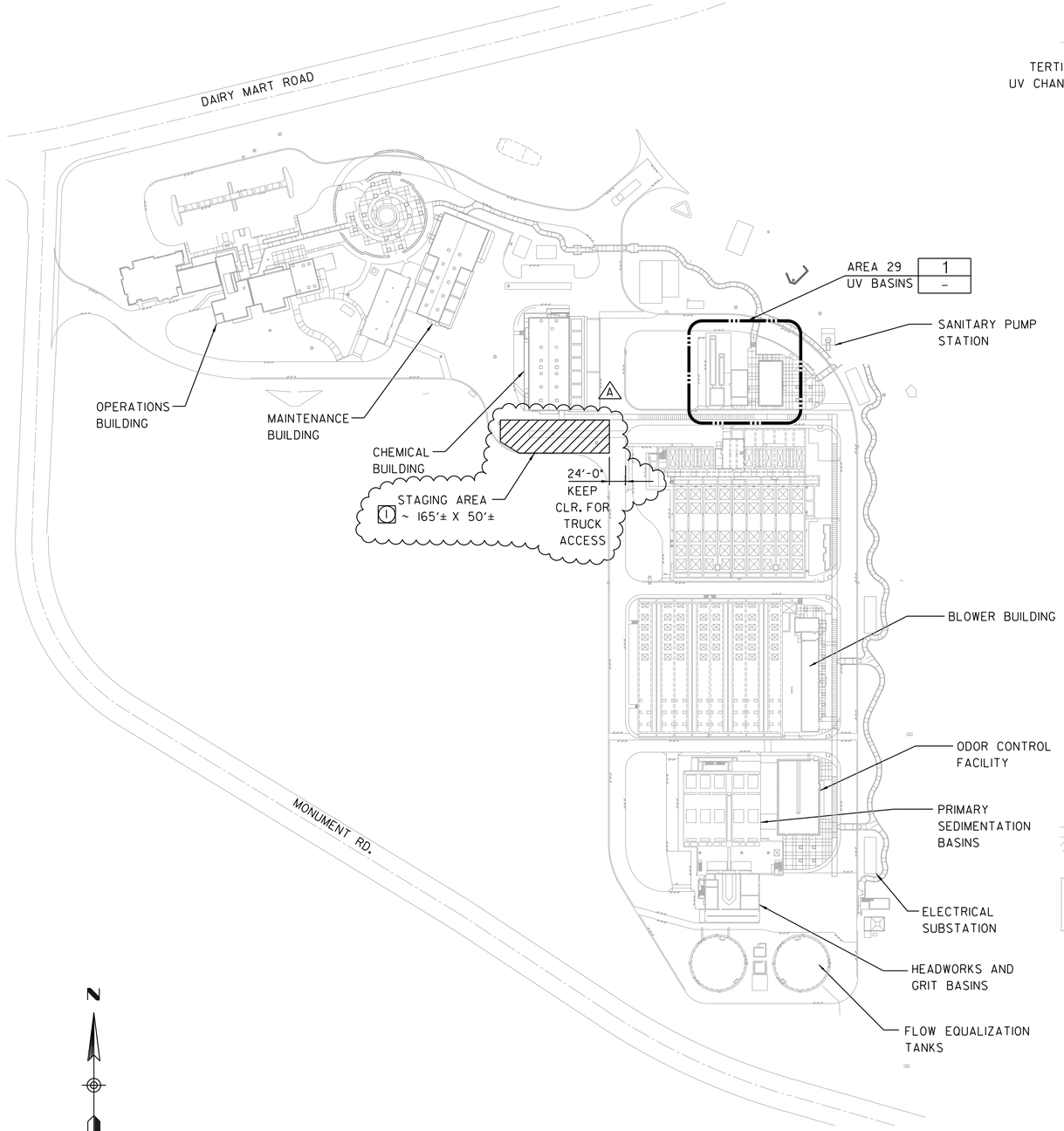
SUBMITTED BY: I. MANUEL DA ROSA, PROJECT MANAGER
CHECKED BY: JOHNNY NGUYEN, PROJECT ENGINEER

