American River Basin

Attachment 3: Work Plan

Supporting Documents

Att3_IG1_ARB_Workplan_2of10 includes the following:

Project No.	Project Name	Supporting Documentation Included	Notes
1	City of Roseville ASR Program – Phase 2	Woodcreek North Pump Station Conformed Plans & Specs	The proposed project will be similar to the Woodcreek North Pump Station. Plans and specifications for the proposed project will therefore be similar to the plans and specs of the Woodcreek North Pump Station project.

ENVIRONMENTAL UTILITIES DEPARTMENT

NOTICE TO CONTRACTORS PROPOSAL AND CONTRACT PROVISIONS FOR THE

WOODCREEK NORTH PUMP STATION

CONFORMED DOCUMENTS

NON-REFUNDABLE FEE

$50.00

TO BE SUPPLEMENTED WITH GENERAL PREVAILING WAGE RATES

FOR PRE-BID INFORMATION CALL:

John Sollo, MWH
(916) 924-8844

BID OPENS: Tuesday, May 1, 2007, 3:00 p.m. **ROSEVILLE CONTRACT #: 3002-6120-043002-45**

ENVIRONMENTAL UTILITIES DEPARTMENT

NOTICE TO CONTRACTORS
PROPOSAL AND CONTRACT
PROVISIONS FOR THE

WOODCREEK NORTH PUMP STATION

CONFORMED DOCUMENTS

Prepared by:

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BIDDING REQUIREMENTS, CONTRACT FORMS, PROVISIONS OF THE CONTRACT

TECHNICAL SPECIFICATIONS

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DIVISION 09 - FINISHES

DIVISION 10 - SPECIALTIES

DIVISION 11 - EQUIPMENT

DIVISION 12 – FURNISHINGS (Not Used)

DIVISION 13 - SPECIAL CONSTRUCTION

DIVISION 14 - CONVEYING SYSTEMS (Not Used)

DIVISION 15 - MECHANICAL

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City of Roseville

PROJECT MANUAL

Name of Project: Woodcreek North Pump Station

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CITY OF ROSEVILLE

DEPARTMENT OF Environmental Utilities

Name of Project: Woodcreek North Pump Station

NOTICE TO CONTRACTORS

Sealed Proposals will be received at the Office of the City Clerk, 311 Vernon Street, Roseville, California, until _____ 3:00 p.m., May 1, 2007.

The Proposals will be publicly opened and read by _____ the clerk _____ of the City of Roseville at 3:05 p.m. on _____ May 1 , 2007 at the Office of the City Clerk at 311 Vernon Street, Roseville, California for the _____ Woodcreek North Pump Station.

A pre-bid meeting will be held at _____

A Project Manual, including all Contract Documents and the Proposal forms for bidding this project, can only be obtained at MWH, 3321 Power Inn Road, Suite 300, Sacramento, California 95826, telephone 916-924-8844 for a non-refundable fee of $ 50 per set. If requested, Project Manuals will be mailed for a non-refundable fee of $ 65 . Please make checks payable to the City of Roseville. All communications relative to this project shall be directed to _____, MWH, Fax 916-924-9102.

The City of Roseville hereby notifies all Bidders that:

1. The City will affirmatively ensure that, in any Contract entered into pursuant to this Notice to Contractors, minority business enterprises will be afforded full opportunity to

submit bids and will not be discriminated against on the grounds of sex, race, color, or national origin in consideration for an award.

2. The Contractor may elect to receive one hundred percent (100%) of payments due under the Contract Documents from time to time, without retention of any portion of the payment by the City, by depositing securities of equivalent value with the City in accordance with the provisions General Conditions Section 7-1.07. Such securities, if deposited by the Contractor, shall be valued by the City, whose decision on valuation of the securities shall be final. Securities eligible for investment under this provision shall be limited to those listed in California Government Code Section 16430.

3. The City has determined that the Contractor shall possess a valid Class ___, Class A General Engineering Contractor's license at the time that the bid is submitted and the Contract is awarded. Said license shall be maintained during the Contract period. Failure to possess the specified license shall render the bid nonresponsive and will act as a bar to the award of the Contract to any Bidder not possessing such a license at the time of award. The Contractor shall provide certification of the license, its number and the expiration date on the proposal form.

4. The Work is to be done in Placer County. Pursuant to California Labor Code Section 1770, the City has ascertained the General Prevailing Rate of Wages in the County in which the Work is to be done to be as determined by the Director of Industrial Relations of the State of California. CONTRACTOR is hereby made aware that information regarding prevailing wage rates may be obtained from the State Department of Industrial Relations and/or the following website address: http:/www.dir.ca.gov/DLSR/PWD/Northern.html. The Contractor is required to post a copy

of the applicable wage rates at the job site. Attention is directed to Section 5 "Legal Relations and Responsibility" of the General Conditions.

_____

City Clerk, City of Roseville

Dated: _____ Affidavits: _____

Published: _____

INSTRUCTIONS TO BIDDERS

SECTION 1: PROPOSAL REQUIREMENTS AND CONDITIONS

1-1.01 **General**: The Bidder shall carefully examine the Instructions to Bidders and all Contract Documents, and shall satisfy himself as to the conditions with which he must comply prior to bid and to the conditions affecting the award of the Contract.

These Instructions to Bidders form a part of the Contract Documents. Capitalized terms are defined in General Conditions Section 1.

1-1.02 **Contractor's Licensing Laws**: Attention is directed to the provisions of Business and Professions Code Chapter 9 of Division 3 concerning the licensing of Contractors.

All Bidders at the time of bid submittal shall be licensed as Contractors in accordance with the laws of this State. Any Bidder or Contractor not so licensed is subject to the penalties imposed by such laws. The form of Contractor's license required is stated in the Notice to Contractors, provided that the City makes no representation as to whether the State may require other or additional licenses. It is the Bidder's and Contractor's responsibility to obtain the correct Contractor's licenses. Bidders shall be skilled and regularly engaged in the general class or type of Work called for under this Contract.

All Bidders and Contractors, including subcontractors, shall have a current City business license before undertaking any Work.

1-1.03 **Examination of Plans, Contract Documents and Site of the Work**: The Bidder shall examine carefully the site of the Work and all the Contract Documents, including

these Instructions to Bidders. 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 to be performed, the quantities of materials to be furnished, and as to the requirements of all the Contract Documents.

Prior soils investigation or other previous site investigation reports are available for inspection at MWH, 3321 Power Inn Road, Suite 300, Sacramento, California 95826.

Where the Department has made investigations of site conditions, including subsurface conditions in areas where Work is to be performed under the Contract, such investigations are made only for the purpose of study and design. City does not represent that such conditions as found in these investigations or inferences or conclusions drawn as a result of these investigations will represent actual site conditions and hereby disclaims any liability as a result of contractor's or bidder's reliance on such investigations. City will presume that all bidders have conducted their own site investigations, including investigations of subsurface conditions. Where such investigations have been made, Bidders or Contractors may, upon written request, inspect the records of the Department as to such investigations subject to the conditions set forth in these Instructions to Bidders. Such inspection of records may be made only at the location noted above. The records of such investigations are not a part of the Contract and are shown solely for the convenience of the Bidder or Contractor. The City assumes no responsibility whatsoever in respect to the sufficiency or accuracy of the investigations made, the records thereof, or of the interpretations set forth therein or made by the City in its use thereof. The City makes no warranty or guarantee, either express or implied, that the conditions indicated by such investigations or records are representative of those existing throughout such areas, or any part thereof, or that unforeseen developments may not occur, or

that materials other than, or in proportions different from those indicated, may not be encountered.

No information derived from such inspection of records of investigations or compilation thereof made by the City, the Department or from the Engineer, or his assistants, will in any way relieve the Bidder or Contractor from any risk or from properly fulfilling the terms of the Contract.

1-1.04 **Proposal Forms**: The Department will furnish to each Bidder a standard proposal form, which, when filled out and executed may be submitted as the bid. Proposals shall include all pages in the Project Manual with page numbers marked "PROP" plus the Addendum acknowledgment form (front sheet) from all addenda received by the Bidder. Proposals shall be removed from the Project Manual. The full Project Manual shall not be submitted with the proposal. Bids not presented on forms so furnished will be disregarded.

The proposal and two copies thereof shall be submitted as directed in the "Notice to Contractors" under sealed cover plainly marked as a proposal, and identifying the project to which the proposal relates and the date of the bid opening therefor. Proposals which are not properly marked may be disregarded.

1-1.05 **Required Listing of Proposed Subcontractors**: Each proposal shall list the name and address of each subcontractor to whom the Bidder proposes to subcontract portions of the Work in an amount in excess of one-half of one percent (0.5%) of his total bid, in accordance with the Subletting and Subcontracting Fair Practices Act (Public Contract Code Part 1, Chapter 4). The Bidder's attention is invited to other provisions of said Act related to the imposition of penalties for a failure to observe its provisions by using unauthorized subcontractors or by making unauthorized substitutions.

1-1.06 **Noncollusion Affidavit**: Bidders shall submit a properly filled out and executed "Noncollusion Affidavit" conforming to the City's form "Noncollusion Affidavit." (PROP – 16)

1-1.07 **Disqualification, Removal or Other Prevention of Bidding**: A bid may be rejected on the basis of a Bidder, any officer of such Bidder, or any employee of such Bidder who has a proprietary interest in such Bidder, having been disqualified, removed, or otherwise prevented from bidding on, or completing a federal, state, or local project because of a violation of law or a safety regulation.

1-1.08 **Proposal Guaranty**: All bids shall be accompanied by one of the following forms of Bidder's security: Cash, a cashier's check, a certified check, or a Bidder's bond executed by an admitted surety insurer, made payable to the City of Roseville. The security shall be in an amount equal to at least ten percent (10%) of the amount bid. A bid will not be considered unless one of the form of Bidder's security is enclosed with it.

A Bidder's bond shall conform to the City's bond form in the Proposal and shall be properly filled out and executed.

1-1.09 **Withdrawal of Proposals**: Any bid may be withdrawn at any time prior to the time fixed in the Notice to Contractors for the opening of bids, provided that a request in writing, executed by the Bidder or his duly authorized representative, for the withdrawal of such bid is filed with the City Clerk. A telegraphic or facsimile request is not acceptable. The withdrawal of a bid shall not prejudice the right of a Bidder to file a new bid. The withdrawal of any bid after the time fixed in the Notice to Contractors for the opening of bids will not be permitted.

1-1.10 **Addendum**: Proposals shall include all costs and account for all addenda issued prior to opening of bids. The Bidder is responsible for verifying that he has received all issued addenda. An Addendum acknowledgment form for each Addendum shall be included as part of the Proposal submittal.

1-1.11 **Public Opening of Proposals**: Proposals will be publicly opened and read at the time and place indicated in the Notice to Contractors. Bidders or their authorized agents are invited to be present.

1-1.12 **Rejection of Irregular Proposals**: Proposals may be rejected in the City's sole discretion if they show any alterations of form, additions not called for, conditional bids, incomplete bids, erasures, or irregularities of any kind.

When proposals are signed by an agent, other than the officer or officers of a corporation authorized to sign Contracts on its behalf, or are signed by an agent other than a partner of a partnership, or are signed by an agent for an individual, a power of attorney must be on file with the Department prior to opening bids or shall be submitted with the proposal; otherwise the proposal will be rejected as irregular and unauthorized. Determination as to the validity of a power of attorney shall be in the City's sole discretion.

1-1.13 **Competitive Bidding**: If more than one proposal is offered by any individual, firm, partnership, corporation, association, or any combination thereof, under the same or different names, all such proposals may be rejected. A party who has quoted prices on materials or Work to a Bidder is not thereby disqualified from quoting prices to other Bidders, or from submitting a bid directly for the materials or Work.

All Bidders are put on notice that any collusive agreement to control or affect the awarding of this Contract is in violation of the competitive bidding requirements of the City

Charter, State Contract Act and the Business and Professions Code and may render void any Contract let under such circumstances.

1-1.14 **Relief of Bidders**: If the Bidder claims a mistake was made in his or her bid, the Bidder shall give the Department written notice within five (5) calendar Days after the opening of the bids of the alleged mistake, specifying in the notice in detail how the mistake occurred. No relief from a claimed mistaken bid shall be granted unless such mistake clearly appears on the face of the bid submitted to the City. Claimed mistakes on backup worksheets, spreadsheets, computerized bidding programs, or any other similar calculative bidding mistake which is not apparent on the face of the bid shall not under any circumstance be considered as a basis for relief. The burden of proving the occurrence of a mistake entitling a bidder to relief from its bid rests entirely on the bidder. Relief from bids shall be in the City's sole discretion.

SECTION 2: AWARD AND EXECUTION OF CONTRACT

2-1.01 **Award of Contract**: The City reserves the right to reject any and all proposals and to award (or not award) any combination of bid items at its option. Any such award will be to the lowest responsible Bidder whose proposal complies with the requirements prescribed for the bid items awarded. Such award, if made, will be made within sixty (60) calendar Days after the opening of the proposals. If the lowest responsible Bidder refuses or fails to execute the Contract, the City may award the Contract to the second lowest responsible Bidder. Such award, if made, will be made within eighty-two (82) calendar Days after the opening of proposals. If the second lowest responsible Bidder refuses or fails to execute the Contract, the City may award the Contract to the third lowest responsible Bidder. Such award, if made, will be made within one hundred four (104) calendar Days after the opening of the proposals. The above time periods within which the award of Contract may be made are subject to extension for such further period as may be agreed upon in writing between the City and the Bidder concerned.

2-1.02 **Return of Bidders' Securities**: Within ten (10) calendar Days after the award of the Contract, the City Clerk will return all Bidders' securities, other than Bidders' bonds, accompanying the proposals that are not to be further considered in making the award. Retained Bidders' securities will be held until the Contract has been fully executed, after which all Bidders' securities, except Bidders' bonds and any Bidders' securities that have been forfeited, will be returned.

2-1.03 **Contract Bonds**: The successful Bidder shall furnish two (2) bonds in the form contained in the section entitled Insurance Broker Information Packet and Bonds. One (1)

bond shall secure the payment of the claims of laborers, mechanics or materialmen employed on the Work under the Contract, and the other bond shall guarantee the faithful performance of the Contract.

Each of the two (2) bonds shall be in a sum equal to one hundred percent (100%) of the Contract price. If the Contract price increases by the issuance of Change Orders, the Contractor shall within ten (10) calendar Days provide a commensurate increase in the penal amounts of the bonds required. Sureties on each of said bonds shall be satisfactory to the City.

All alterations, extensions of time, extra and additional Work, and other changes authorized by the General Conditions, the Supplemental Conditions or any part of the Contract may be made without securing the consent of the surety or sureties on the Contract bonds.

Furthermore, the successful bidder shall furnish a certificate from the County Clerk as required by California Civil Code of Procedure Section 995.660(a)(3).

2-1.04 **Insurance**: At the time of the execution of the Contract, the Contractor shall, at his own expense, procure, and at all times during the prosecution of the Work maintain in full force and effect Worker's Compensation Insurance, and Liability Insurance as specified in the General Conditions. The Contractor shall provide a Certificate of Insurance in the form contained in the section entitled Insurance Broker Information Packet.

2-1.05 **Execution of Contract**: The Contract shall be signed by the successful Bidder and returned, together with all the required Contract bonds and insurance certificates, within fifteen (15) calendar Days after the Contract has been awarded.

2-1.06 **Failure to Execute Contract**: Failure of the lowest responsible Bidder, the second lowest responsible Bidder, or the third lowest responsible Bidder to execute the

Contract and file acceptable bonds and insurance as provided within fifteen (15) calendar Days after the Contract has been awarded, shall be cause for forfeiture of the Bidder's security. The successful Bidder may file with the City Clerk a written notice, signed by the Bidder or Bidder's authorized representative, specifying that the Bidder will refuse to execute the Contract if presented to Bidder. The filing of such notice shall have the same force and effect as the failure of the Bidder to execute the Contract and furnish acceptable bonds within the time prescribed.

PROPOSAL TO THE DEPARTMENT OF ENVIRONMENTAL UTILITIES

Project: Woodcreek North Pump Station

Name of Bidder _____ Business Phone _____

Business Address _____

Place of Residence _____

The Work to be done and referred to herein is in the City of Roseville, Placer County, State of California, and is to be constructed in accordance with the Contract Documents and the Prevailing Wage Rates of the Department.

The Work to be done is described in the Bidding Documents entitled _____ Woodcreek North Pump Station _____, City of Roseville, California.

The undersigned, as Bidder, declares that the only persons or parties interested in this Proposal as principals are those named herein; that this Proposal is made without collusion with any other person, firm, or corporation; that Bidder has carefully examined the location of the proposed Work and the Contract Documents; and proposes, and agrees if this Proposal is accepted, that he or she will Contract with the City of Roseville, in the form of a copy of the Agreement contained in the Project Manual, to provide all necessary machinery, tools, apparatus and other means of construction, and to do all the Work and furnish all the materials specified in the Contract, in the manner and time therein prescribed, and according to the requirements of the Engineer, as therein set forth, and that he or she will take in full payment therefore prices indicated in the Schedule of Bid Items, including all Work modified by Addendum numbers _____ (IF NONE, STATE NONE).

Bids are required for all Bid Items. THE AMOUNT OF THE BID FOR COMPARISON PURPOSES WILL BE THE TOTAL OF ALL ITEMS AWARDED.

The Bidder shall set forth for each item of Work, in clearly legible figures, an item price and a total for the item in the respective spaces provided for this purpose in the Schedule of Bid Items.

In case of discrepancy between the price written in words and the price written in figures for the item, the price written in words shall prevail, provided, however, if the price written in figures is ambiguous, unintelligible or uncertain for any cause, then the amount written in words for the item shall prevail. In case of discrepancy between the unit price and the extension price, the unit price shall prevail. "Extension" shall mean the product of each unit price multiplied by the quantity. In the case where the unit price prevails, the total shall be corrected to reflect the actual extension.

If this Proposal shall be accepted and the undersigned shall fail to Contract, to provide evidence of insurance or to give the two (2) payment and faithful performance bonds required, with Surety satisfactory to the City all within fifteen (15) calendar Days after the Bidder has received notice from the Department that the Contract has been awarded, the City Council may, at its option, determine that the Bidder has abandoned the Contract, and thereupon this Proposal and the Acceptance thereof shall be null and void and the forfeiture of such bid security accompanying this Proposal shall operate and the same shall be the property of the City of Roseville.

Accompanying this Proposal is _____

(Notice: Insert the words "Cash $_____," "Cashier's Check," "Certified Check," or "Bidder's Bond," as the case may be, in an amount equal to at least ten percent (10%) of the total of the Bid.)

The names of all persons interested in the foregoing Proposal as Principals, are as follows: _____

_____

The names of all persons directly involved in this project include:

Project Superintendent _____
Project Manager _____

The Director has the sole authority to approve or reject the above individuals or project team and to require their replacement prior to bid award.

In accordance with the provisions of California Labor Code Section 6707, whenever the State, a County, City and County, or City issues a call for bids for the construction of a pipeline, sewer, sewage disposal system, boring or jacking pits, or similar trenches or open excavations, which are five (5') feet deep or deeper, such call shall specify that each bid submitted in response thereto shall contain, as a bid item, adequate sheeting, shoring, and bracing or equipment method, for the protection of life or limb, which shall conform to applicable safety orders.

As required under the provisions of California Public Contract Code Section 4104 et seq., any person making a bid or offer to perform the Work, shall in his or her bid or offer, set forth: (a) The name and location of the place of business of each subcontractor who will perform Work or labor or render service to the prime Contractor in or about the construction of the Work or improvement, or a subcontractor licensed by the State of California who, under subcontract to the primary Contractor specially fabricates and installs a portion of the

Work or improvement according to detailed Drawings contained in the Contract Documents, in an amount in excess of one-half of one percent (0.5%) of the prime Contractor's total bid; (b) The portion of the Work which will be done by each such subcontractor under this act. The prime Contractor shall list only one subcontractor for each such portion as defined by the prime Contractor in his or her Bid.

The Contractor shall perform, with the Contractor's own organization and with workers under the Contractor's immediate supervision, work of a value not less than ten percent (10%) of the value of all work embraced in the contract except when certain items may be exempted by the Supplemental Provisions from said ten percent (10%) requirement.

In accordance with California Public Contract Code Section 4100 and following, each proposal shall have listed on the form provided with the proposal, the name, location of the place of business, and portion (type) of work of each California licensed subcontractor who will perform work or labor, or render service to the General Contractor in or about the construction of the work or improvement, or a licensed subcontractor who, under subcontract to the General Contractor, specially fabricates and installs a portion of the work or improvement according to detailed drawings contained in the plans and specifications, in an amount in excess of one-half of one percent (0.5%) of the General Contractor's total bid, or in the case of bids or offers for the construction of streets or highways, including bridges, in excess of one-half of one percent (0.5%) of the prime contractor's total bid or ten thousand dollars ($10,000), whichever is greater.

The Contractor shall list only one subcontractor for each portion of work in the bid. If a contractor fails to specify a subcontractor for any portion of the work to be performed under this contract in excess of one-half of one percent (0.5%) of the total bid, or for the

construction of streets or highways including bridges, in excess of one-half of one percent (0.5%) or ten thousand dollars ($10,000), whichever is greater, the Contractor shall perform that portion of the contract.

A listed subcontractor shall perform with the subcontractor's own organization and with workers under the subcontractor's immediate supervision, work of a value of not less than seventy-five percent (75%) of the value of each item of work for which the subcontractor is listed.

The Contractor will submit all subcontractors' license numbers to City within ten (10) days of bid opening. Listing should be sent to:

MWH Americas, Inc.
3321 Power Inn Road, Suite 300
Sacramento, California 95826
Attn:

[LIST OF SUBCONTRACTORS FOLLOWS ON NEXT PAGE.

THE REMAINDER OF THIS PAGE IS BLANK.]

DESIGNATION OF SUBCONTRACTORS

In accordance with the Public Contract Code, Part 1, Chapter 4, Subletting and Subcontracting, bidders must list the name and business address of each subcontractor who will perform work or labor or render service to the prime contractor in or about the construction of the work or improvement, or who will specially fabricate and install a portion of the work or improvement according to detailed drawings contained in the plans and specifications, in an amount in excess of one-half of one percent (0.5%) of the total bid, or in the case of bids for the construction of streets and highways, including bridges, in an amount in excess of one-half of one percent (0.5%) of the prime contractor's total bid or ten thousand dollars ($10,000) whichever is greater.

The apparent low bidder must submit a listing of license numbers for all subcontractors within ten days of bid opening.

PORTION/TYPE OF WORK	% OF CONTRACT	SUBCONTRACTOR'S NAME	BUSINESS ADDRESS (CITY, STATE)

IMPORTANT NOTICE: If Bidder, or other interested person is a corporation, state legal name of corporation, also names of the president, secretary, treasurer, and manager thereof; if a co-partnership, state true name of firm, also names of all individual co-partners composing the firm; if Bidder or other interested person is an individual, state first and last names in full. _____

_____

_____

Licensed in accordance with State law providing for the registration of Contractors, Class and License No._____

Expiration Date _____

SIGN HERE: _____

_____

_____

(Signature of Bidder)

NOTE: If Bidder is a corporation, the legal name of the corporation shall be set forth above together with the signature and title of the officer or officers authorized to sign Contracts on behalf of the corporation; if Bidder is a co-partnership, the name of the firm shall be set forth above together with the signature of the partner or partners authorized to sign Contracts in behalf of the co-partnership; and if Bidder is an individual, his or her signature shall be placed above. If signature is by an agent other than an officer of a corporation or a member of a partnership, a Power of Attorney must be on file with the Department prior to

opening bids or submitted with the bid; otherwise, the bid will be disregarded as irregular and unauthorized.

Business Address _____

Place of Residence _____

Dated _____, 20_____.

SECURITY FOR COMPENSATION CERTIFICATE

(Required by California Labor Code Section 1861)

TO: City Council

City of Roseville

I am aware of the provisions of California Labor Code Section 3700 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.

_____

_____

_____

(Signature of Bidder)

_____

_____

Business Address

_____

Telephone

BIDDER'S BOND II

City Council of the City of Roseville

KNOW ALL MEN BY THESE PRESENTS:

That we _____

_____

_____, as PRINCIPAL, and

_____

_____

_____

as SURETY, are held and firmly bound unto the City of Roseville in the penal sum of TEN PERCENT (10%) OF THE TOTAL AMOUNT OF THE BID of the Principal above named, submitted by said Principal to the City of Roseville, acting by and through the Director, for the Work described below, for the payment of which sum in lawful money of the United States, well and truly to be made, to the Director of the Department to which said Bid was submitted, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents. In no case shall the liability of the Surety hereunder exceed the sum of $ _____

_____

THE CONDITION OF THIS OBLIGATION IS SUCH,

That whereas the Principal has submitted the abovementioned Bid to the City Council of the City of Roseville, as aforesaid, for certain construction specifically described as follows, for which Bids are to be opened at the Civic Center at 311 Vernon Street, Roseville, California, on _____, 2006 FOR Woodcreek North Pump Station

_____

(Copy here the exact title of Work as it appears on the Proposal.)

NOW, THEREFORE, IF THE AFORESAID PRINCIPAL is awarded the Contract and, within the time and manner required under the Contract Documents, after the prescribed forms are presented to him or her for signature, enters into a written Contract, in the prescribed form, in accordance with the Bid, and files all insurance and two (2) Bonds with the Department, one (1) to guarantee Faithful Performance and the other to guarantee Payment for Labor and Materials, as required by law, then this obligation shall be null and void; otherwise, it shall be and remain in full force and effect.

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

_____(Seal)

_____(Seal)

_____(Seal)

Principal

_____(Seal)

_____(Seal)

_____(Seal)

Surety

_____

Address

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

Project _____

Contractor _____

SCHEDULE OF BID ITEMS

Schedule of prices for City of Roseville Woodcreek North Pump Station in accordance with the contract documents.

Item No.	Description	Approximate Quantity	Unit	Unit Price	Amount
1.	Pump Station	1	ls	$_____	$_____
2.	Trench sheeting, shoring, and bracing	1	ls	$_____	$_____

It is understood that the foregoing quantities are approximate only and are solely for the purpose of comparing bids and that the CONTRACTOR's compensation will be computed upon the basis of the actual quantities in the completed work, whether they be more or less than those shown. It is further understood that the Bidder has made independent examinations of the physical conditions of the site work and has carefully studied the attached Contract Documents.

BASE BID PRICE FOR WOODCREEK NORTH PUMP STATION (Item No. 1 through Item No. 2)

$_____

(Do Not Include Item 1A) Price in Figures

ALTERNATIVE BID ITEM 1A:

Alternative Bid will NOT be the basis of bid and award of Contract, but the Contractor **must** bid the Alternative Bid item.

Item No.	Description	Approximate Quantity	Unit	Unit Price	Amount
1A.	Bike Trail	83	LF	$_____	$_____

TOTAL BID PRICE FOR BID ITEM 1A: _____

Price in Figures

The Alternative Bid shall not be used in computing the Total Bid. Only the Base Bid will be the basis for selection of the successful bidder and award of the Contract.