DESCRIPTION	BY	APPROVED	DATE	FILMED
ORIGINAL	LRI			

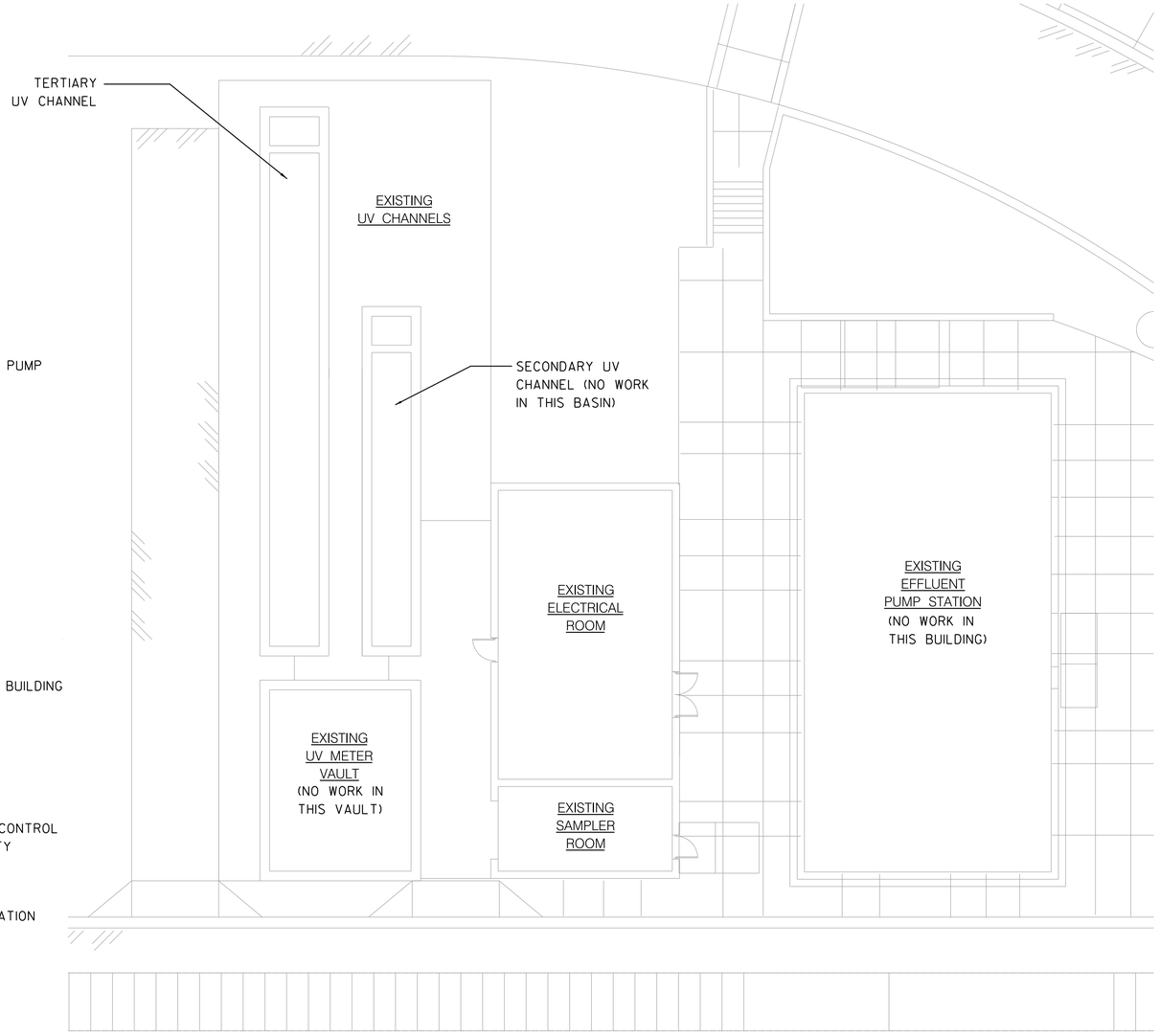
138-1743 CCS27 COORDINATE
4407-8444 CCS83 COORDINATE

CONTRACTOR — DATE STARTED
INSPECTOR — DATE COMPLETED

40775-01-D



PLAN
SCALE: 1"=100'



AREA 29 UV BASINS 1 –
SCALE: 1"=10'

N

0 10 20 30
SCALE 1"=10'

0 100 200 300
SCALE 1"=100'

NOTE:

1. BASED ON AS-BUILT DRAWINGS 28128-0002-D AND 28128-0009-D PREPARED BY PARSONS DATED 04/2003.

KEYED NOTES

(1) PLEASE NOTE THAT THE CITY RESERVES THE RIGHT TO DESIGNATE ANOTHER STAGING AREA WITHIN THE PERIMETER OF THE PLANT.

OVERALL SITE PLAN

G-4

SBWRP ULTRAVIOLET (UV) DISINFECTION SYSTEM REPLACEMENT

OVERALL SITE PLAN

BID SET

CONSULTANT

LEE & RO, Inc.
San Diego, California

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

REGISTERED PROFESSIONAL ENGINEER MANUEL AMRITENDU No. C87036 10/22/2018 CIVIL STATE OF CALIFORNIA

CITY OF SAN DIEGO, CALIFORNIA
PUBLIC WORKS DEPARTMENT
SHEET 04 OF 37 SHEETS

WBS B-18031

APPROVED: FOR CITY ENGINEER BRIAN VITELLE PRINT DOE NAME — DATE 11/4/18 — RCE# 73039

SUBMITTED BY: I. MANUEL DA ROSA, PROJECT MANAGER
CHECKED BY: JOHNNY NGUYEN, PROJECT ENGINEER

DESCRIPTION	BY	APPROVED	DATE	FILMED
ORIGINAL	LRI			
⚠ ADDENDUM A	LRI	Brian Vitelle	4/22/19	

138-1743 LAMBERT COORDINATE
4407-8444 CCS83 COORDINATE
40775-04-D

CONTRACTOR — DATE STARTED
INSPECTOR — DATE COMPLETED

⚠ STAGING AREA

ADDENDUM A

Bid Results

Bidder Details

Vendor Name J.R. Filanc Construction Compnay, Inc.
Address 740 N. Andreasen Drive
Escondido, CA 92029
United States