ADDENDA:

Acknowledgement is hereby made of receipt and incorporation of addenda number(s) _____ through _____ into this Bid.

It is understood that the foregoing quantities are approximate only and are solely for the purpose of comparing bids and that the CONTRACTOR's compensation will be computed upon the basis of the actual quantities in the completed work, whether they be more or less than those shown. It is further understood that the Bidder has made independent examinations of the physical conditions of the site work and has carefully studied the attached Contract Documents.

TOTAL BID PRICE FOR WOODCREEK NORTH PUMP STATION. (Item No. 1 through Item No. 2)

$_____

Price in Figures

END OF PROPOSAL

NONCOLLUSION AFFIDAVIT

I, _____, declare that I am _____

_____ of _____, the party making the foregoing bid, that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization or corporation; that the bid is genuine and not collusive or 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.

Executed on _____, 20__, in _____.

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

_____
(Signature of Declarant)

DISCLAIMER OF WARRANTIES AND ACCURACY OF DATA

Although soil and site investigation reports have been obtained from sources believed to be reliable, no warranty expressed or implied is made regarding accuracy, adequacy, completeness, legality, reliability or usefulness of any information contained therein. These reports are subject to change at any time, may be incomplete, and/or may contain errors. This information is provided for informational purposes only. The City of Roseville provides this information on an "as is" basis. Warranties of any kind, express or implied, or statutory, including but not limited to the implied warranties of merchantability, and fitness for a particular purpose ARE DISCLAIMED to any party viewing these documents or to any third party.

The City of Roseville does not accept and expressly disclaims liability to any party viewing such information, or to any third party whatsoever, for any loss, damage, or injury (including incidental or consequential damages) whether such loss, damage, or injury is the result of negligence, willful or intentional misconduct, or any other cause.

I have read and acknowledged the above disclaimer and agree to hold harmless the City of Roseville on any theory of liability for any loss, damage or injury whether in contract, strict liability or tort arising in any way out of the use or contents of the released information or documents described above.

Print Name	Signature
Name of Business/Company/Corporation	Date
Address	Phone

AGREEMENT

THIS AGREEMENT, is made and entered into this ___day of _____, 20__, by and between the City of Roseville, a municipal corporation, ("CITY"), and _____, a _____, ("CONTRACTOR"),

WITNESSETH:

WHEREAS, the City Council of the City of Roseville, at a meeting held on the ____day of _____, 20__, approved plans and specifications consisting of the General Conditions for Buildings and Grounds and Special Conditions for the _____ Woodcreek North Pump Station _____

_____

and directed the City Clerk to advertise for sealed proposals for doing said work and providing that bids be submitted on the _____ day of _____, 20__, and

WHEREAS, the City Clerk, thereafter duly and regularly caused a notice to be published in the manner and for the time prescribed by law, and

WHEREAS, CONTRACTOR, pursuant to the provisions of said notice duly filed a bid with the City Clerk, a true copy of which bid is now on file in the office of the City Clerk, and is hereby referred to and by this reference made a part hereof as fully as if set forth at length herein, and

WHEREAS, all bids received pursuant to said notice were opened and examined and publicly declared at the time specified in said advertisement for bids and at a meeting of the City Council held on the ___ day of _____, 20__, the City Council found and declared the bid of CONTRACTOR to be the lowest responsible bid and thereupon awarded a contract to CONTRACTOR to do the work referred to in accordance with the aforementioned specifications,

NOW, THEREFORE, the parties hereto as follows:

1. THE WORK. CONTRACTOR agrees:

(a) To do the work and furnish all the labor, materials, tools, equipment and insurance required for the Woodcreek North Pump Station

_____

_____

in accordance with the Contract Documents (the "Work").

(b) To do and perform the Work contemplated hereby in a good and workmanlike manner under the direction of and to the satisfaction of the Department for Contract Administration as defined in the Contract Documents.

2. PAYMENT. CITY shall pay CONTRACTOR _____ for the Work to be done under this contract in accordance with the Contract Documents.

3. CONTRACT DOCUMENTS. The complete Agreement between the parties hereto consists of all of the documents described in section 1-1.12 of the General Conditions.

All Contract Documents are intended to operate so that any work called for in any one and not mentioned in the other, or vice versa, is to be executed the same as if mentioned in all said documents.

4. LIQUIDATED DAMAGES. In the event CONTRACTOR does not complete the work within the time specified, CONTRACTOR agrees that CITY will suffer damages. Inasmuch as the actual damages which would result from such breach by CONTRACTOR under this Agreement are uncertain, and would be impractical or extremely difficult to fix, CONTRACTOR agrees that it shall pay, or CITY shall deduct from CONTRACTOR's fee, the amount of $ 1,000 per day as liquidated damages, in the event of such delay.

5. MISCELLANEOUS. Time is of the essence of this Agreement.

IN WITNESS WHEREOF, the City of Roseville, a municipal corporation, has authorized the execution of this Agreement in duplicate by its City Manager and attestation by its City Clerk under authority of Resolution No. _____, adopted by the Council of the City of Roseville on the ____day of _____, 20___, and CONTRACTOR has caused this Agreement to be duly executed.

CITY OF ROSEVILLE
a municipal corporation

By: _____
W. CRAIG ROBINSON
City Manager

CONTRACTOR:

By: _____

its: _____

ATTEST:

By: _____
SONIA OROZCO
City Clerk

APPROVED AS TO FORM:

By: _____
MARK J. DOANE
City Attorney

and

By: _____

its: _____

Contractor
Business License #: _____

INSURANCE BROKER INFORMATION PACKET

Project: Woodcreek North Pump Station

NOTICE TO CONTRACTOR:

For your convenience, this package contains the Requirements for Insurance and Bonds for this project, including the necessary City forms. You are required to return these forms in addition to the executed Contract within fifteen (15) calendar Days after the award of the Bid. (See the Instructions to Bidders.)

Please insert the dollar amount of your accepted Bid into the blank on page INS-2 and present this entire package to your insurance broker if you are awarded the Bid.

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NOTICE TO INSURANCE BROKER

Your client has been awarded a bid by the City Council of the City of Roseville to perform a public works project known as Woodcreek North Pump Station _____. The Contract Conditions for that project require your client ("the Contractor") to return certain evidence of insurance and bonds to the City Attorney of the City within fifteen (15) Days after the Bid award, or else the Bid award may be terminated and awarded to another company.

This package contains the information you will need as an insurance broker to provide the appropriate insurance and bonds to the City. The insurance coverages the Contractor needs are specified in the section entitled "Insurance Requirements." Please note that, in addition to the insurance certificate itself, copies of several endorsements must be actually furnished for review.

Please refer to Supplementary Conditions for modifications of the General Conditions and the requirements of this insurance packet.

Please use the standard City of Roseville Bond Forms provided in this package.

The Bonds required must each be in the penal amount of: $_____.

Documents should be forwarded to or questions addressed to:

Office of the City Attorney
City of Roseville
311 Vernon Street
Roseville, CA 95678
(916) 774-5325

When forwarding the documents, please refer to the project name so that the documents can be matched with the Contract for which they are submitted.

Thank you.

INSURANCE REQUIREMENTS

The following sections are quoted from the General Conditions of the project:

5-1.19 **Insurance Coverage:**

A. Evidence of Maintenance Required. The CONTRACTOR shall, at all times, maintain in full force and effect the insurance required by this section; and the CONTRACTOR shall not allow any subcontractor to commence Work until similar insurance required of the subcontractor has been obtained and filed. An original Certificate of Insurance, and copies of all required endorsements, all in a form approved by the City Attorney, evidencing all required coverage or policies shall be filed after the award of the bid and prior to approval of the Contract by the City Council. The Certificate shall provide that at least thirty (30) Days prior written notice of any reduction of coverage limits or cancellation of the coverage or policies shall be given to the City of Roseville as Certificate holder.

B. Qualifying Insurers. With the exception of the State Compensation Insurance Fund, all required insurance policies shall be issued by companies licensed to do business in the State of California and who hold a current policy holders alphabetic and financial size category rating of not less than AVII according to the most recent issue of Best's Insurance Reports.

C. Insurance Required. Commercial General Liability, automobile liability, and worker's compensation insurance shall be maintained as follows:

1.	Commercial General Liability	Bodily Injury: $1,000,000 each occurrence $2,000,000 aggregate

Property Damage:
$1,000,000 each occurrence
Personal Injury:
$1,000,000 each occurrence
$2,000,000 aggregate

The Commercial General Liability policy shall include coverage or endorsements for:

a. Completed operations.

b. Losses related to independent contractors, products and equipment.

c. Explosion, collapse and underground hazards.

The Commercial General Liability Insurance shall include the following endorsements, copies of which shall be provided:

a. Inclusion of the City of Roseville, and its officers, agents, volunteers and employees, as additional insured as respects services or operations under the Contract.

b. Cross liability and severability of interest clauses providing that the insurance applies separately to each insured except with respect to the limits of liability.

c. Stipulation that the insurance is primary insurance and that neither the City nor its insurers will be called upon to contribute to a loss.

d. Such insurance shall specifically cover the contractual liability of the CONTRACTOR.

e. The CONTRACTOR shall furnish a certificate for the period covered.

SPECIAL NOTICE - CLAIMS MADE COVERAGE:

Liability insurance coverage may not be written on a "claims made" basis. The Certificate of Insurance must clearly provide that the coverage is on an "occurrence" basis.

2. Comprehensive Automobile Liability for bodily injury (including death) and property damage which provides total limits of not less than One Million Dollars ($1,000,000) combined single limits per accident, applicable to all owned, non-owned, and hired vehicles.

3. Statutory Workers' Compensation and Employer's Liability Insurance, including a Broad Form "All-States" Endorsement for all employees engaged in services or operations under the Contract. The employer's liability insurance shall provide limits of not less than One Million Dollars ($1,000,000) per occurrence. Both the worker's compensation and employer's liability policies shall contain the Insurer's waiver of subrogation in favor of the City, its officers, agents, and employees.

4. Builder's Risk/Course of Construction Insurance:

The Contractor shall be responsible for all loss, damage or destruction whatsoever to the Work called for by this Contract until the approval of a Notice of Completion. The Contractor shall secure "All Risk" type of builder's Risk Insurance of the type covering one hundred percent (100%) of the value of the Work performed under this Contract (the value is presumed to be the Contract amount unless otherwise stated in Supplemental Conditions) and all materials, equipment, or other items to be incorporated therein while the same are located at the construction site, a bonded warehouse, or its place of manufacture. At any time, the policy shall cover the value of the Work completed. The policy shall cover hazards including the losses due to fire,

explosion, hail, rain, lightning, flood (separate insurance as needed), vandalism, malicious mischief, wind, collapse, aircraft, and smoke.

The policies providing such insurance shall name the City as a loss payee as its respective interests may appear, and certified copies of such policies shall be filed with the City. The maximum deductible allowable under the Builder's All Risk policy shall be five percent (5%) of the Contract amount.

In accordance with provisions of California Government Code Section 7105, Builder's Risk Insurance is not required for coverage of losses in excess of five percent (5%) of the Contract amount for damages resulting from earthquake in excess of a magnitude of 3.5 on the Richter scale, or tidal waves. Coverage in the amount of five percent (5%) of the Contract amount for such losses is required.

5-1.19A **Other Insurance Provisions:**

A. The requirements of the Contract Conditions as to types and limits of insurance coverage to be maintained by the Contractor, and any approval of insurance by the City, are not intended to, and shall not in any manner limit or qualify the liabilities and obligations otherwise assumed by the Contractor pursuant to the Contract, including, but not limited to, the provisions concerning indemnification, nor preclude the City from taking any other action available to it under any other provision of the Contract or law.

B. The City acknowledges that some insurance requirements contained in the Contract Conditions may be fulfilled by self-insurance on the part of the Contractor. However, this shall not in any way limit liabilities assumed by Contractor under the Contract. Any self-insurance must be approved in writing by the City, in its sole discretion.

C. Should any of the Work under the Contract be sublet, the Contractor shall require each of its subcontractors of any tier to provide the aforementioned coverage, or the Contractor may insure subcontractor(s) under its own policy.

D. The City, its officers, officials, employees and volunteers are to be covered as insureds with respect to liability arising out of automobiles owned, leased, hired or borrowed by or on behalf of the contractor; and with respect to liability arising out of work or operations performed by or on behalf of the contractor including materials, parts or equipment furnished in connection with such work or operations. Coverage shall not extend to any indemnity coverage for the active negligence of the additional insured in any case where an agreement to indemnify the additional insured would be invalid under California Insurance Code Section 11580.04.

E. THE CITY RESERVES THE RIGHT TO WITHHOLD ANY PROGRESS PAYMENT TO THE CONTRACTOR IN THE EVENT OF NONCOMPLIANCE WITH ALL INSURANCE REQUIREMENT.

Bond No. _____
Premium $_____

PUBLIC WORKS
FAITHFUL PERFORMANCE BOND
(Project: Woodcreek North Pump Station)

WHEREAS, the City of Roseville ("CITY") has awarded a bid and contract to _____ as contractor ("PRINCIPAL") for the public work described as Woodcreek North Pump Station (the "WORK"). The contract ("AGREEMENT"), for the public work described above, and all of its terms and conditions are incorporated by reference and made a part hereof; and

WHEREAS, the PRINCIPAL is required to furnish a bond in connection with the AGREEMENT guaranteeing its faithful performance; and

NOW, THEREFORE, we the undersigned PRINCIPAL and _____ a _____, admitted and duly authorized to transact business under the laws of the State of California, as SURETY ("SURETY"), are held and firmly bound unto the CITY in the sum of _____ dollars ($_____) (which amount is not less than 100% of the AGREEMENT price) to be paid to the CITY or its successors and assigns; and for which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors or assigns jointly and severally, firmly by these presents.

The condition of this obligation is such that if the PRINCIPAL, his or its heirs, executors, administrators, successors or assigns, shall abide by, and in all respects perform the covenants, conditions and provisions in said AGREEMENT and any alteration thereof made as therein provided, on his or its part to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless CITY, its officers, agents and employees, as therein stipulated, then this obligation shall be null and void; otherwise, this obligation shall be and remain in full force and effect.

As condition precedent to the satisfactory completion of the contract, the obligation of the PRINCIPAL and SURETY under this Bond shall remain in effect for a period of one (1) year after the completion and acceptance of the work. During that time, if the PRINCIPAL, his or its heirs, executors, administrators, successors

or assigns fails to make full, complete and satisfactory repair and replacement or totally protect the CITY from any loss or damage made evident during that year which results from or is caused by either defective materials or faulty workmanship in the prosecution of the work, then the obligation shall remain in full force and effect. However, anything in this paragraph to the contrary notwithstanding, the obligation of the SURETY shall continue so long as any obligation of the PRINCIPAL remains.

No prepayment or delay in payments, and no change, extension, addition or alteration of any provision of the AGREEMENT or in the specifications agreed to between the PRINCIPAL and the CITY, or any forebearance on the part of the CITY shall operate to relieve the SURETY. The SURETY hereby waives the provisions of Section 2819 of the California Civil Code. The SURETY waives all rights of subrogation against the CITY or any person employed by the CITY. If the contract price increases by the issuance of change orders, the amount specified in this bond shall increase by the same amount.

As part of the obligation secured hereby and in addition to the face amount specified therefore, there shall be included costs and reasonable expenses and fees, including reasonable attorneys' fees, incurred by CITY in successfully enforcing such obligation, all to be taxed as costs and included in any judgment rendered.

IN WITNESS WHEREOF, this instrument has been duly executed by the PRINCIPAL and SURETY above-named, on the ____ day of _____, 20___.

PRINCIPAL:

BY: _____
PRINT NAME: _____
PRINT TITLE: _____

AND

BY: _____
PRINT NAME: _____
PRINT TITLE: _____

SURETY:

BY: _____
PRINT NAME: _____
PRINT TITLE: _____

MAILING ADDRESS: _____

_____

_____

(Notarization by Surety and copy of Power of Attorney required.)

Bond No. _____
Premium $_____

PUBLIC WORKS
LABOR AND MATERIALS PAYMENT BOND
(Project: Woodcreek North Pump)Station

WHEREAS, the City of Roseville ("City"), has awarded a bid and contract to _____ as contractor ("PRINCIPAL"), for the public work described as Woodcreek North Pump Station (the "WORK"). The contract ("AGREEMENT"), for the public work described above, and all of its terms and conditions are incorporated by reference and made a part hereof; and

WHEREAS, the PRINCIPAL is required to furnish a bond in connection with the AGREEMENT guaranteeing payment of persons who provide labor and material; and

NOW, THEREFORE, we the undersigned PRINCIPAL and _____ a _____, admitted and duly authorized to transact business under the laws of the State of California, as SURETY, ("SURETY") are held and firmly bound unto the CITY or its successors and assigns in the sum of _____ dollars ($_____) (which amount is not less than 100% of the contract price) and for which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors or assigns, jointly and severally, firmly by these presents.

The condition of the obligation is such that if the PRINCIPAL, his or its subcontractors, heirs, executors, administrators, successors or assigns fails to pay any of the persons named in §3181 of the Civil Code of the State of California, or the amounts due under the Unemployment Insurance Code of the State of California with respect to work or labor performed by any such claimant, that the SURETY will pay for the same, in an amount not exceeding the sum specified in this bond, and also, in case suit is brought upon the bond, shall pay reasonable attorney's fees, to be fixed by the Court.

This bond shall inure to the benefit of any and all persons, companies, and corporations entitled to file a Stop Notice pursuant to the provisions of §3179 et

seq. of the Civil Code of the State of California, so as to give a right of action to them or their assigns in any suit brought upon this bond.

No prepayment or delay in payments, and no change, extension, addition or alteration of any provision of the AGREEMENT or in the specifications agreed to between the PRINCIPAL and the CITY, or any forebearance on the part of the CITY shall operate to relieve the SURETY. The SURETY hereby waives the provisions of Section 2819 of the California Civil Code. The SURETY waives all rights of subrogation against the CITY or any person employed by the CITY. If the contract price increases by the issuance of change orders, the amount specified in this bond shall increase by the same amount.

As part of the obligation secured hereby and in addition to the face amount specified therefore, there shall be included costs and reasonable expenses and fees, including reasonable attorneys' fees, incurred by CITY in successfully enforcing such obligation, all to be taxed as costs and included in any judgment rendered.

IN WITNESS WHEREOF, this instrument has been duly executed by the PRINCIPAL and SURETY above-named, on the _____ day of _____, 20__.

PRINCIPAL:

BY:_____
PRINT NAME: _____
PRINT TITLE: _____

AND

BY: _____
PRINT NAME: _____
PRINT TITLE:_____

SURETY:

BY:_____
PRINT NAME: _____
PRINT TITLE:_____

MAILING ADDRESS:

_____
_____
_____

(Notarization by Surety and copy of Power of Attorney required.)

CITY OF ROSEVILLE
RISK MANAGEMENT DIVISION

CLAIMS MADE QUESTIONNAIRE

(to be completed for all insurance policies written on a "claims made" basis)

Date: _____

Insured Name: _____

Address: _____

NOTICE: **Submit one copy of this questionnaire for each policy written on a "claims made" basis. This questionnaire forms a part of, and is subject to all terms and conditions of, the Certificate of Insurance. An original, signed document must be submitted.**

---

1. Type of insurance (e.g., commercial liability, professional liability):

   _____

   Insurer: _____ Policy Number: _____

2. Cost of defense included in the coverage limits: Yes ☐ No ☐

3. Amount of General Aggregate limit: $ _____

4. Amount of Products/Completed Operations Aggregate limit: $ _____

5. Retroactive Date: _____

6. Length of time for Extended Reporting Period: _____

7. Notice of Circumstance allowed: Yes ☐ No ☐

8. State any limitations on invoking the reporting period other than nonpayment:

   _____

   _____

APPROVED AS TO FORM:

_____
Risk Management Division

Date Approved: _____

CERTIFICATE ISSUED BY:

_____
(Signature)

_____
(Print Name)

_____
(Title)

_____
(Company or Agency)

_____
(Address)

_____
(City, State, Zip)

_____
(Telephone)

CITY OF ROSEVILLE

GENERAL CONDITIONS

FOR

BUILDINGS AND GROUNDS

CITY OF ROSEVILLE

GENERAL CONDITIONS

FOR

BUILDINGS AND GROUNDS

SECTION 1

DEFINITIONS AND TERMS

1-1.01 **General:** The following abbreviations and terms or pronouns in place of them appear in the Contract Documents, the intent and meaning shall be interpreted as provided in this Section 1.

1-1.02 **Acceptance:** Formal Acceptance by resolution by the Roseville City Council of the Contract when completed in all respects in accordance with the Contract Documents and any modifications previously approved.

1-1.03 **Addendum:** Document or written communication issued by the Department during the bidding period which modifies, supersedes, or supplements the Contract Documents.

1-1.04 **Bidder:** Individual, firm, copartnership, association, or any combination thereof, submitting a Proposal for the Work, acting directly, or through a duly authorized representative.

1-1.05 **Bidding Documents:** Includes the Notice to Bidders, Bidding Requirements, Contract Conditions, Drawings and Addenda.

1-1.06 **Change Order:** Any additions, deletions, or modifications of the Work to be done after the Agreement has been signed.

1-1.07 **City:** The City of Roseville.

1-1.08 **City Attorney:** The City Attorney of the City.

1-1.09 **City Clerk:** The City Clerk of the City..

1-1.10 **Contract:** Agreement relating to the Work to be performed, the labor, materials, and equipment to be furnished, and the payment to be made therefor. The Contract incorporates all of the Contract Documents.

1-1.11 **Contract Conditions:** Include the General Conditions, Supplemental Conditions, and Specifications.

1-1.12 **Contract Documents:** Include the Bidding Documents, the Bid or Proposal, Contract Bonds, the Contract, all required insurance certificates or endorsements, all required certifications or statements, Change Orders, any Contract Amendment, any City Standard which is incorporated by reference and these City of Roseville General Conditions for Buildings and Grounds.

1-1.13 **Contractor:** Individual, firm, co partnership, corporation, association, or any combination thereof, who has entered into the Contract with City.

1-1.14 **Day or Days:** Unless otherwise designated, Day or Days as used in the Contract Documents will be understood to mean calendar Day or Days.

1-1.15 **Department:** The Department for Contract Administration, as identified in the Supplemental Conditions.

1-1.16 **Direct Costs:** Those cost items (including labor, materials, equipment and any subcontractor's work) that are used in the actual performance of, and are specifically and uniquely attributable to the Work or changed Work. Direct Costs do not include Overhead. Direct Costs include but are not limited to:

A. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by City and Contractor. Payroll costs for employees not employed full time on the Work shall be

apportioned on the basis of their time spent on the Work. Payroll costs shall include salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workers' compensation, health and retirement benefits, sick leave, vacation and holiday pay applicable thereto. Such employees may include superintendents and foremen at the site. The expenses of performing work after regular working hours, on Saturday, Sunday or legal holidays shall be included in the above only to the extent authorized by City in writing.

B. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and suppliers' field services required in connection therewith. All trade discounts, rebates and refunds and all returns from sale of surplus materials and equipment shall accrue to City, and Contractor shall make provisions so that they may be obtained.

C. Payments made by Contractor to the subcontractors for work performed by subcontractors. If required by City, Contractor shall obtain competitive bids from subcontractors acceptable to Contractor and shall deliver such bids to City who will then determine which bids will be accepted. If a subcontract provides that the subcontractor is to be paid on the basis of cost of the work plus a fee, the subcontractor's cost of the work shall be determined in the same manner as Contractor's cost of the work. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

D. Costs of special consultants (including engineers, architects, testing laboratories, surveyors, and accountants) employed for services specifically, and only, related to the Work.

E. Supplemental costs including the following:

1. The proportion of necessary transportation, travel and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

2. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value of such items used but not consumed which remain the property of Contractor.

3. Rentals of all construction equipment and machinery and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by City, and the costs of transportation, loading, unloading, installation, dismantling and removal thereof, all in accordance with terms of said rental agreements. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

4. Sales, consumer, use or similar taxes related to the Work, and for which Contractor is liable, imposed by laws and regulations.

5. The cost of utilities, fuel and sanitary facilities at the site.

6. Cost of premiums for additional bonds and insurance required because of changes in the Work.

1-1-17 **Director:** Director of the Department for Contract Administration or his or her designee.

1-1.18 **Drawings:** The official Drawings including plans, elevations, sections, detail Drawings, diagrams, plated, General Notes, information and schedules thereon, or exact

reproductions thereof, showing the location, character, dimension, and details of the Work. The Drawings include any Drawings or plates bound within the Supplemental Conditions.

1-1.19 **General Notes:** The written instructions, provisions, conditions or other requirements appearing on the Drawings and so identified thereon, which pertain to the performance of the Work.

1-1.20 **Laboratory:** Established professional laboratories authorized by the City to test materials and Work involved in the Contract.

1-1.21 **Liquidated Damages:** The amount prescribed in the Supplemental Conditions to be paid to the City or to be deducted from any payments due or to become due the Contractor for each day's delay in completing the whole or any specified portion of the Work beyond the time allowed in the Supplemental Conditions.

1-1.22 **Overhead:** Business or administrative expenses (including but not limited to office expenses, administrative staff, rent, insurance, utilities) not chargeable to a particular part of the Work. The term "overhead" shall include any of the following:

A. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks and other personnel employed by Contractor whether at the site or in Contractor's principal or a branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in section 1-1.17, all of which are to be considered administrative costs covered by the Contractor's fee.

B. Expenses of Contractor's principal and branch offices other than Contractor's office at the site.

C. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

D. Cost of premiums for all bonds and for all insurance whether or not Contractor is required by the Contract Documents to purchase and maintain the same, except as provided in section 1-1.16.

E. Other overhead or general expense costs of any kind.

1-1.23 **Owner:** City of Roseville.

1-1.24 **Project Manual:** A book containing all Contract Documents.

1-1.25 **Premises:** Shall mean the area within construction easements, easements, rights of entry and City owned property which surrounds the Work Site, limited by the property lines thereof. In some cases Premises may coincide with the Work Site.

1-1.26 **Engineer or Architect:** Private Engineer or Architect as a person, firm or corporation retained by the City of Roseville for this Work or portions thereof.

1-1.27 **Specifications:** The technical Specifications for the Work prepared by the Director or a Engineer or Architect describing in detail the nature of the Work, its components, any performance standards, and how the Work is to be constructed.

1-1.28 **Supplemental Conditions:** The Supplemental Conditions are specific clauses modifying or supplementing these General Conditions.

1-1.29 **Work:** The furnishing of all labor, and the furnishing and installing of all materials, articles, supplies and equipment as specified, designated, or required by the Contract Documents.

1-1.30 **Work Site:** All or portion of the Premises that the Work is limited to as shown on the Drawings or designated by the Director. Public streets are not included unless Work is being done within the street right-of-way.

SECTION 2

CONTROL AND SCOPE OF THE WORK

2-1.01 **Authority of Director:** The Contract shall be performed in a manner satisfactory to the Director who shall decide all questions which may arise as to the quality or acceptability of materials furnished and Work performed and as to the manner of performance and rate of progress of the Work; all questions which may arise as to the interpretation of the Contract Documents; all questions as to the acceptable fulfillment of the Contract on the part of the Contractor; and all questions as to compensation. The Director shall have authority to enforce and make effective such decisions and orders which the Contractor fails to carry out promptly.

2-1.02 **Intent of Contract Documents:** The intent of the Contract Documents is to prescribe the details for the construction and completion of the Work. Where the Contract Documents describe portions of the Work in general terms, but not in complete detail, it is understood that only the best general practice is to prevail and that only materials and workmanship of the first quality are to be used. Unless otherwise specified, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals, and do all the Work involved in executing the Contract in a satisfactory and workmanlike manner.

2-1.03 **Coordination and Interpretation of Contract Documents:** All Contract Documents are essential parts of the Contract, and a requirement occurring in one is as

binding as though occurring in all. They are intended to be complementary, and to describe and provide for a complete Work.

The Supplemental Conditions shall govern over the General Conditions and the Drawings. In the event of any discrepancy, between any Drawing and the figures written thereon, the figures shall be taken as correct. Detail Drawings shall prevail over general Drawings and General Notes shall prevail over Drawings. The Specifications shall prevail over the Drawings. The Contract Conditions shall prevail over the Bidding Documents. The Contract shall prevail over the Contract Conditions.

Should it appear that the Work to be done or any of the matters relative thereto are not sufficiently detailed or explained in the Contract Documents, the Contractor shall apply to the Director for such further explanations as may be necessary and shall conform to them as part of the Contract. In the event of any doubt or question arising respecting the true meaning of the Contract Documents, reference shall be made to the Director. The decisions of the Director shall be final.

2-1.04 **Submittals:** It shall be the Contractor's responsibility to timely submit, so as to cause no delay in the Work, all shop Drawings, descriptive data, manuals, instructions, affidavits, samples for the various trades as required by the Supplemental and Technical Conditions, and offers of alternatives, if any. Such submittals shall be checked and coordinated by the Contractor with the Work of other trades involved before they are submitted to the Director for examination.

Submittals shall be delivered to the Director. Work requiring the submittal of working Drawings, descriptive data or samples shall not begin prior to approval of said submittal by the Director.

The time allowed for review of each submittal will be as indicated in the Supplemental Conditions. Review time will start upon receipt of the submittal by the Director and will end upon the Director's mailing of the submittals to the Contractor. Defective, incomplete or partial submittals will be returned to the Contractor unreviewed.

Submittals shall be made by a letter of transmittal that shall contain a list of all matter submitted and identification of all variations from the Contract Documents contained in the submittal. The letter and all items accompanying the same shall be fully identified as to project name and location, Contractor's name, district, county, and Contract number, with ample cross-references to the Contract Documents, to facilitate identification of items and their location in the Work.

All shop Drawings and supporting data, catalogs, schedules, shall be submitted as the instruments of the Contractor, who shall be responsible for their accuracy and completeness. These submittals may be prepared by the Contractor, subcontractors, or suppliers, but the Contractor shall ascertain that submittals meet all of the requirements of the Contract Documents, while conforming to structural, space, and access conditions at the point of installation. The Contractor shall check all submittals before submitting them to the Director.

2-1.04A **Shop Drawings:** The Contractor shall submit at least seven (7) copies of all shop Drawings required by the Supplemental Conditions or Specifications. Two (2) copies will be returned to the Contractor either approved for use or returned for correction and resubmittal. Shop Drawings include any drawing, which requires execution by a draftsman as distinguished from printed matter. The size of shop Drawings shall not exceed twenty-four (24") inches by thirty-six (36") inches.

2-1.04B **Descriptive Data:** The Contractor shall submit seven (7) copies of each set of manufacturer's brochures or other data required by the Supplemental Conditions or Specifications. The City will examine such submittals and return two (2) copies either approved for use or returned for correction and resubmittal.

2-1.04C **Samples:** The Contractor shall submit samples of articles, materials or equipment as required by the Supplemental Conditions or Specifications. The Work shall be in accordance with the approved samples. Samples shall be removed from City property when directed or may be incorporated in the Work if approved by the Director. Samples not removed by the Contractor will become the property of the City or, at the City's option, will be removed or disposed of by the City at the Contractor's expense.

2-1.04D **Manuals, Instructions and Affidavits:**

A. Manuals and Instructions. Where operation and maintenance manuals are required by the Supplemental Conditions, the Contractor shall submit three (3) sets of manuals, suitably bound, to the Director within forty-five (45) Days after favorable review of the equipment or facilities. All manuals shall be marked to indicate the specific equipment furnished for this project and shall include:

1. Start-up instructions
2. Normal operation instructions
3. Trouble shooting instructions
4. Lubrication instructions
5. Maintenance and reinstallation instructions
6. Parts identification
7. List of spare parts recommended to have on hand

8. Operator safety

In addition, all operation and maintenance manuals for electrical equipment shall include:

9. Equipment ratings

10. Calibration curves and rating tables if appropriate

Operation and maintenance manuals for complex equipment shall also include:

11. Alternate specified operating modes

12. Emergency shutdown instructions

13. Normal shutdown instructions

14. Long term shutdown instructions

Operation and maintenance manuals for systems comprised of separate pieces of equipment shall include a system explanation of items 1, 2, 3, 11, 12, 13 and 14 as well as the instructions for the separate pieces of equipment.

B. Affidavits. Where required in the Supplemental Conditions or Specifications, manufacturers of equipment shall provide field service as a part of this project. Equipment shall not be considered ready for full time operation until after the authorized factory-trained and qualified manufacturer's representative for the specific equipment has checked and adjusted the equipment and certified by written affidavit that the equipment has been properly installed, tested, adjusted, lubricated, and calibrated, and is ready for full time operation. Acceptable affidavits shall be submitted prior to completion of the Work. Affidavits shall contain the following specific wording:

"The (Name of Equipment) has been properly installed, tested, adjusted, lubricated, and calibrated, and is ready for full time operation. The installation has

been inspected and has been found to be in conformance with our (the manufacturer's) standards and requirements."

No amplification, dilution, or modification of this specific wording will be permitted.

2-1.04E **Alternatives:** For convenience in designation in the Contract Documents, certain materials, articles, or equipment may be designated by a brand or a trade name or the name of the manufacturer together with catalog designation or other identifying information, hereinafter referred to generically as "designated by brand name." An alternative material, article, or equipment which is of equal quality and of the required characteristics for the purpose intended may be proposed for use provided the Contractor complies with the following requirements:

A. The Contractor shall submit his proposal for an alternative in writing. Such request shall be made in ample time to permit approval without delaying the Work.

B. No such proposal will be considered unless accompanied by complete information and descriptive data, necessary to determine the equality of the offered materials. The Contractor shall satisfy the Director as to the comparative quality, suitability, or performance of the offered material, articles, or equipment. In the event that the Director rejects the use of such alternative materials, articles, or equipment, then one of the particular products designated by brand name shall be furnished.

The Director will examine, with reasonable promptness, such submittals, and return of submittals to the Contractor shall not relieve the Contractor from responsibility for deviations and alternatives from the Contract Documents, nor shall it relieve the Contractor from responsibility for errors in the submittals. A failure by the Contractor to identify in his or her letter of transmittal, material deviations from the Contract Documents shall void the submittal

and any action taken thereon by the Director. When specifically requested by the Director, the Contractor shall resubmit such shop Drawings, descriptive data and samples as may be required.

If any mechanical, electrical, structural, or other changes are required for the proper installation and fit of alternative materials, articles, or equipment, or because of deviations from the Contract, such changes shall not be made without the approval of the Director and shall be made without additional cost to the City.

2-1.05 **Preservation and Cleaning:** The Contractor shall clean up the Work at frequent intervals and at other times when directed by the Director. While finish Work is being accomplished, floors, Work areas and finished areas shall be kept clean, free of dust, construction debris and trash. Upon completion of the Work, the Contractor shall remove from the Premises his construction equipment and any waste materials not previously disposed of, leaving the Premises thoroughly clean and ready for final inspection.

2-1.06 **Limitations on Work Site and Premises:** The Contractor shall limit his construction operations to the Work Site unless otherwise shown on the Drawings or specified. The Contractor shall perform no operation of any nature over or on the Premises except such operations as are authorized by the Contract Documents or as authorized by the Director.

2-1.07 **Dust Control:** During the performance of all Work under this Contract, the Contractor shall assume all responsibility for dust control and shall furnish all labor, equipment, and means required to carry out proper and efficient measures wherever and whenever dust control is necessary to prevent the operations from producing dust damage and nuisance to persons and property. Any claims resulting from dust damage or nuisance shall be borne solely by the Contractor.

2-1.08 **Sanitation:** The Contractor shall provide sanitary facilities for all persons working on the Work.

2-1.09 **Night Work and Normal Working Hours:** Normal working hours at the construction site shall be between the hours of 7:00 a.m. and 7:00 p.m. Monday through Friday. Legal holidays are excluded. Certain utility connections and street operations are anticipated to require night Work by the Contractor during low usage periods. The Contractor may also be required to prosecute the Work at night if, at any time, the Director shall deem it necessary for the progress of the Work, or if emergencies arise. The Contractor shall promptly comply with any such requirements made in writing by the Director. The Contractor will also be permitted to Work at night if he or she shall satisfy the Director of the need therefor, in order to maintain the required progress or protect the Work from the elements. Certain activities are required to be performed at night for nominal progress of the Work and/or are specified to be performed at night by other portions of the Supplemental Conditions. When required, ordered, or permitted to Work at night, the Contractor shall provide sufficient and satisfactory lighting and other facilities therefor. The Contractor shall receive no extra payment for night Work, if specified or if required to be performed during the normal progress of the Work, but compensation shall be considered as having been included in the price stipulated for the Work.

2-1.10 **Lines and Grades:** Unless otherwise provided in the Supplemental Conditions, the Contractor shall lay out all Work, including structures and pipelines, and shall be responsible for any errors resulting therefrom. In all questions arising as to proper location of lines and grades, the Director's decision will be final.

As part of the bid price for the construction of the improvements, the Contractor shall provide and be responsible for the layout of all Work on this project. The Contractor shall provide all necessary surveys, field staking, and positioning for the construction of all components at the proper alignment, elevations, grades, and positions, as indicated on the Drawings and as required for the proper operation and function. The Contractor shall stake his Work area limits.

The Contractor's lay-out shall be based on existing structures, property lines, survey control, and bench marks established by the City. All structures and pipeline connections shall be installed based on actual elevation of existing structures to which connections are made.

The Contractor shall supply such labor as required, at no extra charge, to aid and assist the Director in checking location and grades of the Work as set by the Contractor if the Director desires to perform this checking. This shall include moving materials and equipment located between monuments and the construction Work.

2-1.11 **Preservation of Monuments:** Any monuments or bench marks disturbed by construction operations shall be promptly re-established by a registered land surveyor or civil engineer. A plat for each monument shall be furnished to the Director after the plat has been recorded with the County Recorder's Office at no additional cost to the City. The recorded plat shall serve as a record of the re-establishment of said existing survey points.

2-1.12 **Final Cleanup:** Prior to final Acceptance of the Work, the Contractor shall thoroughly clean the Premises, remove all temporary structures built by or for the Contractor, and remove all equipment and surplus construction material and debris from the area. The entire project, before Acceptance by the City, shall be left in a neat and clean condition. All

Work areas and temporary construction areas shall be returned to essentially the same conditions existing before the commencing of project construction.

2-1.13 **As-Built Plans:** The Contractor shall maintain one set of the full size prints furnished by the City and mark thereon any deviations from plan dimensions, elevations, or orientations. Also, the Contractor shall locate on said prints, all underground facilities, such as piping, conduits and tanks by accurate field measurement from structure walls, corners, etc. The Contractor shall submit the prints in good condition to the Director upon completion of the job as a condition of Acceptance of the project. Marked prints shall be updated at least once each week and shall be available to the Director for review as to currency prior to developing partial payment estimates. After the completion of testing, but prior to Acceptance, the Contractor shall submit as built electrical Drawings showing all components and their wiring, and as specified in the Supplemental Conditions.

2-1.14 **Superintendence:** The Contractor shall designate in writing before starting Work, an authorized representative who shall have the authority to represent and act for the Contractor.

When the Contractor is comprised of two (2) or more persons, firms, partnerships, or corporations functioning on a joint venture basis, said Contractor shall designate in writing before starting Work, the name of one authorized representative who shall have the authority to represent and act for the Contractor.

Said authorized representative shall be present at the site of the Work at all times while Work is actually in progress on the Contract. When Work is not in progress and during periods when Work is suspended, arrangements acceptable to the Director shall be made for any emergency Work that may be required.

Whenever the Contractor or his authorized representative is not present on any particular part of the Work where it may be desired to give direction, orders will be given by the Director, which shall be received and obeyed by the superintendent or foremen who may have charge of the particular Work in reference to which the orders are given.

Any order given by the Director, not otherwise required by the Supplemental Conditions to be in writing, will on request of the Contractor, be given or confirmed by the Director in writing.

2-1.15 **Character of Worker:** If any subcontractor or person employed by the Contractor shall appear to the Director to be incompetent or to act in a disorderly or improper manner, he or she shall be removed immediately on the requisition of the Director, and such person shall not again be employed on the Work.

2-1.16 **Inspection:** The Contractor shall at all times permit the Director to inspect the Work of any part thereof. The Contractor shall maintain proper facilities and provide safe access for such inspection by the Director to all parts of the Work, and to the shops where the Work is in preparation. Work shall not be covered up until authorized by the Director and the Contractor shall be solely responsible for notifying the Director where and when such Work is in readiness for inspection and testing. Should any such Work be covered without authorization, it shall, if so ordered, be uncovered at the Contractor's expense.

Whenever the Contractor intends to perform Work on Saturday, Sunday, or a legal holiday, he or she shall give notice to the Director of such intention twenty-four (24) hours prior to performing such Work, or such longer period as may be specified so that the Director may make necessary arrangements.

2-1.17 **Removal of Rejected and Unauthorized Work:** All Work which has been rejected shall be remedied, or removed and replaced by the Contractor in a manner acceptable to the Director and no compensation will be allowed the Contractor for such removal, replacement, or remedial Work.

Any Work done beyond the lines shown on the Drawings or established by the Director, or any Work done without written authority will be considered as unauthorized Work and will not be paid for. Upon order of the Director, unauthorized Work shall be remedied, removed, or replaced at the Contractor's expense.

Upon failure of the Contractor to comply promptly with any order of the Director made under this section, the Director may cause rejected or unauthorized Work to be remedied, removed, or replaced, and the costs thereof will be deducted from any moneys due or to become due the Contractor.

SECTION 3

CHANGES IN THE WORK

3-1.01 **Changes:** The Department reserves the right to order changes in the Contract at any time prior to the Acceptance of the Work by the Director, and the Contractor shall comply with such order. Department also reserves the right to use its own forces or to contract with others to accomplish changes in the Work at its discretion. Changes or deviations from the Contract shall not be made without authority in writing from the Director, and any change to the Work without the Director's written approval will be considered unauthorized Work and will not be paid for.

On the basis set forth in this Section 3, the Contract Lump Sum Price shall be adjusted for any ordered change, which results in a change in the cost of the Work.

When ordered by the Director, the Contractor shall halt Work in the area affected by a proposed change. Whenever it appears to the Contractor that a change is necessary, the Contractor shall immediately notify the Director of the reasons for such change; however, Work in the area affected shall not be discontinued unless ordered by the Director.

For any approved change in the Work, the Contractor shall be entitled to an adjustment in time equal to the number of Days which completion of the entire Work is delayed due to the changed Work. The Contractor's cost estimate for the changed Work shall state the amount of extra time, if any, that he or she considers should be allowed for making the requested change. Failure to request additional time when submitting such estimate shall constitute a waiver of

the right to later claim any adjustment in time based upon changed Work. Disagreement as to time adjustments shall not affect Contract price adjustments, nor shall it be cause for not proceeding with the changed Work when ordered by the Director. The Contractor shall have the right, however, to further pursue a time adjustment in the event an agreement is not reached. The Contractor shall not be entitled to a time extension or adjustment for any Change Order or delays in activities not on the critical path unless the delay or change exceeds the total float of the activities being delayed or changed.

3-1.02 **Ordinary Change Orders:** The Contractor will be notified in writing of a proposed Change Order describing the intended change. Within fifteen (15) Days after receipt of a written request, the Contractor shall submit his proposed price to be added or deducted from the Contract price due to the change. The Contractor's proposed price to be added to or deducted from the Contract price shall be supported by a detailed estimate of cost prepared by the Contractor, vendor or supplier. The Contractor's proposed price submittal shall be accompanied by a statement of the time necessary for the changed Work, together with a description of how this time will be incorporated into the current Construction Schedule. The Contractor shall upon request by the Director permit inspection of his original Contract estimate, subcontract agreements or purchase orders relating to the change.

If agreement is reached on the adjustment in compensation as provided in Section 3-1.04, "Agreed Cost for Change Orders," of these General Conditions, the Contractor shall proceed with the Work as changed at the agreed price.

If the Contractor and the Director fail to agree as to the adjustment in compensation for the performance of the changed Work, the Contractor, upon written order from the Director, shall proceed immediately with the changed Work and the Contract price shall be adjusted in

accordance with Section 3-1.05, "Failure to Agree to the Cost of Change Orders," of these General Conditions.

If the Contractor fails to submit his cost estimate within such fifteen (15) day period, the Contractor shall commence the Work as changed immediately upon receipt of written order of the Director, and the Contract price will be adjusted in accordance with the Director's cost estimate for the changed Work, unless the Contractor, within fifteen (15) Days following completion of changed Work, presents proof to the satisfaction of the Director that the Director's estimate of cost was in error.

3-1.03 **Emergency and Indeterminate Type Change Orders:** Changes in the Work made necessary by an emergency, as determined by the Director, or changes of a kind where the extent of the Work cannot be determined until completed, may be authorized by the Director in writing. The Change Order shall state that it is issued pursuant to this Section 3-1.03. Upon receipt of an authorized Change Order or other written order of the Director, the Contractor shall proceed with the ordered Work and the Director will maintain a daily job record containing a detailed summary of all labor, materials and equipment required for the changed Work.

Within fifteen (15) Days after receiving a written request, the Contractor shall submit a detailed estimate of cost for the change and any requested change in Contract time in the same manner as required for ordinary Change Orders in Section 3-1.02 of these General Conditions.

3-1.04 **Agreed Cost for Change Orders:** If the Director and the Contractor agree as to the adjustment in compensation for the performance of changed Work on the basis of the Contractor's proposed cost estimate of the Work, the Contract price will be adjusted accordingly. The agreement shall be in writing and executed by both parties.

3-1.05 **Failure to Agree to the Cost of Change Orders:** When a proposed Change Order decreases the cost of the Work and the Director and the Contractor fail to agree upon the decreased cost thereof, the Director's estimated decrease in cost shall be deducted from the Contract price. The Contractor will be allowed fifteen (15) Days after receipt of a Contract Change Order approved by the Director, in which to file a written protest setting forth in what respects he or she differs from the Director's estimate of decreased cost, otherwise the decision of the Director to deduct the estimate of decreased cost shall be deemed to have been accepted by the Contractor as correct.

In the event the Director and the Contractor fail to agree on the cost of a Change Order which increases the cost of the Work, the Director will maintain a daily job record containing a detailed summary of all labor, materials and equipment required by the ordered change. At the end of each day's Work, the Contractor shall review the Director's daily job record comparing with his own records, and after agreement is reached, the daily job record shall be signed by both the Director and the Contractor and shall become the basis for payment for the changed Work. Upon completion of the Work under the Change Order, the Contractor shall submit an invoice listing only those items of labor, materials and equipment that were agreed to by both the Director and the Contractor to be in addition to the requirements of the Contract, together with allowable markups.

When there is a failure to agree as to cost, no payment for the changed Work will be made to the Contractor until all Work called for in the Change Order has been completed, except that progress payments may be made on those portions of the changed Work which the Contractor and the Director agree as to cost.

3-1.06 **Allowable Costs for Change Orders:** The only costs which will be allowed because of changed Work and the manner in which such costs shall be computed are set forth in Sections 3-1.06(A) through 3-1.06(E) of these General Conditions. Where the term "actual cost" is used in the aforesaid sections, it shall be deemed to mean "estimated cost" where the adjustment in compensation is of a necessity based upon estimated costs.

3-1.06(A) **Labor:** The Contractor will be paid an amount based on the actual cost for labor and supervision directly required for the performance of the changed Work, including payments, assessment of benefits required by lawful labor union collective bargaining agreements; compensation insurance payments; contributions made to the State pursuant to the Unemployment Insurance Code, and for taxes paid to the Federal Government pursuant to the Social Security Act of August 14, 1935, as amended. No labor cost will be recognized at a rate in excess of the wages prevailing in the locality at the time the Work is performed, nor will the use of a labor classification which would increase the cost, be permitted unless the Contractor establishes to the complete satisfaction of the Director the necessity for payment at a higher rate.

3-1.06(B) **Materials:** The Contractor will be paid an amount based on the actual cost of the materials directly required for the performance of the changed Work. Such cost of materials may include the costs of procurement, transportation and delivery if necessarily incurred. If a cash or trade discount by the actual supplier is available to the Contractor, it shall be credited to the City. If the materials are obtained from a supply or source owned wholly or in part by the Contractor, payment therefor will not exceed the current wholesale price for such materials. If, in the opinion of the Director, the cost of materials is excessive, or if the Contractor fails to furnish satisfactory evidence of the cost to him or her from the

actual supplier, the cost of the materials shall be deemed to be the lowest current wholesale price at which similar materials are available in the quantities required. The Department reserves the right to furnish such materials required by the Change Order as it deems advisable, and the Contractor shall have no claim for cost or markups on material furnished by the Department.

3-1.06(C) **Equipment:** The Contractor will be paid an amount based on the actual cost for the use of equipment directly required and approved by the Director in the performance of the changed Work. No payment will be made for time while equipment is inoperative due to breakdowns or on Days when no Work is performed. In addition, the rental time shall include the time required to move the equipment to the Work from the nearest available source of such equipment, and to return it to the source. If such equipment is not moved by its own power, then loading and transportation costs will be paid. Moving time, loading and transportation costs will only be paid if the equipment is used exclusively on the changed Work during the time between move in and move out. Individual pieces of equipment having a replacement value of One Hundred Dollars ($100) or less shall be considered to be tools or small equipment, and no payment will be made therefore. For equipment owned, furnished, or rented by the Contractor, no cost therefore shall be recognized in excess of the rental rates established by distributors or equipment rental agencies in the locality where the Work is performed.

3-1.06(D) **Markups:** When a Change Order increases the cost of the Work, the Contractor may add the following maximum markups to its actual costs of labor, materials, or equipment rental:

16 1/2 percent for labor;

16 1/2 percent for materials; and

16 1/2 percent for equipment rental.

The above markups include full compensation for bonds, profit and Overhead and shall not include work done by a subcontractor. When a Change Order decreases the cost of the Work, the reduction in cost shall include a five percent (5%) markup on the estimated cost for furnishing the labor, materials and equipment, which would have been used on such Work, had the Change Order not been issued.

When a Change Order involves both added Work and deleted Work, the markup or markups to be used shall be as follows:

The actual costs of labor, materials, and equipment rental for added and deleted Work shall be calculated separately without adding markups. If the difference between the calculated costs for labor results in an increased cost, a markup of sixteen and one-half percent (16.5%) shall be applied to the increased cost. If the difference between the calculated costs of materials or equipment rental results in an increased cost, a markup of sixteen and one-half percent (16.5%) shall be applied to the increased costs of materials or equipment rental, as the case may be. If the difference between the calculated costs for labor, materials or equipment rental results in a decreased cost, a markup of five percent (5%) shall be applied to the decreased costs of labor, materials or equipment rental, as the case may be.

3-1.06(E) **General Limitations:** In no event shall any actual cost for added Work be recognized in excess of market values prevailing at the time of the change, unless the Contractor can establish to the satisfaction of the Director that he or she investigated all possible means of obtaining such Work at prevailing market values and that the excess cost

could not be avoided. The Director shall determine the necessity for incurring the costs enumerated above, and as to whether they are directly at the option of the Director. When a Change Order deletes Work from the Contract, the computation of the cost thereof shall be the values that prevailed at the time bids for the Work were opened.

When Change Order Work is performed by a subcontractor, Contractor's compensation shall be based on all Direct Costs as listed in the subcontractor's portion of the proposal and an amount determined by the Director not to exceed fifteen percent (15%) to Contractor as Overhead and profit.

It is understood and agreed by the City and the Contractor that the Contractor will incur Overhead costs for temporary facilities, superintendence, home office Overhead, and similar cost items, and that the costs of such Overhead for the full Contract period through the specified completion date are included in the Contractor's lump sum bid amounts included in his accepted Proposal. No additional compensation will be made to the Contractor for claims of increased Overhead costs occurring within the originally specified construction Contract period plus any time extensions granted by Change Order.

3-1.07 If the Contract price increases by the issuance of Change Orders, the Contractor shall within ten (10) calendar Days provide a commensurate increase in the penal amounts of the bonds required.

SECTION 4

CONTROL OF MATERIALS

4-1.01 **Materials:** The Contractor shall furnish all materials required to complete the Work, except materials that are designated in the Supplemental Conditions to be furnished by the City and materials furnished by the City in accordance with Section 3, "Changes in the Work," of these General Conditions.

Unless otherwise specified in the Supplemental Conditions, materials furnished by the Contractor for incorporation into the Work shall be new. When the quality or kind of materials, articles, or equipment is not particularly indicated, then the quality or kind thereof shall be similar to those that are indicated.

Articles or materials to be incorporated in the Work shall be stored in such a manner as to insure the preservation of their quality and fitness for the Work, and to facilitate inspection.

All materials which do not conform to the requirements of the Contract Documents as determined by the Director, will be rejected whether in place or not. Rejected material shall be removed immediately from the site of the Work, unless otherwise permitted by the Director. No rejected material, the defects of which have been subsequently corrected, shall be used in the Work, unless approval in writing has been given by the Director. Upon failure of the Contractor to comply promptly with any order of the Director made under these provisions, the Director shall have the authority to cause the removal and replacement of rejected material and to deduct the cost thereof from any moneys due or to become due the Contractor.

Manufacturer's warranties, guaranties, instruction sheets and parts lists, which are furnished with certain materials incorporated in the Work, shall be delivered to the Director before Acceptance of the Contract.

Unless otherwise designated in the Supplemental Conditions or Specifications, materials furnished by the City will be delivered to the jobsite. Materials furnished by the City that are designated in the Supplemental Conditions as available at locations other than the job site shall be hauled to the site of the Work by the Contractor at his expense, including any necessary loading and unloading that may be involved.