Respondee David Kiess
Respondee Title Vice President
Phone 760-941-7130 Ext.
Email dkiess@filanc.com
Vendor Type CAU,MALE,CADIR,Local
License # 134877
CADIR 1000001631

Bid Detail

Bid Format Electronic
Submitted May 2, 2019 1:51:06 PM (Pacific)
Delivery Method
Bid Responsive
Bid Status Submitted
Confirmation # 177100
Ranking 0

Respondee Comment

Buyer Comment

Attachments

File Title	File Name	File Type
Contractor's Certification	Contractor's Certification.pdf	CONTRACTOR'S CERTIFICATION OF PENDING ACTIONS
Mandatory Disclosure	Disclosure.pdf	MANDATORY DISCLOSURE OF BUSINESS INTERESTS FORM
Sub Listing (Other than first tier)	Sub Listing (Other than first tier).pdf	SUBCONTRACTOR LISTING (OTHER THAN FIRST TIER)
Bid Bond	Bid Bond.pdf	Bid Bond

Line Items

Type	Item Code	UOM	Qty	Unit Price	Line Total	Comment
	Main Bid					
1	Bonds (Payment and Performance)					
	524126	LS	1	$44,000.00	$44,000.00	
2	Field Orders (EOC Type II)					
		AL	1	$600,000.00	$600,000.00	
3	Mobilization/Demobilzation					
	221320	LS	1	$97,428.00	$97,428.00	

Bid Results

Type	Item Code	UOM	Qty	Unit Price	Line Total	Comment
4	UV Disinfection Equipment					
	221320	LS	1	$1,485,000.00	$1,485,000.00	
5	Civil - Site Improvements (Demolition, installation of staris, rails, storing and staging)					
	221320	LS	1	$209,682.00	$209,682.00	
6	Structural (walls, beams, columns)					
	238110	LS	1	$241,640.00	$241,640.00	
7	Mechanical (installation and testing of UV system, start up and commissioning)					
	221320	LS	1	$157,286.00	$157,286.00	
8	Instrumentation and Control					
	238210	LS	1	$65,230.00	$65,230.00	
9	Electrical					
	238210	LS	1	$485,870.00	$485,870.00	
10	Training and Operations & Maintenance (O&M) Manuals					
	221320	LS	1	$5,500.00	$5,500.00	
				Subtotal	**$3,391,636.00**	
				Total	**$3,391,636.00**	

Subcontractors

Name & Address	Description	License Num	CADIR	Amount	Type
Penhall Company 5775 Eastgate Drive San Diego, CA 92121 United States	Demolition	568673	1000000860	$80,000.00	
Parada Painting, Inc. 14281 Palisades Drive,Poway, CA, 92064 Poway, CA 92064 United States	Coatings	742112	1000004724	$38,000.00	CADIR,DBE,SDB,SLBE
Southern Contracting Co. 559 N. Twin Oaks Valley Rd. San Marcos, CA 92069 United States	Electrical	222252	1000002172	$484,000.00	CADIR

Line Totals (Unit Price * Quantity)								
Item Num	Section	Item Code	Description	**Reference**	Unit of Measure	Quantity	J.R. Filanc Construction Compnay, Inc. - Unit Price	J.R. Filanc Construction Compnay, Inc. - Line Total
1	Main Bid	524126	Bonds (Payment and Performance)	**2-4.1**	LS	1	$44,000.00	$44,000.00
2	Main Bid		Field Orders (EOC Type II)	**9-3.5**	AL	1	$600,000.00	$600,000.00
3	Main Bid	221320	Mobilization/Demobilzation	**01025(3.3A)**	LS	1	$97,428.00	$97,428.00
4	Main Bid	221320	UV Disinfection Equipment	**01025(3.3B)**	LS	1	$1,485,000.00	$1,485,000.00
5	Main Bid	221320	Civil - Site Improvements (Demolition, installation of staris, rails, storing and staging)	**01025(3.3C)**	LS	1	$209,682.00	$209,682.00
6	Main Bid	238110	Structural (walls, beams, columns)	**01025(3.3D)**	LS	1	$241,640.00	$241,640.00
7	Main Bid	221320	Mechanical (installation and testing of UV system, start up and commissioning)	**01025(3.3E)**	LS	1	$157,286.00	$157,286.00
8	Main Bid	238210	Instrumentation and Control	**01025(3.3F)**	LS	1	$65,230.00	$65,230.00
9	Main Bid	238210	Electrical	**01025(3.3G)**	LS	1	$485,870.00	$485,870.00
10	Main Bid	221320	Training and Operations & Maintenance (O&M) Manuals	**01025(3.3H)**	LS	1	$5,500.00	$5,500.00
							Subtotal	$3,391,636.00
							Total	$3,391,636.00