The Contractor will be held responsible for all materials furnished to him or her, and shall pay all demurrage and storage charges. City-furnished materials lost or damaged from any cause whatsoever shall be replaced by the Contractor. The Contractor will be liable to the Department for the cost of replacing City-furnished material and such costs may be deducted from any moneys due or to become due the Contractor.

4-1.02 **Product and Reference Standards:** When descriptive catalog designations, including manufacturer's name, product brand name, or model number are referred to in the Contract Documents, such designations shall be considered as being those found in industry publications in effect on the day the Notice to Contractors for the Work is dated.

When standards or test designations of the Federal Government, trade societies, or trade associations are referred to in the Contract Documents by specific date of issue, these shall be considered a part of the Contract. When such references do not bear a date of issue, the edition in effect on the day the Notice to Contractors for the Work is dated shall be considered as part of the Contract.

4-1.03 **Sampling and Testing of Materials:** Unless otherwise specified, all tests shall be performed in accordance with the methods used by the State Department of Transportation (CalTrans) and shall be made by the Director or his or her designated representative.

The State Department of Transportation has developed test methods for testing the quality of materials and Work. These test methods are identified by California Test followed by the serial number. Copies of individual tests are available at the State Department of Transportation Laboratory, Sacramento, California, and will be furnished to interested persons upon request.

Whenever a reference is made in the Supplemental Conditions to a California Test by number, it shall mean the California test in effect on the day the Notice to Contractors for the Work is dated.

Whenever the Supplemental Conditions provide an option between two (2) or more test methods, the Director will determine the test method to be used.

Whenever a Supplemental Condition, manual, or test designation provides for test reports (such as certified mill test reports) from the manufacturer, copies of such reports, identified as to the lot of material, shall be furnished to the Director. The manufacturer's test reports shall supplement the inspection, sampling and testing provisions of the Section 4-1.03 and shall not constitute a waiver of the City's right to inspect. When material which cannot be identified with specific test reports is proposed for use, the Director may at his or her discretion, select random samples from the lot for testing. Testing specimens from the random samples, including those required for retest, shall be prepared in accordance with the referenced Supplemental Conditions and furnished by the Contractor at his or her expense.

The number of such samples and test specimens shall be entirely at the discretion of the Director.

When requested by the Director, the Contractor shall furnish, without charge, samples of all material entering into the Work, and no material shall be used prior to approval by the Director, except as provided in Section 4-1.04, "Certificates of Compliance," of these General Conditions.

A. Inspection and Access for Testing: The Contractor shall provide safe access for the Director and his or her inspectors to adequately inspect the quality of Work and the conformance with the Supplemental Conditions. The Contractor shall provide adequate lighting, ventilation, ladders and other protective facilities as may be necessary for the safe performance of inspections.

The Contractor shall submit samples or specimens of such materials to be furnished or used in the Work as the Director may require. The Contractor shall furnish the Director all necessary labor and facilities for such things as excavation in the compacted fill to depths required to take samples.

Inspections, tests, or favorable review by the Director or others shall not relieve the Contractor from his or her obligations to perform the Work in accordance with the requirements of the Contract Documents.

Work covered without the favorable review or consent of the Director shall, if required by the Director, be uncovered for examination at the Contractor's expense.

If the engineer considers it necessary or advisable that covered Work be inspected or tested by others, the Contractor, at the Director's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Director may require,

that portion of the Work in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such Work is defective, the Contractor will bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such Work is not found to be defective and the Work was not covered without favorable review of the Director, the Contractor will be allowed an increase in the Contract price or an extension of the Contract time, or both, to cover his or her costs directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction and an appropriate Change Order shall be issued.

Whenever the Contractor varies the period during which Work is carried on each day, he or she shall give due notice to the Director so that proper inspection may be provided. Any Work done in the absence of the Director may be subject to rejection. Proper facilities for safe access for inspection to all parts of the Work shall at all times be maintained for the necessary use of the Director and other agents of the City. Authorized representatives and agents of the Director shall be permitted access to inspect all Work and materials wherever it is required for preparation of progress reports, and the Contractor shall provide proper facilities for such access and inspection.

It is the Contractor's responsibility to supervise the Work and complete the project in accordance with the Contract Documents. In the course of managing that effort, the Contractor shall generate his or her own punch lists as deemed necessary. The Director may prepare punch lists for the Director's own use in communicating with the Contractor; however, the Director shall be under no obligation to prepare punch lists for the Contractor. In general, the Director will prepare punch lists only after the Contractor has given the Director written notice that the subject Work is completed and tested in accordance with the

Contract Documents and is ready for operation and/or use and/or occupancy. Failure of the Director to include an item in a punch list shall not relieve the Contractor of his duty to satisfactorily complete all Work required by the Contract Documents.

Upon final completion of the construction Work and request by the Contractor, the Director will conduct a final inspection as a basis for recommending to the City that the Work be accepted.

B. Field and Materials Testing. Where the Supplemental Conditions require Work to be specially field tested or approved, it shall be tested only in the presence of the Director after timely notice of its readiness for inspection and test, and the Work after testing shall be covered up only upon the consent thereto of the Director.

The results of any tests made are for the information of the Director. Regardless of any test results, the Contractor is solely responsible for the quality of workmanship and materials and for compliance with the requirements of the Drawings and Supplemental Conditions.

Except as specifically required under detailed materials Supplemental Conditions for shop testing and inspection, all tests of materials furnished by the Contractor where tests will be made by the Director will be done in accordance with commonly recognized standards of national organizations. The Contractor shall furnish such samples of all materials as required by the Director without charge. No material shall be used unless it has been favorably reviewed by the Director.

Where such inspection and testing are to be conducted by an independent Laboratory or agency, the sample or samples of materials to be tested shall be selected by such Laboratory or agency, or the Director, and not by the Contractor.

C. Costs of Testing.

1. Initial Services: The City shall furnish and pay for all initial testing services required by the Contract Documents. When initial tests indicate non-compliance with the Contract Documents, the cost of initial tests associated with that non-compliance will be deducted by the City from the balance owed the Contractor. The Contractor shall furnish samples of materials for testing as may be required by the Director. Such samples shall be furnished without cost to the City.

2. Retesting: When initial tests indicate non-compliance with the Contract Documents, all subsequent retesting occasioned by the non-compliance shall be performed by the same testing Laboratory and the cost thereof will be deducted by the City from the balance owed the Contractor.

3. Contractor Convenience Testing: Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

4. When in the opinion of the Director additional tests or inspections are required because of the manner in which the Contractor executes his Work, such tests and inspections shall be paid for by the City, but will be deducted from the Contract price. Examples of such tests and inspections are tests of materials substituted for previously accepted materials or substituted for specified materials, retests made necessary by failure of material to comply with the requirements of the Specifications, load tests made necessary because of portions of the structure not fully meeting Specifications or plan requirements, etc.

4-1.04 **Certificates of Compliance:** A Certificate of Compliance shall be furnished prior to the use of any materials for which the Supplemental Conditions require that such a Certificate be furnished. In addition, the Director may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance. The Certificate shall be signed by the manufacturer of the material or the manufacturer of assembled materials and shall state that the materials involved comply in all respects with the requirements of the Supplemental Conditions. A Certificate of Compliance shall be furnished with each lot of such materials delivered to the Work and the lot so certified shall be clearly identified in the Certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the Work which conforms to the requirements of the Contract Documents and any such material not conforming to such requirements will be subject to rejection whether in place or not.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

The form of the Certificate of Compliance and its disposition shall be as directed by the Director.

SECTION 5

LEGAL RELATIONS AND RESPONSIBILITY

5-1.01 **Laws to be Observed:** The Contractor shall keep informed of and observe, and comply with and cause all of his or her agents and employees to observe and comply with, all prevailing Federal and State laws, and rules and regulations made pursuant to said Federal and State laws, and county and municipal ordinances, and regulations, which in any way affect the conduct of the Contract. If any conflict arises between provisions of the Contract and any such law above referred to, the Contractor shall notify the Director at once in writing. The Contractor shall protect and indemnify the City or any of its officers, agents and servants against any claim or liability arising from or based on the violation of any such law, rule, or regulation, whether by him or herself or his or her agents or employees.

5-1.02 **Hours of Labor:** Eight (8) hours labor constitutes a legal day's Work. The Contractor shall forfeit, as a penalty to City, Fifty ($50) Dollars for each worker employed in the execution of the Contract by the Contractor or any subcontractor under him for each calendar day during which such worker is required or permitted to Work more than eight (8) hours in any one (1) calendar day and forty (40) hours in any one (1) calendar week in violation of the provisions of the Labor Code, and in particular, Section 1810 to Section 1815, thereof, inclusive, except that Work performed by employees of Contractors in excess of eight (8) hours per day, and forty (40) hours during any one (1) week, shall be permitted upon compensation for all hours worked in excess of eight (8) hours per day at not less than one and one-half (1-1/2) times the basic rate of pay, as provided in said Section 1815.

5-1.03 **Nondiscrimination**:

A. Attention is directed to Labor Code Section 1735, which reads as follows:

"No discrimination shall be made in the employment of persons upon public works because of the race, religious creed, color, national origin, ancestry, physical disability, mental disability, medical condition, marital status, or sex of such persons, except as provided in Section 12940 of the Government Code, and every Contractor for public works violating this section is subject to all the penalties imposed for a violation of this chapter."

B. During the performance of this Contract, Contractor and its subcontractors shall not unlawfully discriminate against any employee or applicant for employment because of race, religion, color, national origin, ancestry, physical handicap, medical condition, marital status, age or sex. The Contractor and subcontractors shall insure that the evaluation and treatment of their employees and applicants for employment are free of such discrimination. The Contractor and subcontractors shall comply with the provisions of the Fair Employment and Housing Act (Government Code §12900, et seq.) and the applicable regulations promulgated thereunder (California Code of Regulations, Title 2, §7285.0 et seq.) and other applicable State and Federal regulations pertaining to nondiscrimination and affirmative action which are incorporated into this Agreement by reference and made a part hereof as if set forth in full. The Contractor and its subcontractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement.

C. Contractor shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform Work under the agreement.

5-1.04 **Prevailing Wage:** The Contractor shall comply with Labor Code Sections 1770 et seq. In accordance with said Section 1775 the Contractor shall forfeit as a penalty to the City Fifty Dollars ($50) for each calendar day or portion thereof, for each worker paid less than the prevailing rates for such Work or craft in which such worker is employed for any Work done under the Contract by the Contractor or by any subcontractor under the Contractor in violation of the provisions of the Labor Code and in particular, Labor Code Sections 1770 to 1780, inclusive. In addition to said penalty and pursuant to said Section 1775, the difference between such stipulated Prevailing Wage Rates and the amount paid to each worker for each calendar day or portion thereof for which each worker was paid less than the stipulated Prevailing Wage shall be paid to each worker by the Contractor or subcontractor.

Pursuant to the provisions of California Labor Code Sections 1773, the Department has identified the source, stated below, of the General Prevailing Rate of Wages applicable to the Work to be done, for straight time, overtime, and holiday Work. The holiday wage rate listed shall be applicable to all holidays recognized in the collective bargaining agreement of the particular craft, classification or type of worker concerned. These wage rates may be obtained from the State Department of Industrial Relations and/or the following website address: hhtp:/www.dir.ca.gov/DLSR/PWD/Northern.html, which is a part of this Contract.

Pursuant to Labor Code Section 1773.2, General Prevailing Wage Rates set forth above, which forms a part of this Contract, shall be posted by the Contractor at a prominent place at the site of the Work.

Prevailing Wage Rates to be posted at the job site will be furnished by the Department.

The City will not recognize any claim for additional compensation because of the payment by the Contractor of any wage rate in excess of the Prevailing Wage Rate set forth in

the Contract. The possibility of wage increases is one of the elements to be considered by the Contractor in determining his or her Bid, and will not under any circumstances be considered as the basis of a claim against the City or Contract.

5-1.05 **Travel and Subsistence Payments:** [Reserved]

5-1.06 **Payroll Records:** The Contractor's attention is directed to the following provisions of Labor Code Section 1776. The Contractor shall be responsible for the compliance with these provisions by his or her subcontractors.

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

B. The payroll records enumerated under subdivision A shall be certified and shall be available for inspection at all reasonable hours at the principal office of the Contractor on the following basis:

(1) A certified copy of an employee's payroll record shall be made available for inspection or furnished to such employee or his or her authorized representative on request.

(2) A certified copy of all payroll records enumerated in subdivision A shall be made available for inspection or furnished upon request to a representative of the City, the Division of Labor Standards Enforcement or the Division of Apprenticeship Standards of the Department of Industrial Relations.

(3) A certified copy of all payroll records enumerated in subdivision A shall be made available upon request to the public for inspection or copies thereof made, provided, however, that a request by the public shall be made through either the City, the Division of Apprenticeship Standards of the Division of Labor Standards Enforcement. The public shall not be given access to such records at the principal office of the Contractor.

C. Each Contractor shall file a certified copy of the records enumerated in subdivision A with the entity that requested such records within ten (10) Days after receipt of a written request.

D. Any copy of the records made available for inspection as copies and furnished upon request to the public or any public agency by the City, the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement shall be marked or obliterated in such a manner as to prevent disclosure of an individual's name, address and social security number. The name and address of the Contractor awarded the Contract or performing the Contract shall not be marked or obliterated.

E. The Contractor shall inform the City of the location of the records enumerated under subdivision A, including the street address, city and county, and shall, within five (5) working Days, provide a notice of a change of location and address.

F. In the event of noncompliance with the requirements of this Section, the Contractor shall have ten (10) Days in which to comply subsequent to receipt of written notice specifying in what respects such Contractor must comply with this section. Should noncompliance still be evident after such ten (10) day period, the Contractor shall, as a penalty to the State or City, forfeit twenty-five ($25) Dollars for each calendar day, or portion thereof,

for each worker, until strict compliance is effectuated. Upon the request of the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement, such penalties shall be withheld from progress payment or final payment then due. Responsibility for compliance with this section lies with the Contractor.

5-1.07 **Safety**: In accordance with generally accepted construction practices and State law, the Contractor shall be solely and completely responsible for conditions on the job site, including safety of all persons and property during performance of the Work. This requirement shall apply continuously and not be limited to normal working hours.

The services of the Director in conducting construction review of the Contractor's performance is not intended to include review of the adequacy of the Contractor's Work methods, equipment, bracing or scaffolding, or safety measures, in, on, or near the construction site.

The Contractor is hereby informed that Work on this project could be hazardous. The Contractor shall carefully instruct all personnel working in potentially hazardous Work areas as to potential dangers and shall provide such necessary safety equipment and instructions as are necessary to prevent injury to personnel and damage to property. Special care shall be exercised relative to Work underground.

All Work and materials shall be in strict accordance with all applicable State, City, County, and Federal Rules, Regulations, and Codes, and attention is drawn to the requirements of CAL/OSHA. The Contractor shall be solely responsible for compliance with all City, County and State blasting requirements and for any damages caused by his or her operations.

In accordance with State Labor Code Section 6705, the Contractor shall submit to the City specific plans to show details of provisions for worker protection from caving ground. This in no way relieves the Contractor from the requirement of maintaining safety in all operations performed by the Contractor or the Contractor's subcontractors. The detailed Plan showing design of shoring, bracing, sloping or other provisions shall be prepared by a registered Civil or Structural Director in the State of California as required. Acceptance by the City or its designated agent only constitutes acknowledgment of the submission and does not constitute review or approval of the designs, design assumptions or criteria, completeness of submissions, applicability to areas of intended use, nor implementation of the Plans, which are solely the responsibility of the Contractor and his or her registered Director.

Notwithstanding any classifications relative to the Tunnel Safety Orders, Work within confined spaces on this project is subject to the definitions and applicable provisions of California Code of Regulations Section 5156 et seq., Title 8.

The Contractor shall so perform its Work as not to expose personnel to, or to discharge into the atmosphere from any source whatever, smoke, dust, asbestos, toxic chemicals or other air contaminants in violation of the laws, rules, and regulations of the governmental entities having jurisdiction. Contractors or subcontractors removing one hundred (100') or more square feet of asbestos must be "Certified" in accordance with State law. All Work involving exposure to asbestos and all other hazardous materials shall be performed with protection of personnel in compliance with all applicable regulations and safety requirements.

Nothing in these General Conditions is to be construed to permit Work not conforming to governing codes. When Contract Documents differ from governing codes, the Contractor shall furnish and install the higher standards called for without extra charge. All equipment

furnished shall be grounded and provided with guards and protection as required by safety codes. Where vapor tight or explosion proof electrical installation is required by code, this shall be provided. In accordance with the provisions of Labor Code Section 6707, the Contractor shall provide adequate sheeting, shoring and bracing for employee protection, as provided in his proposal as separate Bid Items.

5-1.08 **Apprentices:** Attention is directed to Labor Code Sections 1777.5, 1777.6 and 1777.7and Title 8, California Code of Regulations Section 200 et seq. To insure compliance and complete understanding of the law regarding apprentices, and specifically the required ratio thereunder, each Contractor or subcontractor should, where some questions exist, contact the Division of Apprenticeship Standards, 455 Golden Gate Avenue, San Francisco, California, or one of its branch offices prior to commencement of Work on the public works Contract. Responsibility for compliance with this section lies with the prime Contractor.

It is State and City policy to encourage the employment and training of apprentices on public works Contracts as may be permitted under local apprenticeship standards.

5-1.09 **Fair Labor Standards Act:** Attention is invited to the fact that the City has been advised by the Wage and Hour Division, U.S. Department of Labor, that Contractors engaged in construction Work are required to meet the provisions of the Fair Labor Standards Act of 1958 and as amended (52 Stat. 1060).

5-1.10 **Workers' Compensation:** Pursuant to the requirements of Labor Code Section 1860, the Contractor will be required to secure the payment of workers' compensation to his employees in accordance with the provisions of Labor Code Section 3700.

Prior to the commencement of Work, the Contractor shall sign and file with the Director a certification in the following form:

"I am aware of the provisions of Labor Code Section 3700 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."

5-1.11 **Air Pollution Control and Asbestos:** The Contractor shall comply with all air pollution control rules, regulations, ordinances and statutes which apply to any Work performed pursuant to the Contract, including any air pollution control rules, regulations, ordinances and statues, specified in Government Code Section 11017.

In the absence of any applicable air pollution control rules, regulations, ordinances or statutes governing solvents, all solvents, including but not limited to the solvent portions of paints, thinners, curing compounds, and liquid asphalt used on the project shall comply with the applicable material requirements of the applicable Air Quality Management District. All containers of solvent, paint, thinner, curing compound or liquid asphalt shall be labeled to indicate that the contents fully comply with said requirements.

Unless otherwise provided in the Supplemental Conditions, material to be disposed of shall not be burned, either inside or outside the Premises.

The Contractor shall comply with all rules, regulations, statutes and ordinances regarding asbestos removal and disposal, including but not limited to, 42 U.S.C. Sections 7401, 7412 and 7601 and 40 C.F.R. Part 61, Subpart M.

If the Contractor discovers that a building to be demolished or renovated contains asbestos containing material, the Contractor shall immediately cease Work and notify the City.

5-1.12 **Use of Pesticides:** The Contractor shall comply with all rules and regulations of the Department of Food and Agriculture, the Department of Health, the Department of

Industrial Relations and all other agencies which govern the use of pesticides required in the performance of the Work on the Contract.

Pesticides shall include but shall not be limited to herbicides, insecticides, fungicides, rodenticides, germicides, nematocides, bactericides, inhibitors, fumigants, defoliants, desiccants, soil sterilants, and repellents.

Any substance or mixture of substances intended for preventing, repelling, mitigating, or destroying weed, insects, diseases, rodents, or nematodes and any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant shall be considered as pesticide.

5-1.13 **Sound Control Requirements:** The Contractor shall comply with all local sound control and noise level rules, regulations and ordinances which apply to any Work performed pursuant to the Contract. Work shall not begin before 7 a.m. nor occur after 7 p.m.

Each internal combustion engine, used for any purpose on the Work or related to the Work, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the project without said muffler.

5-1.14 **Environmental Clearances; Mitigation Monitoring Programs; and Regulatory Agency Permit Requirements:** The Department will obtain all environmental clearances and other authorizations necessary for this project as set forth in the Contract Documents. The Contractor shall comply with the provisions, including giving notices during construction when required, of said authorizations. In the event the obtaining of said authorizations delays completion of all or any portion of the Work, an extension of time

determined pursuant to the provisions in Section 6-1.08, "Liquidated Damages," of these General Conditions will be granted.

Contractor shall comply with: 1) all mitigation identified in the mitigation monitoring program (attached to and adopted as a component of the mitigated negative declaration or Environmental Impact Report) to mitigate impacts to protected natural resources; and 2) all related permit requirements issued by the regulatory agencies authorizing the project. Contractor shall defend, indemnify, and save and hold harmless the CITY, its officers, agents, and employees from any fines, claims, suits, actions or regulatory sanctions of every name, kind and description brought forth, or on account of, damage to protected natural resources from or arising out of Contractor's negligence or willful misconduct in the performance of this Agreement.

5-1.15 **Permits and Licenses:** The Contractor shall procure all permits and licenses in coordination with the Director and give all notices necessary and incident to the due and lawful prosecution of the Work. All permits and licenses shall be obtained in sufficient time to prevent delays to the Work. All fees and connection charges specifically related to the Work shall be paid by City. The Contractor shall obtain and maintain a City business license.

5-1.16 **Assignment of Antitrust Actions:** The Contractor's attention is directed to the following provision of Government Code Section 4551 which shall be applicable to the Contractor and his subcontractors:

> "In entering into a Public Works Contract or a subcontract to supply goods, services, or materials pursuant to a Public Works Contract, the Contractor or subcontractor offers and agrees to assign to the awarding body all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act

(15 U.S.C. Sec. 15) or under the Cartwright Act (Chapter 2 (commencing with Section 16700) of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services, or materials pursuant to the public works Contract or the subcontract. This assignment shall be made and become effective at the time the awarding body tenders final payment to the Contractor, without further acknowledgment by the parties."

5-1.17 **Protection and Use of Property:** The Contractor shall be responsible for and provide and maintain all proper temporary walks, roads, guards, railings, lights, warning signs, and take precaution at all times to avoid injury or damage to any person or any property, and upon completion of the Work, or at other times as directed, restore Premises and adjacent property to a proper condition.

The Contractor shall protect adjoining property and nearby buildings, including City buildings, City roads, and public streets or roads, from dust, dirt, debris, or the nuisance arising out of the Contractor's operations or storage practices, and, if ordered by the Director, the Contractor shall provide and install suitable safeguards, approved by the Director, to protect such objects from damage. If such objects are damaged by reason of the Contractor's operations, they shall be replaced or restored at the Contractor's expense.

If the Contractor damages any buildings, roads or other property which belong to the City, or any Department or agency thereof, then the Director, at his or her option, may retain from the money due under the Contract an amount sufficient to insure repair of the damage.

The Director may make or cause to be made such temporary repairs as are necessary to restore to service any such damaged facility. The cost of such repairs shall be borne by the

Contractor and may be deducted from any moneys due or to become due the Contractor under the Contract.

5-1.18 **Responsibility for Damage:** The City of Roseville, its officers, agents, volunteers and employees, including but not limited to the Director and the City Director, shall not be answerable or accountable in any manner: for any loss or damage that may happen to the Work or any part thereof; for any loss or damage to any of the materials or other things used or employed in performing the Work; for injury to or death of any person, either workers or the public; or for damage to property from any cause which might have been prevented by the Contractor, his or her workers, or anyone employed by the Contractor or the Contractor's subcontractors.

The Contractor shall be responsible for any liability imposed by law and for injuries to, or death of, any person including, but not limited to, workers and the public, or damage to property resulting from defects or obstructions, or from any cause whatsoever during the progress of the Work or at any time before its completion and final Acceptance.

The Contractor shall defend, indemnify, and save harmless the City of Roseville, and its officers, Directors, agents, subcontractors, and employees from all claims, suits or actions of every name, kind and description, brought forth, or on account of, injuries to or death of any person including, but not limited to, workers and the public, or damage to property resulting from the performance of the Contract, except as otherwise provided by statute. The duty of the Contractor to indemnify and save harmless includes the duties to defend as set forth in Civil Code Section 2778.

The Contractor waives any and all rights to any type of express or implied indemnity against the City, its officers, agents, volunteers or employees.

It is the intent of the parties that the Contractor will defend, indemnify, and hold harmless the City of Roseville, and its officers, agents, volunteers and employees, from any and all claims, suits or actions as set forth above regardless of the existence or degree of fault or negligence whether active or passive, primary or secondary on the part of the City, the Contractor, the subcontractor or employee of any of these, except where the claims, suits or actions arise from the sole active negligence of the City. The parties intend this indemnity to be broadly construed.

In addition to any remedy authorized by law, so much of the money due the Contractor under and by virtue of the Contract as shall be considered necessary by the Department may be retained by the City until disposition has been made of such suits or claims for damages as aforesaid.

The retention of money due the Contractor shall be subject to the following:

A. The City will give the Contractor thirty (30) Days notice of its intention to retain funds from any partial payment which may become due to the Contractor prior to Acceptance of the Contract. Retention of funds from any payment made after Acceptance of the Contract may be made without such prior notice to the Contractor.

B. No retention of additional amounts out of partial payments will be made if the amount to be retained does not exceed the amount being withheld from partial payments pursuant to Section 7-1.05, "Partial Payments," of these General Conditions.

C. If the City has retained funds and it is subsequently determined that the City is not entitled to be indemnified and saved harmless by the Contractor in connection with matter for which such retention was made, the Department shall be liable for interest on the amount retained at the legal rate of interest for the period of such retention.

5-1.19 **Insurance Coverage:**

A. Evidence of Maintenance Required. The Contractor shall, at all times, maintain in full force and effect the insurance required by this section; and the Contractor shall not allow any subcontractor to commence Work until similar insurance required of the subcontractor has been obtained and filed. A Certificate of Insurance, and copies of all required endorsements, all in a form approved by the City Attorney, evidencing all required coverage or policies shall be filed after the award of the bid and prior to approval of the Contract by the City Council. The Certificate shall provide that at least thirty (30) Days prior written notice of any reduction of coverage limits or cancellation of the coverage or policies shall be given to the City of Roseville as Certificate holder.

B. Qualifying Insurers. With the exception of the State Compensation Insurance Fund, all required insurance policies shall be issued by companies licensed to do business in the State of California and who hold a current policy holders alphabetic and financial size category rating of not less than AVII according to the most recent issue of Best's Insurance Reports.

C. Insurance Required. Commercial General Liability, automobile liability, and workers' compensation insurance shall be maintained as follows:

1.	Commercial General Liability	Bodily Injury: $1,000,000 each occurrence $2,000,000 aggregate Property Damage: $1,000,000 each occurrence Personal Injury: $1,000,000 each occurrence $2,000,000 aggregate

The Commercial General Liability policy shall include coverage or endorsements for:

a. Completed operations.

b. Losses related to independent contractors, products and equipment.

c. Explosion, collapse and underground hazards.

The Commercial General Liability insurance shall include the following endorsements, copies of which shall be provided:

a. Inclusion of the City of Roseville, and its officers, agents, volunteers and employees, as additional insured as respects services or operations under the Contract.

b. Cross liability and severability of interest clauses providing that the insurance applies separately to each insured except with respect to the limits of liability.

c. Stipulation that the insurance is primary insurance and that neither the City nor its insurers will be called upon to contribute to a loss.

d. Such insurance shall specifically cover the contractual liability of the CONTRACTOR.

e. The CONTRACTOR shall furnish a certificate for the period covered.

SPECIAL NOTICE - CLAIMS MADE COVERAGE:

Liability insurance coverage may not be written on a "claims made" basis. The Certificate of Insurance must clearly provide that the coverage is on an "occurrence" basis.

2. Comprehensive Automobile Liability for bodily injury (including death) and property damage which provides total limits of not less than One Million Dollars ($1,000,000) combined single limits per accident, applicable to all owned, non-owned, and hired vehicles.

3. Statutory Workers' Compensation and Employer's Liability Insurance, including a Broad Form "All-States" Endorsement; for all employees engaged in services or operations under the Contract. The employer's liability insurance shall provide limits of not less than One Million Dollars ($1,000,000) per occurrence. Both the workers' compensation and employer's liability policies shall contain the Insurer's waiver of subrogation in favor of the City, its officers, agents, and employees.

4. Builder's Risk/Course of Construction Insurance: The Contractor shall be responsible for all loss, damage or destruction whatsoever to the Work called for by this Contract until the approval of a Notice of Completion. The Contractor shall secure "All Risk" type of builder's Risk Insurance of the type covering one hundred percent (100%) of the value of the Work performed under this Contract (the value is presumed to be the Contract amount unless otherwise stated in Supplemental Conditions) and all materials, equipment, or other items to be incorporated therein while the same are located at the construction site, a bonded warehouse, or its place of manufacture. At any time, the policy shall cover the value of the Work completed. The policy shall cover hazards including the losses due to fire, explosion, hail, rain, lightning, flood (separate insurance as needed), vandalism, malicious mischief, wind, collapse, aircraft, and smoke.

The policies providing such insurance shall name the City as a loss payee as its respective interests may appear, and certified copies of such policies shall be filed with the City. The maximum deductible allowable under the Builder's All Risk policy shall be five percent (5%) of the Contract amount.

In accordance with provisions of California Government Code Section 4150, Builder's Risk Insurance is not required for coverage of losses in excess of five percent (5%) of the Contract amount for damages resulting from earthquake in excess of a magnitude of 3.5 on the Richter scale, or tidal waves. Coverage in the amount of five percent (5%) of the Contract amount for such losses is required.

5-1.19(A) **Other Insurance Provisions:**

A. The requirements of the Contract Conditions as to types and limits of insurance coverage to be maintained by the Contractor, and any approval of insurance by the City, are not intended to, and shall not in any manner limit or qualify the liabilities and obligations otherwise assumed by the Contractor pursuant to the Contract, including, but not limited to, the provisions concerning indemnification, nor preclude the City from taking any other action available to it under any other provision of the Contract or law.

B. The City acknowledges that some insurance requirements contained in the Contract Conditions may be fulfilled by self-insurance on the part of the Contractor. However, this shall not in any way limit liabilities assumed by Contractor under the Contract. Any self-insurance must be approved in writing by the City, in its sole discretion.

C. Should any of the Work under the Contract be sublet, the Contractor shall require each of its subcontractors of any tier to provide the aforementioned coverage, or the Contractor may insure subcontractor(s) under its own policy.

D. The City, its officers, officials, employees and volunteers are to be covered as insureds with respect to liability arising out of automobiles owned, leased, hired or borrowed by or on behalf of the contractor; and with respect to liability arising out of work or operations performed by or on behalf of the contractor including materials, parts or equipment furnished

in connection with such work or operations. Coverage shall not extend to any indemnity coverage for the active negligence of the additional insured in any case where an agreement to indemnify the additional insured would be invalid under California Insurance Code Section 11580.04.

E. THE CITY RESERVES THE RIGHT TO WITHHOLD ANY PROGRESS PAYMENTS TO THE CONTRACTOR IN THE EVENT OF NONCOMPLIANCE WITH ANY INSURANCE REQUIREMENTS.

5-1.20 **Third Party Beneficiary:** Nothing in the Contract is intended to make the public or any member thereof a third party beneficiary hereunder, nor is any term and condition or other provision of the Contract intended to establish a standard of care owed to the public or any member thereof.

5-1.21 **Occupancy by the Department Prior to Acceptance:** The Department reserves the right to occupy all or any part of the project prior to completion of the entire Contract, upon written order therefor. In such event, the Contractor will be relieved of responsibility for any injury or damage to such part as results from such occupancy and use by the Department. If the Contractor carries insurance against damage to such Premises or against liability to third persons covering the Premises so used and occupied by the Department, and of such occupancy results in increased premiums for such insurance, the Department will pay to the Contractor the added cost for such insurance during the period of occupancy.

Such occupancy does not constitute Acceptance by the Director either of the complete Work or of any portion thereof, nor will it relieve the Contractor of full responsibility for correcting defective Work or materials found at any time before the formal written Acceptance

of the entire Contract by the Director or during the full guarantee period after such Acceptance, as provided in Section 7-1.09, "Guarantee," of these General Conditions.

5-1.22 **Right To Operate Unsatisfactory Equipment**: If, after installation, the operation or use of the facilities or equipment to be furnished under this Contract proves to be unsatisfactory to the Director, the City shall have the right to operate and use such facilities until they can, without damage to the City, be taken out of service for correction or replacement. Such period of use of the defective facilities, pending correction or replacement, shall in no way decrease the guarantee period required for the acceptable corrected or replaced items of materials or equipment.

5-1.23 **Contractor's Responsibility for the Work:** Except as otherwise provided herein, the Contractor shall have the charge and care of the Work and shall bear the risk of injury or damage to any part of the Work by the action of the elements or from any other cause whether arising from the execution or from the nonexecution of the Work until the Acceptance of the Contract by the Director. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the Work occasioned by any cause before its completion and Acceptance, and shall bear the expense thereof. In case of suspension of Work from any cause whatever, the Contractor shall be responsible for the Work and he shall also be responsible for all materials, and shall properly store them if necessary, and shall provide suitable drainage and erect temporary structures where necessary.

The Contractor will be relieved of responsibility for any injury or damage to the Work caused by the following:

A. An earthquake in excess of a magnitude of 3.5 on the Richter Scale or a tidal wave, when the effect of such has been proclaimed a disaster or state of emergency by the

Governor of the State of California or by the President of the United States, or was of such magnitude at the site of the Work as to have been sufficient to have caused a proclamation of disaster or state of emergency, had it occurred in a populated area.

B. Occupancy and use by the Department or the public prior to the completion of the entire project.

C. Acts of the Federal Government or the public enemy.

5-1.24 **Responsibility for Utilities:** The Contractor shall be responsible at his or her own cost for any and all Work, expense or special precautions caused or required by the existence or proximity of utilities encountered in performing the Work, including without limitation, repair of any or all damage and all hand or exploratory excavation required. The Contractor is cautioned that such utilities may include communication cables or electrical cables which may be high voltage, and when working or excavating in the vicinity of such cables, or the ducts enclosing such cables, the Contractor shall observe at his or her own cost any special precautions required. Suitable warning signs, barricades, and safety devices shall be erected as necessary or required.

However, if during the course of the Work the Contractor encounters utility installations which are not shown or indicated in the Contract Documents or which are found in a location substantially different from that shown, and such utilities are not reasonably apparent from visual examination, then the Contractor shall promptly notify the Director in writing. Where necessary for the Work of the Contract, the Director shall issue a written order to the Contractor to make such adjustments, rearrangement, repair, removal, alteration, or special handling of such utility, including repair of the damaged utility. The Contractor shall perform the Work described in such written order, and compensation therefor will be

made in accordance with Section 3 of these General Conditions relating to changes in the Work. Except for the items of cost specified in said Section 3, the Contractor shall receive no compensation for any other cost, damage delay, interference, or hindrance to him or her due to the presence of such utility. If the Contractor fails to give the notice specified above and thereafter acts without instructions for the Director, then he or she shall be liable for any or subsequent to discovery thereof, and he or she shall repair and make good such damage at his or her own cost.

The precise location of underground facilities can only be determined by careful probing or hand digging in compliance with Article 6 of the OSHA Construction Safety Orders which states in part:

> "Prior to opening an excavation, effort shall be made to determine whether underground installations, i.e., sewer, water, fuel, electric lines, etc., will be encountered, and if so, where such underground installations are located. When the excavation approaches the approximate location of such an installation, the exact location shall be determined by careful probing or hand digging, and, when it is uncovered, adequate protection shall be provided for the existing installation."

The location of known existing utilities and pipelines are shown on the Drawings in their approximate locations. Some of the locations include multiple conduits. The Contractor shall exercise care in avoiding damage to those facilities which are to remain in service subsequent to the construction of the particular new facility involved and he or she will be held responsible for their repair if damaged. The Contractor shall also exercise care in maintaining those pipes and facilities required for continuing operation of the existing facilities until such

time as they can be abandoned. There is no guarantee that all utilities or obstructions are shown or that the locations indicated are accurate.

The Contractor shall exercise extreme caution in working in the area adjacent to the existing pipelines and utility services. It is essential that all the existing facilities be maintained in service. Construction of the connections between the existing facilities and the new facilities shall be at times and during periods acceptable to the City. The Contractor shall advise the Director in writing of his proposed construction schedule for these connections at least forty-eight (48) hours in advance.

The Contractor shall uncover all piping and conduits, to a point one foot (1') below the pipe, where crossings, interferences, or connections are shown on the Drawings, prior to trenching or excavating for any pipe or structures, to determine actual elevations. New pipelines shall be laid to such grade as to clear all existing facilities which are to remain in service. If the Contractor does not expose all required utilities, he shall not be entitled to additional compensation for Work necessary to avoid interferences nor for repair to damaged utilities. Excavations around underground electrical ducts and conduits shall be performed using extreme caution to prevent injury or damage to workers and to the electrical ducts or conduits.

5-1.25 **Property Rights in Materials:** Nothing in the Contract shall be construed as vesting in the Contractor any right of property in the materials used after they have been attached or affixed to the Work or soil or after partial payment has been made as provided in Section 7-1.05, "Partial Payment," of these General Conditions for material delivered on the ground or stored subject to or under the control of the City and unused. All such material

shall become the property of the City upon being so attached or affixed or upon payment for materials

delivered on the ground or stored subject to or under the control of the City and unused, as provided in said Section 7-1.05.

5-1.26 **Court Ordered Delay:** If, pursuant to court order, the Department temporarily suspends performance of all or any portion of the Work, an extension of time determined pursuant to the provisions in Section 6-1.08, "Liquidated Damages," of these General Conditions will be granted.

5-1.27 **No Personal Liability:** Neither the Director, nor any other officer or authorized employee of the City shall be personally responsible for any liability arising under the Contract.

5-1.28 **Patents:** The Contractor shall assume all costs arising from the use of patented materials, equipment, devices, or processes used on or incorporated in the Work, and agrees to indemnify and save harmless the City, and its duly authorized representatives, from all suits at law, or in equity, and actions of every nature for, or on account of the use of any patented materials, equipment, devices or processes.

5-1.29 **Payment of Taxes:** The Contract price paid for the Work shall include full compensation for all taxes which the Contractor is required to pay, whether imposed by Federal, State or local government, including, without being limited to, Federal excise tax. No tax exemption certificate nor any document designed to exempt the Contractor from payment of any tax will be furnished to the Contractor by the Department, as to any tax on labor, services, materials, transportation, or any other items furnished pursuant to the Contract.

5-1.30 **Cooperation:** Should construction be under way by City forces or other forces or by other Contractors within or adjacent to the limits of the Work or should Work of any other nature be under way by such forces within or adjacent to said limits, the Contractor shall cooperate with all such forces to the end that any delay, interference or hindrance to their Work will be avoided. The right is reserved to perform other or additional Work at or near the site at any time, by the use of such forces.

5-1.31 **Digging Trenches or Other Excavations:** In the event any work involves digging trenches or other excavations that extend deeper than four feet below the surface City and Contractor shall comply with the following:

A. The Contractor shall promptly, and before the following conditions are disturbed, notify City in writing of any:

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

2. Subsurface or latent physical conditions at the site differing from those made available to Contractor for inspection as provided in the project proposal.

3. Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in Work of the character provided for in the contract.

B. The City shall promptly investigate the conditions, and if it finds that the conditions do materially so differ, or do involve hazardous waste, and cause a decrease or

increase in the Contractor's cost of, or the time required for, performance of any part of the Work shall issue a Change Order under the procedures described in the contract.

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

SECTION 6

PROSECUTION AND PROGRESS

6-1.01 **Subletting and Subcontracting:** The Contractor shall be responsible for all Work performed under the Contract. All persons engaged in the Work will be considered as employees of the Contractor. The Contractor shall give his or her personal attention to the fulfillment of the Contract and shall keep the Work under his or her control. When any subcontractor fails to prosecute a portion of the Work in a manner satisfactory to the Director, that subcontractor shall not again be employed on the Work. Although the sections of the Contract may be arranged according to various trades, or general grouping of the Work, the Contractor is not obligated to sublet the Work in such manner. The Director will not arbitrate disputes among subcontractors or between Contractor and one or more subcontractors concerning responsibility for performing any part of the Work.

The Contractor shall not substitute any person as subcontractor in place of a subcontractor listed on his bid proposal without the written approval of the Director. Substitutions must be in accordance with the provisions of the "Subletting and Subcontracting Fair Practices Act" beginning with Government Code Section 4100. Violations of this Act by the Contractor may subject him or her to penalties which may include cancellation of Contract, assessment of ten percent (10%) of the subcontractor's bid, and disciplinary action by the State Contractors' License Board.

6-1.02 **Assignment:** The performance of this Contract may not be assigned, except upon the written consent of the City Council of the City of Roseville. Consent will not be

given to any proposed assignment which would relieve the original Contractor or his surety of their responsibilities under the Contract nor will the Director consent to any assignment of a part of the Work under the Contract.

The Contractor may assign moneys due or to become due to him or her under the Contract and such assignment will be recognized by the Department, if given proper notice thereof, to the extent permitted by law, but any assignment of moneys shall be subject to all proper set-offs in favor of the Department and to all deductions provided for in the Contract and particularly all money withheld, whether assigned or not, shall be subject to being used by the Department for the completion of the Work in the event that the Contractor should be in default therein.

6-1.03 **Beginning of Work:** The Contractor shall begin Work within fifteen (15) Days after receiving Notice to Proceed from the Director and shall diligently prosecute the same to completion within the time limit provided in the Supplemental Conditions.

The Contractor shall notify the Director, in writing, of his or her intent to begin Work at least seventy-two (72) hours before Work is begun. The notice shall be delivered to the Director and shall specify the date the Contractor intends to start. If the project has more than one location of Work, a separate notice shall be given for each location.

Should the Contractor begin Work in advance of receiving notice that the Contract has been approved as above provided, any Work performed by him or her in advance of the said date of approval shall be considered as having been done by the Contractor at his or her own risk and as a volunteer unless said Contract is so approved.

6-1.04 **Progress Schedule:**

A. Preliminary Progress Schedule: The Contractor shall submit to the Director, within twenty (20) Days after date of the Notice to Proceed, a Preliminary Progress Schedule covering the Contractor's activities over the first three (3) months of operation in detail and the remainder of the project in summary. The Preliminary Progress Schedule shall schedule the project within the calendar Days set forth above for completion of the Work, and shall be subject to favorable review by the Director.

B. CPM Schedule: The Contractor shall submit an acceptable Critical Path Method (CPM) Schedule to the Director within thirty (30) Days after the receipt of the Notice to Proceed. Subsequent revisions to said schedule shall be submitted as set forth hereinafter. The requirement for the CPM schedule is included to allow for adequate planning and execution of the Work, to determine the critical nature of delays, and to assist the Director in appraising the reasonableness of the proposed schedule and evaluating progress of the Work. The CPM schedule submitted under this Section shall utilize a critical path method (CPM) format, either the precedence or arrow diagramming method. The definitions of CPM terms and functions shall be as provided in the Associated General Contractors of America book "CPM in Construction, A Manual for General Contractors," or a favorably reviewed alternative publication or reference. No progress payment will be made prior to submission and Acceptance of the CPM Schedule.

1. The CPM schedule system shall consist of diagrams and accompanying mathematical analyses. The diagrams shall show elements of the project in detail and an entire project summary. Diagrams shall show the order and interdependence of activities and sequence in which the Work is to be accomplished as planned by the Contractor. The basic concept of a network analysis diagram shall be followed to show how the start of a given

activity is dependent on the completion of preceding activities and its completion restricts the start of following activities. Detailed network activities shall include, in addition to construction activities, the submittal and favorable review of samples of material and shop Drawings, the procurement of critical materials and equipment, fabrication of special material and equipment, and their installation and testing. All activities of the City and the Director that affect progress and required Contract dates for completion of all or parts of the Work shall be shown. The selection and number of activities shall be subject to favorable review by the Director. Summary networks shall be time scaled. Durations shall be in Days and shall not exceed fifteen (15) Days, except for submittal and delivery items. Where the duration of continuous Work exceeds fifteen (15) Days, Work items in the construction schedule shall be subdivided by location, approximate stationing or other sub-element of the Work.

The graphic network diagram shall include for each activity, the description, activity number, the estimated duration in Days, and all activity relationship lines. The network diagram shall be drawn for the early start of activities. All significant submittals shall be scheduled along with manual submittals and training on all large or critical pieces of equipment. If the precedence technique is utilized, the schedule project shall include a calendar in Work Days, a network report sorted by early start and a logic table report sorted by preceding Work item. If the arrow technique is utilized, the schedule report shall include a calendar in Work Days, a network report sorted by early start, a network report sorted by I-J numbers, and a network sorted by slack time and I-J numbers.

2. The critical path shall be shown on all reports and on the graphic network diagram. The activities which constitute the critical path shall be identified.

3. The mathematical analysis of the network diagram shall include a tabulation of each activity. The following information shall be furnished as a minimum for each activity:

(a) preceding and following event numbers

(b) activity description and number

(c) estimated duration of activities

(d) earliest start date (by calendar date)

(e) earliest finish date (by calendar date)

(f) actual start date (by calendar date)

(g) actual finish date (by calendar date)

(h) latest start date (by calendar date)

(i) latest finish date (by calendar date)

(j) slack or float

(k) percentage of activity completed

4. The program shall be capable of accepting revised completion dates as modified by approved time adjustments and recomputations of all tabulation dates and float accordingly.

5. Submission and review of the system shall be as follows:

(a) The complete network analysis system, consisting of the detailed network mathematical analysis and network diagrams, shall be submitted within thirty (30) calendar Days after receipt of Notice to Proceed.

(b) The Contractor shall participate in a review and evaluation of the proposed network diagrams and analysis by the Director. Any revisions

necessary as a result of this review shall be resubmitted for review by the Director within ten (10) calendar Days. When completed, the favorably reviewed schedule shall then be the schedule to be used by the Contractor for planning, organizing and directing the Work and for reporting progress. If the Contractor thereafter desires to make significant changes in his or her method of operating and scheduling, he or she shall notify the Director in writing stating the reasons for the change.

(c) The Contractor shall submit at monthly intervals a report of the actual construction progress. Each monthly report shall cover a period of approximately thirty (30) Days ending around the 20th of each month. The monthly reports shall be submitted within ten (10) calendar Days of the end of the reporting period.

(1) If the project is proceeding on schedule, the monthly update report may consist of a marked-up copy of the graphical network diagram. This submittal shall clearly indicate the status of any minor shifts in sequence or schedule and the estimated completion date or percent complete of all activities currently in progress. The Contract completion date shall also be indicated. The Contractor shall submit a narrative report relating to status of construction, the schedule, and factors which may affect the remainder of the schedule. The report shall show the activities or portions of activities completed during the reporting period. The report shall state the percentage of the Work actually completed and scheduled as of the report date and the progress

along the critical path in terms of Days ahead or behind the allowable dates.

(2) If, in the opinion of the Director, the project is behind schedule, the monthly report shall include a revised network diagram and/or mathematical analysis showing the Contractor's proposed revised schedule. An analysis of the effect that the delay has on progress along other paths shall also be included in the report. The Contractor shall also submit a narrative report with each updated analysis which shall include but not to be limited to a description of current and anticipated problem areas, delaying factors and their impact, and an explanation of corrective actions taken or proposed.

(3) Periodic report shall be submitted in sufficient copies to cover Contractor needs plus five (5) copies to be retained by the Director.

6. To the extent that the favorably reviewed initial Construction Schedule, or revisions thereto, indicate anything not jointly agreed upon, it shall be deemed to be not favorably reviewed by the Director. Any omission of Work from the detailed schedule, otherwise required for Contract compliance, will not excuse the Contractor from completing such Work within any applicable completion date. The CPM schedule shall be generated by computer methods.

C. Schedule Review: Once each month, on a date mutually agreed upon, but no later than seven (7) working Days after the monthly schedule progress report date, a jobsite meeting will be held to review the Construction Schedule and job progress. The Contractor

shall also attend weekly meetings scheduled by the Director to review the progress of the Work in the preceding week and in the subsequent week, coordinate the Work with public agencies or other Contractors as required, and allow the Director to plan his activities for testing, inspection, etc.

D. Schedule Revisions: The conditions under which the Director will require revisions of the Construction Schedule include the following:

1. When delay in completion of any Work item or sequence of Work items results in an estimated extension of project completion by either twenty (20) working Days or by ten percent (10%) of the remaining duration of time to complete the Contract, whichever is less.

2. When delays in submittals or deliveries make replanning or rescheduling of the Work necessary.

3. When the schedule does not represent actual prosecution and progress of the Work.

4. When any change to the sequence of activities, the completion date for major portions of the Work, or when changes occur which affect the critical path.

5. When Contract Amendments or a Change Order necessitates schedule revision, the Contractor shall submit a schedule analysis of all Change Order Work with his or her proposal.

E. Cash Flow Projection: A cash flow projection shall be submitted with the Construction Schedule. This cash flow projection shall be revised and resubmitted when revisions of the Construction Schedule will result in changes to the projected cash flow.

F. Schedules showing project completion dates earlier than specified in the Supplemental Conditions will be rejected unless justification can be provided for early completion.

6-1.05 **Schedule of Values:** Prior to preparation of the first estimate for a progress payment, the Contractor shall submit for favorable review by the Director a detailed Schedule of Values or cost breakdown of the Work under each bid item awarded. The breakdown will then become the basis for partial payment determination. Elements of Work shall be grouped by structure, pipeline, system, etc. Within each grouping, Work should be itemized by readily measurable quantities of Work complete in place. For example, concrete should be in units of cubic yards including form Work and reinforcing steel. Move-on costs, bond and insurance costs, and Overhead costs shall not be considered an item of cost for this purpose but shall be prorated over items of Work. In the event the Schedule of Values is not favorable reviewed by the Director, another Schedule of Values shall be submitted that is mutually acceptable to the Contractor and the Director.

6-1.06 **Temporary Suspension of Work:** The Director shall have the authority to suspend the Work wholly or in part, for such period as he or she may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the Work, or for such time as he or she may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the Contract.

The Contractor shall immediately comply with the written order of the Director to suspend the Work wholly or in part. The suspended Work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Director.

If a suspension of Work is ordered by the Director, due to normal inclement weather, or due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the Contract, the Days on which the suspension order is in effect shall not entitle the Contractor to an extension of time.

If any delay to the current controlling operation or operations is caused the Contractor by specific order of the Director to stop Work due to any reason other than those described in the preceding paragraph, and such suspension of Work is without the fault or negligence of the Contractor, such delay, if it affects construction tasks which are considered to be "controlling" on the construction schedule, will entitle the Contractor to an equivalent extension of time, except as otherwise provided in the paragraphs herein covering "Termination of Contract." Application for extension of time shall be presented in writing to the Director within fifteen (15) Days of start of delay and shall be accompanied by the formal consent of the Sureties, but an extension of time, whether with or without such consent, shall not release the Sureties from their obligation which shall remain in full force until the discharge of the Contract. The decision of the Director with regard to such requests shall be final.

In the event of a suspension of Work under any of the conditions set forth in this Section 6-1.06, such suspension of Work shall not relieve the Contractor of his or her legal responsibilities as set forth in these General Conditions.

6-1.07 **Time of Completion:** The Contractor shall complete the entire Work, including installation, repairs, startup, troubleshooting, painting, and touchup, training, submittal or record Drawings, and manuals, cleanup, demolization, and all other Work within the number of calendar Days set forth in the Supplemental Conditions. The time for completion includes an allowance for working time lost due to normal inclement weather.

Extensions of time may be allowed for unusual inclement weather under the provisions hereinafter described. Unusual inclement weather is weather which adversely affects "controlling" operations or the critical path of construction and which meets one of the following criteria:

A. For the particular calendar month in question, the number of individual Days with rainfall exceeding 0.10 inches exceeds the average number of such Days for that month over the immediately preceding five (5) years of record by at least three (3) Days.

B. For the particular calendar month in question, the total cumulative rainfall for that month exceeds the average cumulative rainfall for that month over the immediately preceding five (5) years of record by at least two (2") inches.

Rainfall shall be measured at a publicly operated, maintained, and reported station in reasonable proximity to the construction site. A claim for delay shall indicate the period of rainfall which is claimed as "unusual," the specific dates during which the unusual rainfall and subsequent wet soil conditions prevented Work, and the specific critical path tasks adversely affected by such unusual weather. A claim for delay due to unusual inclement weather shall be filed within ten (10) Days of the apparent end of the unusual inclement rainfall period, whether or not the monthly totals are available at that time. The burden of proof that weather meets the criteria for unusual weather shall be solely the responsibility of the Contractor.

It is the responsibility of the Contractor to order materials required for the Work properly and promptly on Notice to Proceed. If evidence presented demonstrates that, in spite of the Contractor's efforts, government-established priorities controls delay material deliveries, suitable extension of time will be made.

If performance of extra Work ordered by the City or failure of the City to provide the necessary site for installation affects construction tasks which are "controlling" or which are on the "critical path" of the construction schedule, suitable extensions of time will be made.

The Contractor shall not be entitled to a time extension for delays in activities on non-critical paths of the favorably reviewed schedule unless the duration of the excusable delay exceeds the total float of the activities being delayed. If the duration of an excusable delay does exceed the total float of the activities affected by the delay, the Contractor shall be entitled to an extension equal to the difference.

C. Determination that a day is a non-working day by reason of inclement weather or conditions resulting immediately therefrom, shall be made by the Director or their designee.

6-1.08 **Liquidated Damages:** It is agreed by the parties to the Contract that in case all the Work called for under the Contract in all parts and requirements is not finished or completed within the number of calendar Days as set forth in the Supplemental Conditions, damage will be sustained by the City and that it is and will be impracticable and extremely difficult to ascertain and determine the actual damage which the City will sustain in the event of and by reason of such delay; and it is therefore agreed that the Contractor will pay to the City, the monetary amount indicated in the Supplemental Conditions in dollars (U.S.) per day for each and every calendar day of delay in finishing the Work in excess of the number of Days prescribed; and the Contractor agrees to pay said Liquidated Damages herein provided for, and further agrees that the Department may deduct the amount thereof from any moneys due or that may become due the Contractor under the Contract.

It is further agreed that in case the Work is not finished and completed in all parts and requirements within the number of Days specified, the Director shall have the right to increase the number of Days or not, as he or she may deem best to serve the interest of the City, and if he or she decides to increase the said number of Days, he or she shall further have the right to charge to the Contractor, his or her heirs, assigns or sureties and to deduct from the final payment for the Work all of any part, as he or she may deem proper, of the actual cost of engineering, inspection, superintendence, and other Overhead expenses which are directly chargeable to the Contract, and which accrue during the period of such extension, except that cost of preparation of final statement shall not be included in such charges.

The Contractor will be granted an extension of time and will not be assessed with Liquidated Damages or the cost of engineering and inspection for any portion of the delay in completion of the Work beyond the time named in the Supplemental Conditions for the completion of the Work caused by acts of God or of the public enemy, fire, floods, tidal waves, earthquakes, epidemics, quarantine restrictions, strikes, labor disputes, shortage of materials, freight embargoes, and unusual inclement weather as described in Section 6-1.07; provided, that the Contractor shall notify the Director in writing of the causes of delay within fifteen (15) Days from the beginning of any such delay. The Director shall ascertain the facts and the extent of the delay, and his or her findings thereon shall be final and conclusive.

No extension of time will be granted for a delay caused by a shortage of materials unless the Contractor furnishes to the Director documentary proof that he or she has diligently made every effort to obtain such materials from all known sources within reasonable reach of the Work and further proof in the form of supplementary progress schedules, as required in Section 6-1.04, "Progress Schedule" of these General Conditions that the inability to obtain

such materials when originally planned, did in fact cause a delay in final completion of the operations. Only the physical shortage of material will be considered under these provisions as a cause for extension of time.

If the Contractor is delayed in completion of the Work by reason of changes made under Section 3, "Changes in the Work," of these General Conditions or by any act of the Director or of the Department, not contemplated by the Contract, an extension of time commensurate with the delay in completion of the Work thus caused will be granted and the Contractor shall be relieved from any claim for Liquidated Damages, or engineering and inspection charges or other penalties for the period covered by such extension of time; provided that the Contractor shall notify the Director in writing of the causes of delay within fifteen (15) Days from the beginning of any such delay. The Director shall ascertain the facts and the extent of the delay.

It is the intention of the above provisions that the Contractor shall not be relieved of liability for Liquidated Damages or engineering and inspection charges for any period of delay in completion of the Work other than that expressly provided for in this Section 6-1.08. Progress payments made after the completion date shall not be construed as a waiver of Liquidated Damages.

6-1.09 **Claims For Extra Compensation For Delays:** It is understood and agreed by the City and the Contractor that the Contractor will incur Overhead costs for temporary facilities, superintendence, home office Overhead, and similar cost items, and that the costs of such Overhead for the full Contract period through the specified completion date are included in the Contractor's lump sum bid amounts included in his accepted Proposal. No additional compensation will be made to the Contractor for claims of increased Overhead costs occurring

within the originally specified construction Contract period plus any time extensions granted by Change Order.

6-1.10 **Termination:**

6-1.10A **Termination of Contract - "Convenience of City":** The Department reserves the right to terminate the Contract at any time if the Director determines that to do so would be in the best interest of the City.

Termination of the Contract and the total compensation payable to the Contractor in the event of termination shall be governed by the following:

1. The Director will issue the Contractor a written notice signed by the Director, specifying that the Contract is to be terminated. Upon receipt of said written notice and, except as otherwise directed in writing by the Director, the Contractor shall:

   (a) Stop all Work under the Contract except that specifically directed to be completed prior to Acceptance.

   (b) Perform Work the Director deems necessary to secure the project for termination.

   (c) Remove equipment from the site of the Work.

   (d) Take such action as is necessary to protect materials from damage.

   (e) Notify all subcontractors and suppliers that the Contract is being terminated and that their Contracts or orders are not to be further performed unless otherwise authorized in writing by the Director.

(f) Provide the Director with an inventory list of all material previously produced, purchased or ordered from suppliers for use in the Work and not yet used in the Work, including its storage location, and such other information as the Director may request.

(g) Dispose of material not yet used in the Work as directed by the Director. It shall be the Contractor's responsibility to provide the City with good title to all materials purchased by the City hereunder, including material for which partial payment has been made as provided in Section 7-1.05, "Partial Payments," of these General Conditions and with bills of sale or other documents of title for such materials.

(h) Subject to the prior written approval of the Director, settle all outstanding liabilities and all claims arising out of subcontracts or orders for material terminated hereunder. To the extent directed by the Director, the Contractor shall assign to the Department all the right, title and interest of the Contractor under subcontracts or orders for materials terminated hereunder.

(i) Furnish the Director with the documentation required to be furnished by the Contractor under the provisions of the Contract including, on projects as to which Federal funds are involved, all documentation required under the Federal requirements included in the Contract.

(j) Take such other actions as the Director may direct.

2. Acceptance of the Contract as hereinafter specified shall not relieve the Contractor of responsibility for damage to materials except as follows:

The Contractor's responsibility for damage to materials for which partial payment has been made as provided in Section 7-1.05, "Partial Payments," of these General Conditions and for materials furnished by the City for use in the Work and unused shall terminate when the Director certifies that such materials have been stored in the manner and at the locations he or she has directed.

The Contractor's responsibility for damage to materials purchased by the City subsequent to the issuance of the notice that the Contract is to be terminated shall terminate when title and delivery of such materials has been taken by the City.

When the Director determines that the Contractor has completed the Work under the Contract directed to be completed prior to termination and such other Work as may have been ordered to secure the project for termination, he or she will recommend that the Director formally accept the Contract, and immediately upon and after such Acceptance by the Director, the Contractor will not be required to perform any further Work thereon and shall be relieved of his or her Contractual responsibilities for injury to persons or damage to property which occurs after the formal Acceptance of the project by the Director.

3. The total compensation to be paid to the Contractor shall be determined by the Director on the basis of the following:

(a) The reasonable cost to the Contractor, without profit, for all Work performed under the Contract, including mobilization, demobilization and Work done to secure the project for termination. Reasonable cost will include a reasonable allowance for project Overhead and general administrative Overhead not to exceed a total of seven percent (7%) of Direct Costs of such Work.

(b) A reasonable allowance for profit on the cost of the Work performed as determined under Subsection (a), provided the Contractor establishes to the satisfaction of the Director that it is reasonably probable that he or she would have made a profit had the Contract be completed and provided further, that the profit allowed shall in no event exceed four percent (4%) of said cost.

(c) The reasonable cost to the Contractor of handling material returned to the vendor, delivered to the Department or otherwise disposed of as directed by the Director.

(d) A reasonable allowance for the Contractor's administrative costs in determining the amount payable due to termination of the Contract.

All records of the Contractor and the Contractor's subcontractors, necessary to determine compensation in accordance with this Section shall be open to inspection or audit by representatives of the Department at all times

after issuance of the notice that the Contract is to be terminated and for a period of three (3) years, and such records shall be retained for that period.

After Acceptance of the Work by the Director, the Director may make payments on the basis of interim estimates pending issuance of the Final Statement, when in his or her opinion the amount thus paid, together with all amounts previously paid or allowed, will not result in total compensation in excess of that to which the Contractor will be entitled. All payments, including payment upon the Final Statement, shall be subject to deduction for prior payments and amounts, if any, to be kept or retained under the provisions of the Contract.

The provisions of this Section shall be included in all subcontracts.

6-1.10B **Termination of Control - "Default of Contractor":** Failure to supply an adequate working force, or material of proper quality, or in any other respect to prosecute the Work with the diligence and force specified by the Contract, is grounds for termination of the Contractor's control over the Work and for taking over the Work by the City.

SECTION 7

ACCEPTANCE AND PAYMENT

7-1.01 **Acceptance:** The Contract will be accepted by Resolution of the City Council of the City of Roseville, and a Notice of Completion will be caused to be recorded by the City Clerk, when the whole shall have been completed in all respects in accordance with the provisions of the Contract Documents to the full satisfaction of the Department.

7-1.02 **Scope of Payment:** The Contractor shall accept the compensation provided in the Contract as full payment for furnishing all labor, materials, tools, equipment, and incidentals necessary to the completed Work and for performing all Work contemplated and embraced under the Contract; also for loss or damage arising from the nature of the Work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the Work until the Acceptance by the Director and for all risks of every description connected with the prosecution of the Work, also for all expenses incurred in consequence of the suspension or discontinuance of the Work as provided in the Contract; and for completing the Work according to the Contract. Neither the payment of any estimate nor of any retained percentage shall relieve the Contractor of any obligation to make good any defective Work or material.

No compensation will be made in any case for loss of anticipated profits.

7-1.03 **Notice of Potential Claim:** The Contractor shall not be entitled to the payment of any additional compensation for any act or failure to act by the Director, including failure

or refusal to issue a Change Order, or for the happening of any event, thing, occurrence or other cause unless he shall have given the Director due written Notice of Potential Claim as hereinafter specified, provided, however, that compliance with this Section 7-1.03 shall not be a prerequisite as to matters within the scope of the protest provisions in Section 3, "Changes in the Work," or Section 6-1.07, "Time of Completion," or the notice provisions in Section 6-1.08, "Liquidated Damages," of these General Conditions.

The written Notice of Potential Claim shall set forth the reasons for which the Contractor believes additional compensation will or may be due, the nature of the costs involved, and, insofar as possible, the amount of the potential claim. The said Notice as above required must have been given to the Director prior to the time that the Contractor shall have performed the Work giving rise to the potential claim for additional compensation, if based on an act or failure to act by the Director, or in all other cases within fifteen (15) Days after the happening of the event, thing, occurrence or other cause giving rise to the potential claim.

It is the intention of this Section 7-1.03 that differences between the parties arising under and by virtue of the Contract be brought to the attention of the Director at the earliest possible time in order that such matters may be settled, if possible, or other appropriate action promptly taken. The Contractor hereby agrees that he shall have no right to additional compensation for any claim that may be based on any such act, failure to act, event, thing or occurrence for which no written Notice of Potential Claim as herein required was filed.

7-1.04 **Stop Notices:** The City, by and through the Department or other appropriate office or officers, may at its option and at any time retain out of any amounts due the Contractor, sums sufficient to cover claims, filed pursuant to Civil Code Section 3179 et seq..

7-1.05 **Partial Payments:** The Contractor, once in each month shall prepare a request for partial payments, for approval by the Director. The estimate shall include the total amount of Work done and acceptable materials, provided such acceptable materials meet the conditions set forth in Section 7-1.06.

The Department shall retain ten percent (10%) of such estimated value of the Work done and ten percent (10%) of the value of materials so estimated to have been furnished, delivered and unused or furnished and stored as described in Section 7-1.06, as partial security for the fulfillment of the Contract by the Contractor.

Contractor may submit a written request to the Director for a reduction in the above retention for up to a maximum of five percent (5%). The Director shall evaluate the request on the basis of, including but not limited to, the following guidelines:

1) the Surety of the Faithful Performance and Payment for Labor and Materials bonds have consented, in writing, to the reduction of retention; and

2) the Work is eight percent (80%) complete; and

3) stop notice claims on file with City do not exceed twenty-five percent (25%) of the amount of the Contract; and

4) Contractor has filed valid stop notice release bonds with City for all outstanding stop notice claims; and

5) the Work has proceeded without unreasonable delays; and

6) no disputes relating to the Work exist between the City and Contractor; and

7) other work related considerations the Director deems appropriate.

The Director's determination shall be final and not subject to challenge or appeal.

The Department shall pay monthly to the Contractor, while carrying on the Work, the balance not retained, as aforesaid, after deducting therefrom all previous payments and all sums to be kept or retained under the provisions of the Contract. No such estimate or payment shall be required to be made when, in the judgment of the Director, the Work is not proceeding in accordance with the provisions of the Contract, or when in his or her judgment the total value of the Work done since the last estimate amounts to less than Three Hundred ($300) Dollars.

No such estimate or payment shall be construed to be an Acceptance of any defective Work or improper materials.

Attention is directed to the express prohibition against payment to unlicensed Contractors, the provisions of which are set forth in Section 1-1.02, "Competency of Bidders," of the Instruction to Bidders.

7-1.06 **Payment For Materials And Equipment On Hand:** Partial payments may be made to the extent of seventy-five percent (75%) of the delivered cost of materials and equipment to be incorporated in the Work, provided that such materials meet the requirements of the Contract Documents and are delivered to acceptable sites on the plant site or at other sites in the vicinity that are acceptable to the City. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

A. Equipment and materials will only be eligible if given conditional or final Acceptance by the Director and are in apparent compliance with favorably reviewed shop Drawings.

B. Only equipment or materials which have received favorable review of shop Drawings will qualify.

C. The material or equipment has been stored or stockpiled adequately protected against damage in a manner acceptable to the Director at an approved site.

D. The Contractor has furnished the Director with acceptable evidence of the quantity and the quality of such stored or stockpiled materials or equipment with identification of where they will be incorporated in project with Specification reference.

E. The Contractor has furnished the Director with satisfactory evidence that the material and transportation costs have been paid.

F. The Contractor has furnished the City legal title (free of liens or encumbrances of any kind) to the material or equipment so stored or stockpiled.

G. The Contractor has furnished the City evidence that the material or equipment so stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the Work.

It is understood and agreed that the transfer of title and the City payment for such stored or stockpiled materials shall in no way relieve the Contractor of his/her responsibility for furnishing and placing such materials in accordance with the requirements of the Contract Documents.

In no case will the amount of partial payments for materials on hand exceed the Contract price for such materials or the Contract price for the Contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials or equipment in accordance with the provisions of this Section.

7-1.07 **Payment of Withheld Funds:** Except as otherwise prohibited by law, the Contractor may elect to receive all payments due under the Contract pursuant to 7-1.05 of General Conditions without any retention. If the Contractor so elects, he or she and a City approved escrow company shall execute a City form retention agreement in a form approved by the City Attorney and meeting all requirements imposed by the City Attorney (copies of which are available in the Office of the City Attorney) by which the Contractor shall deposit with the escrow company securities with a value equivalent to the retention which would otherwise be withheld by the City. Said security and agreement shall be as provided in California Government Code Section 4590, and shall be approved by the City both as to sufficiency and form.

7-1.08 **Final Payment and Claims:** Final payment will be made within fifteen (15) working Days following the expiration of the thirty-five (35) day lien period. The start of this period is the date the County Recorder files the Notice of Completion.

7-1.09 **Clerical Errors:** Notwithstanding the provisions of Section 7-1.08, "Final Payment and Claims," of these General Conditions, for a period of three (3) years after Acceptance of the Work, all estimates and payments made pursuant to said Section 7-1.08, are subject to correction for clerical errors in the calculations involved in the determination of quantities and payments. The Contractor and the City agree to pay to the other any sum due under the provisions of this Section 7-1.09, provided, however, if the total sum to be paid is less than $100, no such payment shall be made.

7-1.10 **Guarantee:** The Contractor hereby unconditionally guarantees that the Work will be done in accordance with the requirements of the Contract, and further guarantees the Work of the Contract to be and remain free of defects in workmanship and materials for a

period of one (1) year from the date of Acceptance of the Contract, unless a longer guarantee period is required by the Supplemental Conditions.

The Contractor hereby agrees to repair or replace any and all Work, together with any other adjacent Work which may be displaced in so doing, that may prove to be not in accordance with the requirements of the Contract or that may be defective in its workmanship or material within the guarantee period specified, without any expense whatsoever to the City, ordinary wear and tear and unusual abuse or neglect excepted.

The Contractor further agrees, that within ten (10) calendar Days after being notified in writing by the Department of any Work not in accordance with the requirements of the Contract or of any defects in the Work, the Contractor will commence and prosecute with due diligence all Work necessary to fulfill the terms of this guarantee, and to complete such Work within a reasonable period of time. In the event Contractor fails to comply, he or she does hereby authorize the Department to proceed to have such Work done at the Contractor's expense and the Contractor will honor and pay the cost and charges therefore upon demand. The Department shall be entitled to all costs and expenses, including reasonable attorney's fees, necessarily incurred upon the Contractor's refusal to honor and pay the above costs and charges.

Nothing in this section shall be construed to limit, relieve or release the Contractor's, subcontractor's and equipment supplier's liability to the City for damages sustained as the result of latent defects in the equipment furnished caused by the negligence of the supplier's agents, employees or subcontractors. Stated in another manner, the warranty contained in this section shall not amount to nor shall it be deemed to be a waiver by the City of any rights or remedies (or time limits in which to enforce such rights or remedies) it may have against the

supplier of the equipment to be furnished under the Contract Conditions for defective workmanship or defective materials or against the Contractor under the laws of this State pertaining to acts of negligence.

7-1.11 **Warranty of Title:** No material, supplies, or equipment for the Work under this Contract shall be purchased subject to any chattel mortgage, security agreement, or under a conditional sale or other agreement by which an interest therein or any part thereof is retained by the seller or supplier. The Contractor warrants good title to all material, supplies, and equipment installed or incorporated in the Work and agrees upon completion of all Work to deliver the Premises, together with all improvements and appurtenances constructed or placed thereon by him or her, to the City free from any claim, liens, security interest, or charges, and further agrees that neither the Contractor nor any person, firm, or corporation furnishing any materials or labor for any Work covered by this Contract shall have any right to a lien upon the Premises or any improvement or appurtenances thereon. Provided, that this shall not preclude the Contractor from installing metering devices and other equipment of utility companies, the title of which is commonly retained by the utility company. In the event of the installation of any such metering device or equipment, the Contractor shall advise the City as to the legal owner thereof. Nothing contained in this Paragraph, however, shall defeat or impair the right of such persons furnishing materials or labor under any bond given by the Contractor for their protection or any rights under any law permitting such persons to look to funds due the Contractor in the hands of the City. The provisions of this Paragraph shall be inserted in all subcontracts and material Contracts, and notice of its provisions shall be given to all persons furnishing materials for the Work when no formal Contract is entered into for such materials.

[END OF GENERAL CONDITIONS]

SUPPLEMENTAL CONDITIONS

Project: Woodcreek North Pump Station

Scope of Supplemental Conditions

1. The Work shall be performed in accordance with the General Conditions and Department Standards, except as the General Conditions may be modified by the following additional City Standards, incorporated herein by this reference, if so indicated.

	COMMUNITY DESIGN GUIDELINES
	ELECTRIC SPECIFICATIONS
	PARKS CONSTRUCTION STANDARDS
X	PUBLIC WORKS CONSTRUCTION STANDARDS
	OTHER
	NONE

2. Numbering in these Supplemental Conditions conforms to that in the General Conditions. The existence of a section in these Supplemental Conditions means that the corresponding section in the General Conditions is modified in some respect. Unless otherwise specified, the modified General Condition is deleted entirely and the provisions of these Supplemental Conditions are substituted. However, note that the following changes have been made to the Insurance Requirements, Pages INS 1 - 7 which are not part of the General Conditions as follows:

a. Paragraph 5-1.19 of the Insurance Requirements is hereby amended in the second subparagraph a. on page INS-4 to include MWH Americas, Inc. as an additional insured.

b. Paragraph 5-1.19 of the Insurance Requirements is hereby amended in paragraph 2 Comprehensive Automobile Liability on page INS-5 to include the City of Roseville, MWH Americas, Inc. and their officers, agents, volunteers, and employees, as additional insureds as respects services or operations under the Contract.

c. Paragraph 5-1.19 of the Insurance Requirements is hereby amended in paragraph 3 Statutory Workers' Compensation and Employer's Liability Insurance on page INS-5 to change the last portion of the paragraph to read: ". . .shall contain the Insurer's waiver of subrogation in favor of the City and MWH Americas, Inc. and their officers, agents, and employees."

SECTION 1. DEFINITIONS AND TERMS

1-1.15 Department: Section 1-1.15 of the General Conditions is amended to include the following:

The Department for Contract Administration is the Environmental Utilities Department of the City of Roseville.

1-1.17 Director: Section 1-1.17 of the General Conditions is amended to include the following:

The Director of the Department for Contract Administration or his or her designee which is the firm of MWH Americas, Inc., 3321 Power Inn Road, Suite 300, Sacramento, California 95826. Tel: 916-924-8844, Fax: 916-924-9102.

1-1.26 Engineer or Architect: Section 1-1.26 is amended to include the following:

The Engineer retained by the City of Roseville for this Work or portions thereof and who is the designee of the Director of the Department for Contract Administration is the firm of MWH Americas, Inc. The Engineer will be responsible for the Construction Management of this Project. As used in these General Conditions the terms "Director" and "Engineer" may be used interchangeably

SECTION 2. CONTROL AND SCOPE OF WORK

2-1.04 Submittals: Section 2-1.04 of the General Conditions is deleted in its entirety and is covered by Section 01300 Submittals of the Technical Specifications.

2-1.04A Shop Drawings: Section 2-1.04A of the General Conditions is deleted in its entirety and is covered by Section 01300 Submittals of the Technical Specifications.

2-1.04B Descriptive Data: Section 2-1.04B of the General Conditions is deleted in its entirety and is covered by Section 01300 Submittals of the Technical Specifications.

2-1.04C Samples: Section 2-1.04C of the General Conditions is deleted in its entirety and is covered by Section 01300 Submittals of the Technical Specifications.

2-1.04D Manuals, Instructions and Affidavits: Section 2-1.04D of the General Conditions is deleted in its entirety and is covered by Section 01300 Submittals of the Technical Specifications.

2-1.04E Alternatives: Section 2-1.04E of the General Conditions is deleted in its entirety and is covered by Section 01600 Products, Equipment, Materials, and Substitutions.

SECTION 3. CHANGES IN THE WORK

There are no amendments to the General Conditions.

SECTION 4. CONTROL OF MATERIALS

There are no amendments to the General Conditions.

SECTION 5. LEGAL RELATIONS AND RESPONSIBILITY

5-1.01 Laws to be Observed: Section 5-1.01 of the General Conditions is amended to include the following:

The Contractor shall protect and indemnify the City, the Engineer, and any of their officers, agents, servants, subcontractors, and subconsultants against any claim or liability arising from or based on the violation of any such law, rule, or regulation, whether by him or herself or his or her agents or employees.

5-1.11 Air Pollution Control and Asbestos: Section 5-1.11 of the General Conditions is amended to include the following:

To the best of the City's knowledge, asbestos is not present in the vicinity of the Project. Additional information shall be made available to Contractor upon request.

5-1.15 Permits and Licenses: Section 5-1.15 of the General Conditions is amended to include the following:

The intent of this section is to provide Bidders with all the now known lists of permits required for the Project under this Contract. The completeness and inclusiveness of the list provided is not guaranteed. Information provided in this section does not relieve the Contractor of the responsibility to determine and

verify the extent of the permits required for this Contract, nor the responsibility to obtain and abide by necessary permits.

The Contractor shall acquire the following specific permits:

1. The Contractor shall provide a letter of Compliance, signed and wet stamped by a California Registered Electrical Engineer, that the electrical work performed meets local and State electrical codes, the 2005 National Electrical Code and is in compliance with the Contract Documents. The Letter of Compliance, on company letterhead, shall be submitted prior to final payment for the Work
2. City of Roseville Permit for Construction Water. The Contractor shall apply for a permit to connect to city fire hydrants from the City of Roseville, Department of Environmental Utilities. Water will be supplied at no cost to the Contractor. Fees for backflow device testing or rental shall be the Contractor's responsibility.
3. City of Roseville Encroachment Permit. The Contractor shall apply for a no-fee Encroachment Permit from the City of Roseville, Department of Public Works.

The Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) for the work. The objective of the SWPPP is as follows:

1. To identify pollutant sources that may affect the quality of storm water discharges associated with construction activity from the construction site.

2. To identify, construct, and implement storm water pollution prevention measures (control practices) to reduce pollutants in storm water discharges from the construction site.

The Contractor shall submit the SWPPP per Section 01300. The SWPPP shall be signed and stamped by a civil engineer registered by the state of California. The SWPPP must be approved by the City prior to the beginning of any construction activities. The SWPPP shall be prepared using the guidelines described in the City of Roseville Department of Public Works Improvement Standards.

5-1.18 Responsibility for Damage: Section 5-1.18 of the General Conditions is amended to include the following:

The Engineer, its officers, directors, employees, agents, consultants and subcontractors shall be added as indemnitees under this paragraph except that the indemnification obligation of the Contractor shall not extend to the liability of the Engineer, its officers, directors, employees, agents, consultants, and subcontractors arising out of: 1) the preparation or approval of, or the failure to prepare or approve, maps, drawings, opinions, reports, surveys, Change Orders, designs, or specifications; or 2) giving directions or instructions or failing to give them, if that is the primary cause of the injury or damage. Nothing in this paragraph shall be construed as causing the Contractor to indemnify the Engineer,

its officers, directors, employees, agents, consultants and subcontractors from their own sole negligence.

5-1.19 C Insurance Required: Section 5-1.19 C of the General Conditions is amended to include the following:

The Commercial General Liability policy shall include the Engineer, its officers, directors, employees, agents, consultants, and subcontractors as additional insureds as respects the services or operations of the Contractor under the Contract.

The workers' compensation and employer's liability policies shall contain the Insurer's waiver of subrogation in favor of the Engineer, its officers, directors, employees, agents, consultants, and subcontractors.

5-1.19(A) Other Insurance Provisions: Section 5-1.19(A) D. of the General Conditions is amended to include the following:

The City, its officers, officials, employees and volunteers and the Engineer, its officers, directors, employees, agents, consultants and subcontractors are to be covered as additional insured.

5-1.28 Patents: Section 5-1.28 of the General Conditions is amended to include the following:

The Engineer, its officers, directors, employees, agents, consultants, and subcontractors are to be added as indemnitees under this paragraph except for patented materials, equipment, devices, or processes called out in the drawings and specifications.

SECTION 6. PROSECUTION AND PROGRESS

6-1.04(A) Preliminary Progress Schedule: Section 6-1.04(A) of the General Conditions is amended to include the following:

The Contractor shall submit to the Director at the Preconstruction Meeting, a Preliminary Progress Schedule covering the Contractor's activities over the first month of operation in detail and the remainder of the project in summary.

6-1.05 Schedule of Values: Section 6-1.05 of the General Conditions is deleted in its entirety and is covered by Section 01301 Schedule of Values of the Technical Specifications.

6-1.07 Time of Completion: Section 6-1.07 of the General Conditions is amended to include the following:

The Contractor shall begin Work within seven (7) Days after receiving a notice to proceed and shall diligently prosecute the Work to completion. The Contractor shall complete the work within three hundred (300) Days of the notice to proceed.

6-1.08 Liquidated Damages: Section 6-1.08 of the General Conditions is amended to include the following:

The amount of Liquidated Damages is the sum of $1,000 per day for the CONTRACTOR's delay in completing the entire work.

SECTION 7: ACCEPTANCE AND PAYMENT

7-1.10 Guarantee: Section 7-1.10 of the General Conditions is amended as follows:

The guarantee period shall be for two (2) years.

[END OF SUPPLEMENTAL CONDITIONS]

SPECIFICATIONS

Project: Woodcreek North Pump Station

SECTION 01010 - SUMMARY OF WORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

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

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The WORK shall include the construction of a pump station, including all appurtenant work complete and operable, all in accordance with requirements of the Contract Documents.

1.3 CONTRACT METHOD

A. The WORK hereunder will be constructed under a single unit-price lump sum contract.

1.4 WORK BY OTHERS

A. The CONTRACTOR’s attention is directed to the fact that work may be conducted at the Woodcreek North Pump Station Site by other contractors during the performance of the WORK under this contract. Work under one contract may interfere with work under another and the OWNER will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the OWNER may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount , and in manner and at time that the OWNER may determine. No OWNER determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. **Interference With Work On Utilities:** The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.5 CONTRACTOR USE OF SITE

A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials.

1.6 PROJECT MEETINGS

A. Preconstruction Conference

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:

   a. ENGINEER and the Resident Project Representative.

   b. Representatives of OWNER.

   c. Governmental representatives as appropriate.

   d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with Section 01300 - Contractor Submittals.

3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.

   a. Status of CONTRACTOR's insurance and bonds.

   b. CONTRACTOR's tentative schedules.

   c. Transmittal, review, and distribution of CONTRACTOR's submittals.

   d. Processing applications for payment.

   e. Maintaining record documents.

   f. Critical work sequencing.

   g. Field decisions and Change Orders.

   h. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.

   i. Major equipment deliveries and priorities.

   j. CONTRACTOR's assignments for safety and first aid.

   k. Daily Report Form.

   l. Submittal Transmittal Form.

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

B. Progress Meetings

1. The ENGINEER will schedule and hold regular on-Site progress meetings as requested by CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The ENGINEER will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

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SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 -- GENERAL

1.1 SCOPE

A. Payment for the various items of the Bid Schedule, as further specified herein, shall include all compensation to be received by the CONTRACTOR for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work being described, as necessary to complete the various items of the WORK all in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including all costs of permits and cost of compliance with the regulations of public agencies having jurisdiction, including Safety and Health Requirements of the California Division of Industrial Safety and the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA). No separate payment will be made for any item that is not specifically set forth in the Bid Schedule, and all costs therefore shall be included in the prices named in the Bid Schedule for the various appurtenant items of work.

1.2 UNIT PRICE ITEMS LABELED “LUMP SUM”

A. Measurement for payment of the “lump sum” items will be based upon the completion of the work, complete, as specified and as indicated on the drawings.

B. Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items. Lump sum contracts shall be complete, tested and fully operable prior to request for final payment.

1.3 UNIT PRICE ITEMS LABELED “EACH”

A. Measurement for payment of the “each” items will be based upon the completion of the work, complete, as specified and as indicated on the drawings.

B. Payment for completion for the “each” items will be made at the price named in the Bid Schedule which price shall constitute full compensation for completing said work.

1.4 UNIT PRICES BASED UPON TIME

A. Measurement of time will be recorded by the hour with one-half hour intervals as the smallest unit of time credited to the CONTRACTOR. Fractions of an hour less than one-half hour, but exceeding one-quarter hour, will be considered one-half hour. The time recorded for payment shall commence when the installed equipment is placed in operation, at the direction of the ENGINEER, and shall end when operations are stopped at the direction of the ENGINEER.

B. Payment will be made at the contract price per hour. No time will be recorded for delays resulting from (1) equipment breakdown; or (2) failure to conduct the operations in a diligent and responsible manner by which the desired results could ordinarily be expected. No payment will be made for static recovery periods.

1.5 UNIT PRICE ITEMS BASED UPON FOOTAGE

A. Description – The CONTRACTOR shall provide all labor, supervision, tools, equipment, and materials necessary to provide the item specified.

B. Measurement – Measurement of the item will be based on the number of linear feet accepted, all in accordance with the Contract Documents.

C. Payment – Payment for the item shall be at the unit price per linear foot indicated in the Bid Schedule, which price shall constitute full compensation for the completed WORK in all accordance with the Contract Documents. This includes, but is not limited to, all materials, tools, labor, equipment, supplies, permits, removal and disposal of waste or excess material necessary to have the item ready for use as its intended purpose.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01070 - ABBREVIATIONS OF INSTITUTIONS

PART 1 -- GENERAL

1.1 GENERAL

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

1.2 ABBREVIATIONS

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturer's Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturer's Association, Inc.
AFPA	American Forest Products Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association or American Parquet Association, Inc.
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQC	American Society for Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute

AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association
CABO	Council of American Building Officials
CBM	Certified Ballast Manufacturers
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLPCA	California Lathing and Plastering Contractors Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drill Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EIA	Electronic Industries Association
ETL	Electrical Test Laboratories
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HPMA	Hardwood Plywood Manufacturers Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IME	Institute of Makers of Explosives
IP	Institute of Petroleum (London)
IPC	Institute of Printed Circuits
IPCEA	Insulated Power Cable Engineers Association
ISDSI	Insulated Steel Door Systems Institute
ISA	Instrument Society of America
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
MTI	Marine Testing Institute
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
NAGDM	National Association of Garage Door Manufacturers
NB	National Board of Boiler and Pressure Vessel Inspectors (alternate NBBPVI)
NBS	National Bureau of Standards (Now NIST)
NCCLS	National Committee for Clinical Laboratory Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association

NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association or National Forest Products Association
NISO	National Information Standards Organization
NLGI	National Lubricating Grease Institute
NMA	National Microfilm Association
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWMA	National Woodwork Manufacturers Association
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastics Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SAMA	Scientific Apparatus Makers Association
SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry, Inc.
SPIB	Southern Pine Inspection Bureau
SPR	Simplified Practice Recommendation
SSA	Swedish Standards Association
SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction
TAPPI	Technical Association of the Pulp and Paper Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
WCLIB	West Coast Lumber Inspection Bureau
WCRSI	Western Concrete Reinforcing Steel Institute
WEF	Water Environment Federation
WIC	Woodwork Institute of California
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01090 - REFERENCE STANDARDS

PART 1 -- GENERAL

1.1 GENERAL

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

B. **Applicable Publications:** Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the WORK is advertised for bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. **Specialists, Assignments:** In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with the CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to or exceed the requirements of applicable codes and the applicable requirements of the following documents.

B. References herein to "Building Code" or "Uniform Building Code" shall mean Uniform Building Code of the International Conference of Building Officials (ICBO). Similarly, references to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Conference of the Building Officials (ICBO). "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the WORK is advertised for bids, as adopted by the agency having jurisdiction, shall apply to the WORK herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to

the attention of the ENGINEER for clarification and directions prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.

D. References herein to "OSHA Regulations for Construction" shall mean **Title 29, Part 1926, Construction Safety and Health Regulations,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

E. References herein to "OSHA Standards" shall mean **Title 29, Part 1910, Occupational Safety and Health Standards,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

F. **Applicable Standard Specifications**: References in the Contract Documents to "Standard Specifications" or SSPWC shall mean the Standard Specifications for Public Works Construction, Latest Edition.

G. **Applicable Safety Standards:** References herein to "Cal-OSHA" shall mean **State of California, Department of Industrial Relations, Construction Safety Orders,** as amended to date, and all changes and amendments thereto.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The CONTRACTOR shall be responsible that all work included in the Contract Documents, regardless if shown or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other Federal, State, and Local Regulations governing the storage and conveyance of hazardous materials, including petroleum products.

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

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01300 - CONTRACTOR SUBMITTALS

PART 1 -- GENERAL

1.1 GENERAL

A. Wherever submittals are required in the Contract Documents, submit them to the ENGINEER.

B. Within 7 days after the date of commencement as stated in the Notice to Proceed, the CONTRACTOR shall submit the following items to the ENGINEER for review:

1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("Or-Equal") submittals listed in the Bid.

2. A list of all permits and licenses the CONTRACTOR shall obtain indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference referred to in Section 01010 - Summary of Work, the CONTRACTOR shall submit the following items to the ENGINEER for review:

1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.

2. A list of all permits and licenses the CONTRACTOR shall obtain indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

3. A preliminary schedule of values in accordance with Section 01301 - Schedule of Values.

4. A preliminary progress schedule of the first three months of operation.

1.3 SHOP DRAWINGS

A. Wherever called for in the Contract Documents or where required by the ENGINEER, the CONTRACTOR shall furnish to the ENGINEER for review, seven (7) copies plus one reproducible copy, of each Shop Drawing submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the state wherein the project is located, unless otherwise indicated.

B. Organization

1. A single submittal transmittal form shall be used for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable, unless the primary

specification references other sections for components. Example: if a pump section references other sections for the motor, protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted; a single submittal covering vertical turbine pumps and horizontal split case pumps would not be acceptable.

2. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, or room number or building name, as applicable.

3. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match those used in the Contract Documents.

C. Format

1. Minimum sheet size shall be 8.5 inches by 11 inches. Maximum sheet size shall be 24 inches by 36 inches. Every page in a submittal shall be numbered in sequence. Each copy of a submittal shall be collated a stapled or bound, as appropriate. The ENGINEER will not collate copies.

2. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with all pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail shall be presented for assessment of compliance with the Contract Documents.

3. Each submittal shall be assigned a unique number. Submittals shall be numbered sequentially. The submittal numbers shall be clearly noted on the transmittal. Original submittals shall be assigned a numeric submittal number. Resubmittals shall bear an alpha-numeric system which consists of the number assigned to the original submittal for that item, followed by a letter of the alphabet to represent that it is a subsequent resubmittal of the original. For example, if submittal 25 requires a resubmittal, the first resubmittal will bear the designation "25-A" and the second resubmittal will bear the designation "25-B" and so on.

D. Disorganized submittals which do not meet the requirements above will be returned without review.

E. Except as may otherwise be indicated herein, the ENGINEER will return prints of each submittal to the CONTRACTOR with comments noted thereon, within 30 calendar days following receipt by the ENGINEER. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submittal to the ENGINEER by the first resubmittal on an item. The OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal. The ENGINEER'S maximum review period for each submittal or resubmittal will be 30 days. Thus, for a submittal that requires two resubmittals before it is complete, the maximum review period could be 90 days.

F. If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

G. If a submittal is returned marked "MAKE CORRECTIONS NOTED," CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.

H. If a submittal is returned marked "AMEND-RESUBMIT," the CONTRACTOR shall revise it and shall resubmit the required number of copies to the ENGINEER for review. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND - RESUBMIT," the submittal as a whole is deemed "AMEND - RESUBMIT," and all 10 drawings are required to be resubmitted.

I. If a submittal is returned to the CONTRACTOR marked "REJECTED-RESUBMIT," the CONTRACTOR shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the engineer.

J. Resubmittal of rejected portions of a previous submittal will not be allowed. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

K. Fabrication of an item shall be commenced only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or MAKE CORRECTIONS NOTED." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

L. All submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR, prior to submission to the ENGINEER. Each submittal shall be dated, signed, and certified by the CONTRACTOR as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, each sheet shall be so dated, signed, and certified. The ENGINEER will only review submittals which have been so certified by the CONTRACTOR. All non-certified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

M. The ENGINEER's review of submittals shall not relieve the CONTRACTOR of the entire responsibility for the correctness of details and dimensions. The CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in submittals. The CONTRACTOR shall be responsible for the dimensions and the design of adequate connections and details.

1.4 CONTRACTOR'S SCHEDULE

A. The CONTRACTOR's construction schedules and reports shall be prepared and submitted to the ENGINEER in accordance with GC 6-1.04.

1.5 SAMPLES

A. Whenever in the Specifications samples are required, the CONTRACTOR shall submit not less than 3 samples of each item or material to the ENGINEER for acceptance.

B. Unless otherwise indicated, samples shall be submitted a minimum of 21 days prior to ordering such material.

C. Samples shall be individually and indelibly labeled or tagged, indicating thereon all specified physical characteristics and Manufacturer's name. Upon receiving acceptance of the ENGINEER, one set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR, and one set of samples will be retained by the

ENGINEER, and one set of samples shall remain at the Site until completion of the WORK.

D. Unless indicated otherwise, all colors and textures of items presented in sample submittals shall be from the manufacturer's standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in Contract Times or Price, the CONTRACTOR shall clearly indicate same on the transmittal page of the submittal.

E. The CONTRACTOR shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the ENGINEER has 45 days to assemble color panels and select color and texture dependent products and materials without delay to the construction schedule, and

2. After the ENGINEER selects colors and textures, the CONTRACTOR has sufficient time to provide the products or materials without delay to the construction schedule. The Contract Times will not be extended for the CONTRACTOR's failure to allow enough review and approval or selection time, failure to submit all samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.6 TECHNICAL MANUAL

A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical and instrumentation equipment in an organized manner in the Technical Manual. It shall be written so that it can be used and understood by the OWNER'S operation and maintenance staff.

B. The Technical Manual shall be subdivided first by specification section number; second, by equipment item; and last, by "Category." "Categories" shall conform to the following (as applicable):

1. Category 1 - Equipment Summary:

a. Summary: A summary table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

b. Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

2. Category 2 - Operational Procedures:

a. Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

Installation
Adjustment
Startup
Location of controls, special tools, equipment required, or related instrumentation needed for operation
Operation procedures

Load changes
Calibration
Shutdown
Troubleshooting
Disassembly
Reassembly
Realignment
Testing to determine performance efficiency
Tabulation of proper settings for all pressure relief valves, low and high pressure switches, and other protection devices
List of all electrical relay settings including alarm and contact settings

3. Category 3 - Preventive Maintenance Procedures:

    a. Procedures: Preventive maintenance procedures shall include all manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by leaving the equipment in place.

    b. Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

4. Category 4 - Parts List:

    a. Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

    b. Drawings: Cross-sectional or exploded view drawings shall accompany the parts list.

5. Category 5 - Wiring Diagrams:

    a. Diagrams: Part 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

6. Category 6 - Shop Drawings:

    a. Drawings: This part shall include approved shop or fabrication drawings, complete with dimensions.

7. Category 7 - Safety:

    a. Procedures: This part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

8. Category 8 - Documentation:

    a. All equipment warranties, affidavits, and certifications required by the Technical Specifications shall be placed in this part.

C. The CONTRACTOR shall furnish to the ENGINEER 7 identical Technical Manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, looseleaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents indicating all equipment in the manuals shall be prepared.

D. Manuals shall be submitted in final form to the ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by the ENGINEER shall be corrected within 30 days from the date of written notification by the ENGINEER.

E. Incomplete or unacceptable manuals at the 75 percent construction completion point shall constitute sufficient justification to retain the amount in paragraph “Technical Manual Submittals" of Section 01700 - Project Closeout, from any monies due the CONTRACTOR.

1.7 SPARE PARTS LIST

A. The CONTRACTOR shall furnish to the ENGINEER 5 identical sets of spare parts information for all mechanical, electrical, and instrumentation equipment. The spare parts list shall include the current list price of each spare part. The spare parts list shall include those spare parts which each manufacturer recommends be maintained by the OWNER in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to assist the OWNER in ordering. The CONTRACTOR shall cross-reference all spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists shall be bound in standard size, 3-ring, looseleaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

1.8 RECORD DRAWINGS

A. The CONTRACTOR shall maintain one record set of Drawings at the Site. On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the information represented on the original Contract Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings. Said record drawings shall be supplemented by any detailed sketches as necessary or directed to fully indicate the WORK as actually constructed. These master record drawings of the CONTRACTOR's representation of as-built conditions, including all revisions made necessary by addenda and change orders shall be maintained up-to-date during the progress of the WORK. Red ink shall be used for alterations and notes. Notes shall identify relevant Change Orders by number and date.

B. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final Shop Drawings, and by including appropriate reference information describing the change orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.

C. Record drawings shall be accessible to the ENGINEER at all times during the construction period.

D. Final payment will not be acted upon until the record drawings have been prepared and delivered to the ENGINEER. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information overlaid.

E. Upon Substantial Completion of the WORK and prior to final acceptance, the CONTRACTOR shall finalize and deliver a complete set of record drawings to the ENGINEER for transmittal to the OWNER, conforming to the construction records of the CONTRACTOR. This set of drawings shall consist of corrected Drawings showing the reported location of the WORK. The information submitted by the CONTRACTOR and incorporated by the ENGINEER into the record drawings will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information, and for any errors or omissions which may appear on the record drawings as a result.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

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SECTION 01301 - SCHEDULE OF VALUES

PART 1 -- GENERAL

1.1 GENERAL

A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown for the Pump Station) shall be developed.

1.2 PRELIMINARY SCHEDULE OF VALUES

A. The CONTRACTOR shall submit a preliminary Schedule of Values for the major components of the WORK at the Preconstruction Conference in accordance with Section 01010 - Summary of Work. The listing shall include, at a minimum, the proposed value for the following major WORK components:

1. Mobilization (shall not exceed 5% of the total bid amount)

2. The total value of electrical WORK.

3. The total value of Instrumentation and Control WORK.

4. The total value of Protective Coatings WORK.

5. The total value of yard piping WORK inclusive of excavation, pipe installation, testing and backfill of pipe, and all incidental WORK associated with underground pipe installations.

6. The total value of all mechanical WORK, exclusive of yard piping WORK included in Item 5 above. This includes all piping, valves, process equipment, tanks, pumps, HVAC equipment and appurtenances.

7. The total value of structural reinforced concrete WORK inclusive of all excavation, dewatering, subgrade preparation, backfill and incidental WORK for all new structures.

8. The total value of masonry building, inclusive of architectural WORK, roofing, doors, windows and other incidental systems and features.

9. The total value of site civil WORK inclusive of clearing and grubbing, paving, grading and drainage WORK.

10. The total value of all other WORK not specifically included in the above items.

B. The CONTRACTOR and ENGINEER shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the ENGINEER, these are necessary to establish fair and reasonable allocation of values for the major WORK components. Front end loading will not be permitted. The ENGINEER may require reallocation of major WORK components from items in the above listing if in the opinion of the ENGINEER such reallocation is necessary. This review and any necessary revisions shall be completed within 15 days from the date of Notice to Proceed.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01400 - QUALITY CONTROL

PART 1 -- GENERAL

1.1 DEFINITION

A. Specific quality control requirements for the WORK are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the WORK beyond furnishing of manufactured products. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.

1.2 INSPECTION AT PLACE OF MANUFACTURE

A. Unless otherwise indicated, all products, materials, and equipment shall be subject to inspection by the ENGINEER at the place of manufacture.

B. The presence of the ENGINEER at the place of manufacturer, however, shall not relieve the CONTRACTOR of the responsibility for providing products, materials, and equipment which comply with all requirements of the Contract Documents. Compliance is a duty of the CONTRACTOR, and said duty shall not be avoided by any act or omission on the part of the ENGINEER.

1.3 SAMPLING AND TESTING

A. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the OWNER reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the ENGINEER, will assure the OWNER that the quality of the workmanship is in full accord with the Contract Documents.

B. Any waiver by the OWNER of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the testing or other quality assurance requirements originally indicated, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial WORK, shall not be construed as a waiver of any requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the ENGINEER reserves the right to make independent investigations and tests, and failure of any portion of the WORK to meet any of the requirements of the Contract Documents, shall be reasonable cause for the ENGINEER to require the removal or correction and reconstruction of any such WORK in accordance with the General Conditions.

1.4 INSPECTION AND TESTING SERVICE

A. Inspection and testing laboratory service shall comply with the following:

1. The OWNER or independent firm will perform inspections, testings, and other services as required by the ENGINEER under Paragraph 1.3C above.

2. Reports of testing, regardless of whether the testing was the OWNER's or the CONTRACTOR’s responsibility, will be submitted to the ENGINEER in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

3. The CONTRACTOR shall cooperate with the OWNER or independent firm and furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.

4. The CONTRACTOR shall notify ENGINEER 24 hours prior to the expected time for operations requiring inspection and laboratory testing services.

5. Retesting required because of non-conformance to requirements shall be performed by the same independent firm on instructions by the ENGINEER. The CONTRACTOR shall bear all costs from such retesting.

6. For samples and tests required for CONTRACTOR's use, the CONTRACTOR shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the CONTRACTOR's use shall be the CONTRACTOR’s responsibility.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **Inspection**: The CONTRACTOR shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation, and reject damaged and defective items.

B. **Measurements**: The CONTRACTOR shall verify measurements and dimensions of the WORK, as an integral step of starting each installation.

C. **Manufacturer's Instructions**: Where installations include manufactured products, the CONTRACTOR shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

- END OF SECTION -

SECTION 01505 - MOBILIZATION

PART 1 -- GENERAL

1.1 GENERAL

A. Mobilization shall include the obtaining of all permits; moving onto the site of all plant and equipment; furnishing and erecting plants, temporary buildings, and other construction facilities; and implementing security requirements; all as required for the proper performance and completion of the WORK. Mobilization shall include the following principal items:

1. Moving on to the site of all CONTRACTOR's plant and equipment required for first month operations.

2. Installing temporary construction power, wiring, and lighting facilities.

3. Establishing fire protection system.

4. Developing construction water supply.

5. Providing on-site sanitary facilities and potable water facilities.

6. Arranging for and erection of CONTRACTOR's work and storage yard.

7. Obtaining all required permits.

8. Having all OSHA required notices and establishment of safety programs.

9. Having the CONTRACTOR's superintendent at the job site full time.

10. Submitting initial submittals.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

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SECTION 01510 - TEMPORARY UTILITIES

PART 1 -- GENERAL

1.1 GENERAL REQUIREMENTS

A. **Types**: The types of utility services required for general temporary use at the Site include the following:

Potable water service
Electric power service

1.2 JOB CONDITIONS

A. **Scheduled Uses**: The CONTRACTOR shall, in conjunction with establishment of job progress schedule, establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when acceptable to OWNER and ENGINEER, change over from use of temporary utility service to permanent service.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. The CONTRACTOR shall provide either new or used materials and equipment, which are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry, by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by the utility company, the CONTRACTOR shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of the utility company.

PART 3 -- EXECUTION

3.1 INSTALLATION OF TEMPORARY UTILITY SERVICES

A. **General**: Wherever feasible, the CONTRACTOR shall engage the utility company to install temporary service to project, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with total project construction WORK, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate total project construction WORK.

B. **Approval of Electrical Connections:** Temporary connections for electricity shall be subject to approval of the ENGINEER and the power company representative, and shall be removed in like manner at the CONTRACTOR's expense prior to final acceptance of the WORK.

C. **Separation of Circuits:** Unless otherwise permitted by the ENGINEER, circuits used for power purposes shall be separate from lighting circuits.

D. **Construction Wiring:** Wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. Electrical facilities shall conform to the requirements of Title 8, Industrial Relations, Subchapter 5, Electrical Safety Orders, California Administrative Code; and Subpart K of the OSHA Safety and Health Standards for Construction.

3.2 INSTALLATION OF POWER DISTRIBUTION SYSTEM

A. **Power:** The CONTRACTOR shall provide power required for its operations under the Contract, and shall provide and maintain all temporary power lines required to perform the WORK in a safe and satisfactory manner.

3.3 INSTALLATION OF LIGHTING

A. **Construction Lighting:** WORK conducted at night or under conditions of deficient daylight shall be suitably lighted to insure proper WORK and to afford adequate facilities for inspection and safe working conditions.

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

3.4 WATER SUPPLY

A. **General:** The CONTRACTOR shall provide a potable supply of water of a quality suitable for construction purposes.

B. The CONTRACTOR shall provide and operate all pumping facilities, pipelines, valves, hydrants, storage tanks, and all other equipment necessary for the adequate development and operation of the water supply system. The CONTRACTOR shall be solely responsible for the adequate functioning of its water supply system and shall be solely liable for any claims arising from the use of same, including discharge or waste of water therefrom.

C. **Water Connections**: The CONTRACTOR shall be responsible for supplying potable water to the site necessary for drinking operations. The CONTRACTOR shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the CONTRACTOR shall first attach to the fire hydrant or pipeline a valve and a meter, if required by the owner of the fire hydrant, of a size and type acceptable to the said authority and agency. The CONTRACTOR shall pay all permit and water charges.

3.5 INSTALLATION OF SANITARY FACILITIES

A. **Toilet Facilities:** Fixed or portable chemical toilets shall be provided wherever needed for the use of CONTRACTOR's employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction.

B. **Sanitary and Other Organic Wastes**: The CONTRACTOR shall establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the Site in a manner satisfactory to the ENGINEER and in accordance with all laws and regulations pertaining thereto.

3.6 OPERATIONS AND TERMINATIONS

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

B. **Protection**: The CONTRACTOR shall maintain distinct markers for underground lines, and protect from damage during excavating operations.

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

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

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SECTION 01530 - PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.1 GENERAL

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

1.2 RIGHTS-OF-WAY

A. The CONTRACTOR shall not do any WORK that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the CONTRACTOR enter upon the rights-of-way involved until notified that the OWNER has secured authority therefor from the proper party. Copies of encroachment agreements for work in existing rights of way are included in the contract documents. The CONTRACTOR shall implement actions required by those agreements.

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

1.3 PROTECTION OF STREET OR ROADWAY MARKERS

A. The CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the CONTRACTOR shall be accurately restored after street or roadway resurfacing has been completed.

1.4 RESTORATION OF PAVEMENT

A. **General:** All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.

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

C. **Permanent Resurfacing:** In order to obtain a satisfactory junction with adjacent surfaces, the CONTRACTOR shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.

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

1.5 EXISTING UTILITIES AND IMPROVEMENTS

A. **General:** The CONTRACTOR shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The CONTRACTOR shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

B. Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the WORK, the CONTRACTOR shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the CONTRACTOR's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the CONTRACTOR shall so notify the ENGINEER.

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

D. **Utilities to be Moved:** In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the CONTRACTOR, be notified by the OWNER to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, the CONTRACTOR shall notify the ENGINEER a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

E. **Utilities to be Removed:** Where the proper completion of the WORK requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the CONTRACTOR shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the ENGINEER and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by the CONTRACTOR in a manner that will restore or replace the Utility or improvement

as nearly as possible to its former locations and to as good or better condition than found prior to removal.

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

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

H. **Underground Utilities Not Indicated:** In the event that the CONTRACTOR damages existing Utility lines that are not indicated or the locations of which are not made known to the CONTRACTOR prior to excavation, a verbal report of such damage shall be made immediately to the ENGINEER and a written report thereof shall be made promptly thereafter. The ENGINEER will immediately notify the owner of the damaged Utility. If the ENGINEER is not immediately available, the CONTRACTOR shall notify the Utility owner of the damage. If directed by the ENGINEER, repairs shall be made by the CONTRACTOR under the provisions for changes and extra work contained in the City of Roseville front-end documents.

I. Costs of locating and repairing damage not due to failure of the CONTRACTOR to exercise reasonable care, and removing or relocating such Utility facilities not indicated in the Contract Documents with reasonable accuracy, and for equipment on the project which was actually working on that portion of the WORK which was interrupted or idled by removal or relocation of such Utility facilities, and which was necessarily idled during such work will be paid for as extra work in accordance with the provisions of Section 3 of the General Conditions.

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

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

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

A. **General:** Except where trees or shrubs are indicated to be removed, the CONTRACTOR shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or OWNER. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by the CONTRACTOR or a certified tree company under permit from the jurisdictional agency and/or the OWNER. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

B. **Trimming:** Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. **Replacement:** The CONTRACTOR shall immediately notify the jurisdictional agency and/or the OWNER if any tree or shrub is damaged by the CONTRACTOR's operations. If, in the opinion of said agency or the OWNER, the damage is such that replacement is necessary, the CONTRACTOR shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, the CONTRACTOR shall pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or OWNER. The size of the tree or shrub shall be not less than 1-inch diameter nor less than 6 feet in height. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants. Unless otherwise indicated, the CONTRACTOR shall water and maintain the replacement trees and shrubs for 6 months after planting.

1.7 LAWN AREAS

A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition to the satisfaction of the land owner and the OWNER.

1.8 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the CONTRACTOR shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 days nor more than 7 days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire. The CONTRACTOR shall also notify the regional notification center at 1-800-642-2444 at least 2 days, but no more than 14 days, prior to such excavation.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

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SECTION 01532 - SITE CONDITIONS SURVEYS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs.

1.2 CONTRACTOR SUBMITTALS

A. Photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

B. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

PART 2 -- PRODUCTS (Not used)

PART 3 -- EXECUTION

3.1 PHOTOGRAPHS

A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing photographs of the following:

1. Roadways used to access the Site or haul materials and equipment to the Site.

2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.

3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.

4. Driveways, sidewalks, and buildings which might be affected by the WORK.

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SECTION 01540 - SPECIAL INSPECTIONS AND STRUCTURAL OBSERVATIONS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall cooperate with the OWNER and ENGINEER in performing Special Inspections of the WORK.

1.2 SCHEDULE OF INSPECTIONS/OBSERVATIONS

A. Special Inspections and tests are listed in Appendix A - Schedule of Special Inspections following this specification. Certain individual specification sections may contain Special Inspections and tests specific to those sections.

B. Structural Observations are described in Appendix B - Schedule of Structural Observations following this specification.

1.3 DEFINITIONS

A. **Approved Agency**: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the Building Official.

B. **Approved Fabricator**: An established and qualified person, firm, or corporation identified as such by the Building Official. Approval is based on written procedural and quality control manuals and periodic auditing of fabrication practices by an Approved Agency.

C. **Building Official:** Local department or its representatives responsible for enforcing local codes, reviewing construction documents, and issuing permits for the erection, alteration, demolition, and moving of buildings and structures.

D. **Continuous Special Inspection:** The full-time observation of WORK by a Special Inspector who is present in the area where the WORK is being performed as it is performed.

E. **Fabricated Item:** Structural, load-bearing, or lateral load-resisting assemblies consisting of materials assembled prior to installation in a building or structure, or subjected to operations such as heat treatment, thermal cutting, cold working, or reforming after manufacture and prior to installation in the building or structure. Materials produced in accordance with standard specifications referenced in the Contract Documents or the Code, such as rolled structural steel shapes, steel-reinforcing bars, masonry units, and plywood sheets are not Fabricated Items.

F. **Periodic Special Inspection:** The part-time or intermittent observation of WORK by a Special Inspector who is present in the area where the WORK has been or is being performed and at the completion of the WORK.

G. **Special Inspection:** Inspection as herein required of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the Contract Documents and referenced standards.

Special Inspection does not include, waive, or otherwise affect the CONTRACTOR's responsibility for inspections required by the Contract Documents.

H. **Special Inspector:** An individual employed by an Approved Agency who is regularly engaged in conducting tests and furnishing Special Inspection services. The Special Inspector is an agent of the ENGINEER and is responsible to the ENGINEER. The Special Inspector will be approved and registered by the local Building Official.

I. **Structural Observer:** Registered design professional and agent of the ENGINEER, who provides Structural Observation services during construction.

J. **Structural Observation:** Visual observation by a Structural Observer of the structural system for general conformance to the Contract Documents at significant construction stages and at completion of the structural system. Structural observation does not include, waive, or otherwise affect the CONTRACTOR's responsibility for inspections required by the Contract Documents.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. The CONTRACTOR and Subcontractors whose WORK will be inspected or tested shall disclose any past or present business relationship or potential conflict of interest with the Special Inspector, Testing Laboratory, and Structural Observer.

C. When fabrication of assemblies that would otherwise require Special Inspection is done on an Approved Fabricator's premises, the following shall be submitted:

1. At completion of fabrication, the Approved Fabricator shall submit to the ENGINEER and the Building Official a certificate of compliance stating that the WORK was performed in accordance with the Contract Documents.

D. CONTRACTOR’s Statement of Responsibility: The CONTRACTOR shall submit to the Building Official and to the ENGINEER a written Contractor’s Statement of Responsibility prior to commencing WORK on any system or component requiring a Quality Assurance Plan for Seismic Resistance. The CONTRACTOR’s Statement of Responsibility shall contain the following:

1. Acknowledgment that control will be exercised to obtain conformance with the Contract Documents.

2. Procedures for exercising control within the CONTRACTOR’s organization, the method and frequency of reporting, and the distribution of reports.

3. Identification and qualifications of the persons exercising such control and their positions in the organization.

1.5 CONTRACTOR RESPONSIBILITIES

A. In performing the WORK, the CONTRACTOR shall cooperate with the Special Inspector and the Structural Observer, so that the Special Inspections, Structural Observations, and testing may be performed without hindrance.

B. The CONTRACTOR shall review the Schedule of Special Inspections in Appendix A, the Schedule of Structural Observations in Appendix B, and individual specification sections and shall be responsible for coordinating and scheduling inspections, observations, and tests. The CONTRACTOR shall notify the ENGINEER at least 48 hours in advance of a required Special Inspection, Structural Observation, or test.

C. If any WORK that is to receive any Special Inspection, test, or Structural Observation is covered without concurrence in writing from the ENGINEER, it shall be uncovered at the CONTRACTOR's expense unless the CONTRACTOR has given the notice required above and the Special Inspector, testing laboratory, or Structural Observer has not acted with reasonable promptness to such notice. Removal and replacement of any finished WORK damaged by the uncovering process or as required for corrective action shall be at the CONTRACTOR's expense.

D. The CONTRACTOR shall furnish incidental labor and facilities for access to the WORK to be inspected, observed, or tested, shall obtain and handle samples at the Site or at the source of products to be tested, and shall facilitate tests, observations, inspections, storage, and curing of test samples.

E. The CONTRACTOR shall keep at the Site the latest set of Contract Drawings, field sketches, change orders, approved submittals, and specifications for use by the Special Inspector and Structural Observer.

F. The Special Inspection and observation program shall in no way relieve the CONTRACTOR of this obligation to perform WORK in accordance with the requirements of the Contract Documents or from implementing an effective Quality Control program. The CONTRACTOR's quality control personnel shall first review all WORK that is to be subjected to Special Inspection or Structural Observation.

G. Prior to the beginning of construction, the CONTRACTOR shall have a pre-construction meeting with the ENGINEER, Building Official, OWNER, Special Inspector, Structural Observer, and Testing Laboratories, to review the Special Inspection and Structural Observation requirements.

H. The OWNER will engage and pay for the services of the Special Inspector, Testing Laboratory, and Structural Observer.

I. If any materials that require Special Inspections are fabricated in a plant further than 100 miles from the Site, the CONTRACTOR shall pay for travel expenses of the Special Inspector and Testing Laboratory.

J. The CONTRACTOR shall be responsible for the Special Inspection cost of any replacement and re-testing or re-inspection of WORK that is determined to be Defective WORK.

1.6 INSPECTION OF FABRICATIONS

A. When WORK is performed on the premises of an Approved Fabricator, no Special Inspection is required.

1.7 RECORDS AND REPORTS

A. The Special Inspector will prepare detailed daily reports of each Special Inspection or test.

B. The Structural Observer will prepare detailed reports of each structural observation.

C. Any deviations from the Contract Documents found during a Special Inspection or Structural Observation will be immediately reported to the CONTRACTOR. If the discrepancies are not corrected promptly, the Special Inspector or Structural Observer will notify the ENGINEER and Building Official. Daily reports will identify all discrepancies and the corrective actions taken.

1.8 FINAL REPORTS OF SPECIAL INSPECTIONS AND STRUCTURAL OBSERVATIONS

A. The Final Report of Special Inspections, completed by the Special Inspector, will be submitted to the ENGINEER and Building Official prior to issuance of a Certificate of Use and Occupancy.

B. The Final Report of Special Inspections will certify that required inspections have been performed and will itemize any deviations that were not corrected or resolved.

C. The Final Structural Observation Report will certify that Site visits have been made and identify any deviations, which, to the best of the Structural Observer's knowledge, have not been corrected or resolved.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 STAFFING

A. The firms to be retained to perform the special inspections will be designated by the OWNER.

- END OF SECTION -

Appendix A - SCHEDULE OF SPECIAL INSPECTIONS

Appendix B - SCHEDULE OF STRUCTURAL OBSERVATIONS

APPENDIX A - SCHEDULE OF SPECIAL INSPECTIONS

Required inspections and tests are described in the following "Schedule of Special Inspections" and in the individual Specification Sections for the items to be inspected or tested.

1. **FABRICATORS**

   A. Where fabrication of structural load-bearing members and assemblies is performed at a fabricator's shop, no Special Inspection is required if the fabricator is an Approved Fabricator. If the fabricator is not, then Special Inspection will be required.

2. **STEEL CONSTRUCTION**

   A. Welding inspection will be in compliance with AWS D1.1.

   B. The Special Inspector will inspect the steel to verify compliance with the details on the Contract Drawings, such as bracing, stiffening, member locations and proper application of joint details at each connection.

   C. Installation of high strength bolts will be inspected periodically in accordance with AISC specifications and IBC requirements.

   D. While the WORK is in progress, the Special Inspector will determine that the requirements for bolts, nuts, washers, bolted parts, painting, and installation and tightening in such standards are met.

   E. Monitoring of bolt installation for pretensioning will be performed on a periodic basis when the CONTRACTOR uses the turn-of-nut method with matchmarking techniques, the direct tension indicator method, or the alternate design fastener (twist-off bolt) method. Joints designed as snug tight will be inspected only on a periodic basis.

REQUIRED VERIFICATION AND INSPECTION OF STEEL CONSTRUCTION

Verification And Inspection	Inspection		Referenced Standards
	Continuous	Periodic	
Material verification of high-strength bolts, nuts, and washers:		X	Applicable ASTM material specifications; AISC ASD, Section A3.4; AISC LRFD, Section A3.3
▪ Identification markings conforming to ASTM standards indicated in the Contract Documents.			
▪ Manufacturer's certificate of compliance required.			
Inspection of high-strength bolting:			AISC LRFD Section M 2.5
▪ Bearing-type constructions.		X	
▪ Slip-critical connections.			

Material verification of structural steel:			ASTM A 6 or ASTM 568
▪ Identification markings conforming to ASTM standards indicated in the Contract Documents.			
▪ Manufacturer's certified mill test reports required.			
Material verification of weld filler materials:			AISC, ASD, Section A3.6; AISC LRFD, Section A3.5
▪ Identification markings conforming to AWS specification indicated in the Contract Documents.			
▪ Manufacturer's certificate of compliance required.			
Inspection of welding - Structural steel:			AWS D1.1 AISC Seismic AWS D1.3 IBC 1704.3
▪ Complete and partial penetration groove welds.	X		
▪ Multi-pass fillet welds.	X		
▪ Single-pass fillet welds > 5/16-in (7.9 mm).	X		
▪ Single-pass fillet welds < 5/16-in (7.9 mm).		X	
▪ Welded studs when used for structural diaphragms.			
▪ Welded sheet steel for cold-formed steel framing members such as studs and joists.			
▪ Welding of stairs and railing systems.			
▪ Floor and deck welds.			
Inspection of welding - Reinforcing steel:			AWS D1.4 ACI 318 - 3.5.2
▪ Verification of weldability of reinforcing steel other than ASTM A 706		X	
▪ Reinforcing steel-resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special reinforced concrete shear walls, and shear reinforcement.	X		
▪ Shear reinforcement.	X		
▪ Other reinforcing steel.		X	

Inspection of steel frame joint details for compliance with the Contract Documents:			
▪ Details such as bracing and stiffening.			
▪ Member locations.			
▪ Application of joint details at each connection.			

3. **CONCRETE CONSTRUCTION**

REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION

Verification And Inspection	Inspection		Referenced Standards
	Continuous	Periodic	
Inspection of reinforcing steel, including prestressing tendons, and placement.		X	ACI 318 - 3.5, 7.1-7.7
Inspection of reinforcing steel welding in accordance with inspection of steel table above.			AWS D1.4 ACI 318 - 3.5.2
Inspect bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased.	X		
Sampling fresh concrete and performing slump, air content and determining the temperature of fresh concrete at the time of making specimens for strength tests.	X		ASTM C 172 ASTM C 31 ACI 318 - 5.6, 5.8
Inspection of concrete and shotcrete placement for proper application techniques.	X		ACI 318 - 5.9 & 5.10
Inspection for maintenance of specified curing temperature and techniques.		X	ACI 318 - 5.11-5.13
Adhesive anchor installation.	X		Per ICBO Report

4. **MASONRY CONSTRUCTION**

REQUIRED VERIFICATION AND INSPECTION OF MASONRY CONSTRUCTION

Verification And Inspection	Inspection (Note 1)		Referenced Standards
	Continuous	Periodic	
From the beginning of masonry construction, the following shall be verified to ensure compliance:			ACI 530 Sec. 1.12.3 ACI 530.1 Art. 2.6A, 3.2D, 3.3B, 3.4 & 3.5
▪ Proportions of site-mixed mortar and grout.		E	
▪ Placement of masonry units and construction of mortar joints.		E	
▪ Placement of reinforcement and connectors.		E	
▪ Grout space prior to grouting.		E	
▪ Placement of grout.		E	
The inspection program shall verify:			ACI 530 Sec. 1.15.4, 2.1.2, 1.12, 2.1.8.6 & 2.1.8.6.2 ACI 530.1 Art. 3.3G, 2.4, 3.4 & 1.8
▪ Size and location of structural elements.		E	
• Type, size, and location of anchors, including other details of anchorage of masonry to structural members frames or other construction.	E		
▪ Specified size, grades, and types of reinforcement.		E	
▪ Welding of reinforcing bars	E		
▪ Protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperatures above 90 degrees F)		E	
Preparation of any required grout specimens, mortar specimens, and/or prisms shall be observed.	E		ACI 530.1 Art. 1.4
Compliance with required inspection provisions of the Contract Documents and the approved submittals shall be verified.		E	ACI 530.1 Art. 1.5
Adhesive Anchor Installation	E		Per ICBO Report

Note 1 E – Essential Facility
N – Non-Essential Facility
See the Structural Drawings for classification of structures into essential and non-essential categories

5. **WOOD CONSTRUCTION**

A. Wood construction of the seismic force-resisting system shall have the following Inspections:

1) Field gluing operations, continuous
2) Screw attachment, bolting, anchoring and other fastening of components, including struts, braces, and hold-downs, periodic.
3) Horizontal roof Diaphragm nail spacing
4) Vertical shear wall nail spacing
5) Fabrication welding of steel accessories

- END OF APPENDIX A -

APPENDIX B - SCHEDULE OF STRUCTURAL OBSERVATIONS

Required observations are described in the following "Schedule of Structural Observations".

WHEN TO OBSERVE	WHAT TO OBSERVE
FOUNDATIONS	
Prior to the first concrete pour, but after placement of reinforcing is well under way	Review areas of particular concern such as highly congested areas or any mechanically-coupled splices and check that approved placing plans are being used.
	Review anchor bolt placement and placement of hold-down bolts or steel embeds.
WOOD FRAMING	
After the installation of shear wall sheathing, hold-down, and framing connections.	This may require several Site visits due to the CONTRACTOR's sequencing of the WORK. Make it clear that the ENGINEER has the option to observe nailing, hold-downs, and connections
Prior to roofing.	Observe nailing of the roof diaphragm.
MASONRY CONSTRUCTION	
During lay-up of the first section of wall with special reinforcement requirements, such as boundary elements	Special inspection may not include full time inspection of lay-up or reinforcement placement, so it may be important to verify that reinforcement is placed with the appropriate positioners.
Prior to grouting of the first lift.	Verify that the Special Inspector is performing the required special inspections and that elements for connection of other framing are in place.

- END OF APPENDIX B -

SECTION 01550 - SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.1 HIGHWAY LIMITATIONS

A. The CONTRACTOR shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the WORK. It shall be the CONTRACTOR's responsibility to construct and maintain any haul roads required for its construction operations.

1.2 TEMPORARY CROSSINGS

A. **General**: Continuous, unobstructed, safe, and adequate pedestrian and vehicular access shall be provided to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300 feet shall be provided. The CONTRACTOR shall cooperate with parties involved in the delivery of mail and removal of trash and garbage so as to maintain existing schedules for such services. Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time.

B. **Temporary Bridges**: Wherever necessary, to maintain vehicular crossings, the CONTRACTOR shall provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the CONTRACTOR shall secure the written consent of the responsible individuals or authorities to omit such temporary bridges or steel plates, which written consent shall be delivered to the ENGINEER prior to excavation. All such bridges or steel plates shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the CONTRACTOR shall adopt designs furnished by said authority for such bridges or steel plates, or shall submit designs to said authority for approval, as may be required.

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

D. **Traffic Control:** For the protection of traffic in public or private streets and ways, the CONTRACTOR shall provide, place, and maintain all necessary barricades, traffic

cones, warning signs, lights, and other safety devices in accordance with the requirements of the “Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1).

1. The CONTRACTOR shall take all necessary precautions for the protection of the WORK and the safety of the public. Barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. The CONTRACTOR shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. Signs, signals, and barricades shall conform to the requirements of Cal-OSHA and Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

2. The CONTRACTOR shall submit 3 copies of a traffic control plan to the City Engineer for approval a minimum of 2 weeks prior to construction. The City Engineer shall be allowed access to observe these traffic control plans in use and to make any changes as field conditions warrant. Any changes required by the City Engineer shall supersede these plans and be done solely at the CONTRACTOR's expense.

3. The CONTRACTOR shall remove traffic control devices when no longer needed, repair all damage caused by installation of the devices, and shall remove post settings and backfill the resulting holes to match grade.

E. **Temporary Street Closure:** If closure of any street is required during construction, the CONTRACTOR shall apply in writing to the City Engineer and any other jurisdictional agency at least 30 days in advance of the required closure. A Detour and Traffic Control Plan shall accompany the application.

F. **Temporary Driveway Closure**: The CONTRACTOR shall notify the owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one eight-hour work day at least 3 working days prior to the closure. The CONTRACTOR shall minimize the inconvenience and minimize the time period that the driveways will be closed. The CONTRACTOR shall fully explain to the owner/occupant how long the closure will take and when closure will start.

1.3 CONTRACTOR'S WORK AND STORAGE AREA

A. The CONTRACTOR shall construct and use a separate storage area for hazardous materials used in constructing the WORK.

1. For the purpose of this paragraph, hazardous materials to be stored in the separate area are all products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, Flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, two-part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.

2. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.

3. The CONTRACTOR shall develop and submit to the ENGINEER a plan for storing and disposing of the materials above.

4. The CONTRACTOR shall obtain and submit to the ENGINEER a single EPA number for wastes generated at the Site.

5. The separate storage area shall meet all the requirements of all authorities having jurisdiction over the storage of hazardous materials.

6. The separate storage area shall be inspected by the City of Roseville Hazardous Materials Management Division prior to construction of the area, upon completion of construction of the area, and upon cleanup and removal of the area.

7. All hazardous materials which are delivered in containers shall be stored in the original containers until use. Hazardous materials which are delivered in bulk shall be stored in containers which meet the requirements of authorities having jurisdiction.

1.4 PARKING

A. The CONTRACTOR shall:

1. The CONTRACTOR shall direct its employees to park in areas as directed by the ENGINEER.

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

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01560 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.1 EXPLOSIVES AND BLASTING

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

1.2 DUST ABATEMENT

A. The CONTRACTOR shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity. The CONTRACTOR shall be responsible for any damage resulting from dust originating from its operations. The CONTRACTOR shall never leave the construction premises dirty and dusty. The dust abatement measures shall be continued until the CONTRACTOR is relieved of further responsibility by the ENGINEER.

1.3 SEDIMENTATION ABATEMENT

A. The CONTRACTOR shall be responsible for collecting, storing, hauling, and disposing of spoil, silt, and waste materials in compliance with applicable federal, state, and local rules and regulations and the Contract Documents.

B. Install and maintain erosion and sediment control measures, such as swales, grade stabilization structures, berms, dikes, waterways, filter fabric fences, and sediment basins.

C. Filter fabric barrier systems, if used, shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

D. Remove and dispose of sediment deposits at the designated spoil area. If a spoil area is not indicated, dispose of sediment off-Site at a location not in or adjacent to a stream or floodplain. Sediment to be placed at the spoil area should be spread evenly, compacted, and stabilized. Sediment shall not be allowed to flush into a stream or drainage way.

E. Maintain erosion and sediment control measures until final acceptance or until requested by the ENGINEER to remove it.

1.4 RUBBISH CONTROL

A. During the progress of the WORK, the CONTRACTOR shall keep the Site and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. The CONTRACTOR shall dispose of all rubbish and waste materials of any nature occurring at the Site, and shall establish regular intervals of collection and disposal of such materials and waste. The CONTRACTOR shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of all rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

1. 5 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in Section 5 of the General Conditions.

1. 6 CULTURAL RESOURCES

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

B. The CONTRACTOR shall conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources.

C. In the event potential cultural resources are discovered during subsurface excavations at the site of construction, the following procedures shall be instituted:

1. The ENGINEER will issue a Field Order directing the CONTRACTOR to cease all construction operations at the location of such potential cultural resources find.

2. Such Field Order shall be effective until such time as a qualified archaeologist can be called to assess the value of these potential cultural resources and make recommendations to the State Historic Preservation Office.

D. If the archaeologist determines that the potential find is a bona fide cultural resource, at the direction of the State Historic Preservation Office, the CONTRACTOR shall suspend work at the location of the find under the provisions for changes contained in Section 3 of the General Conditions.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01600 - PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 -- GENERAL

1.1 DEFINITIONS

A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the WORK, regardless of whether specifically purchased for the project or taken from CONTRACTOR's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form WORK. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

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

1.2 QUALITY ASSURANCE

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

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

1.3 PRODUCT DELIVERY AND STORAGE

A. The CONTRACTOR shall deliver and store the WORK in accordance with manufacturer's written recommendations and by methods and means that will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the CONTRACTOR shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.4 TRANSPORTATION AND HANDLING

A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

B. The CONTRACTOR shall provide equipment and personnel to handle products, materials, and equipment, including those furnished by OWNER, by methods to prevent soiling and damage.

C. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.5 STORAGE AND PROTECTION

A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.

B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.

C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.

D. Storage shall be arranged to provide access for inspection. The CONTRACTOR shall periodically inspect to assure products are undamaged and are maintained under required conditions.

E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.6 MAINTENANCE OF PRODUCTS IN STORAGE

A. Stored products shall be periodically inspected on a scheduled basis. The CONTRACTOR shall maintain a log of inspections and shall make the log available on request.

B. The CONTRACTOR shall comply with manufacturer's product storage requirements and recommendations.

C. The CONTRACTOR shall maintain manufacturer-required environmental conditions continuously.

D. The CONTRACTOR shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.

E. For mechanical and electrical equipment, the CONTRACTOR shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.

F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the OWNER in accordance with the Contract Documents.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

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SECTION 01655 - GRAVITY PIPELINE TESTING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall test sanitary system pipelines in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. Furnish

1. A testing plan and schedule including methods for water conveyance, control, leak testing, and water disposal shall be submitted in writing for approval.

2. Where deflection testing of flexible pipe is required, submit a method for mandrel testing or other measurement, as applicable to pipe size.

PART 2 -- PRODUCTS

2.1 DEFLECTION MANDREL

A. **Mandrel Design:** The CONTRACTOR shall construct a mandrel of steel or rigid plastic which can withstand a force of 200 psi without deforming. The mandrel shall have 9 or more "runners" or legs, as long as the number is an odd number. The mandrel barrel length shall be at least 75 percent of the pipe inside diameter.

B. **Mandrel Diameter:** The outside diameter shall taper out to 95 percent of the inside diameter of the pipe. For the purpose of determining the mandrel diameter, the inside diameter of the pipe shall be the average outside diameter of the pipe minus 2 minimum wall thicknesses for OD controlled pipe and shall be the average inside diameter for ID controlled pipe, all dimensions in accordance with the respective pipe standards. Statistical or "tolerance packages" shall not be considered in mandrel sizing. The mandrel shall be stamped or engraved at a location other than a runner with the pipe size and material it is intended to test.

PART 3 -- EXECUTION

3.1 GENERAL

A. Gravity sewer pipes and service laterals shall be tested for exfiltration or infiltration and deflection as indicated. Manholes and pipe shall be backfilled prior to testing. Manholes shall be tested for leakage prior to backfill placement, whereas pipes shall be backfilled prior to testing. The maximum length of pipe tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, the CONTRACTOR shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually

detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

B. Unless otherwise indicated, water for testing will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

C. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges, and if required by the ENGINEER, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

D. Testing operations shall be performed in the presence of the ENGINEER.

3.2 TESTING SCHEDULE

A. Leakage Tests

1. Perform the type of leakage tests determined from the table below, based on pipe size, slope between manholes (Criterion 1), and difference in water levels (Criterion 2).

	Criterion 1		**Criterion 2**	
Nominal Pipe Size	**Manhole Delta H, feet**		**Test Water vs Ground Water Delta H, feet**	
	Less than or equal to10 ft	greater than 10 ft	greater than or equal to 4 ft	less than 4 ft
less than or equal to 24 inches	See Criterion 2	Infiltration or Air See Note 1	Exfiltration	Infiltration or Air
greater than 24 inches	See Criterion 2	See Criterion 2	Exfiltration	Infiltration

Note 1. If ground water is present, perform an infiltration test or air test at the option of the CONTRACTOR; if no ground water is present, perform an air test.

2. Definitions

a. Delta H is the difference between 2 elevations, expressed in feet.

b. Manhole Delta H is the invert elevation difference in 2 adjacent manholes.

c. Test Water vs Ground Water Delta H is the required elevation of water surface for testing minus the average elevation of ground water adjacent to the pipe to be tested. Units are feet.

3. For pressure sewers and force mains, conduct water pressure tests as required by Section 01656 - Pressure Pipe Testing and Disinfection.

B. **Deflection Tests:** Flexible pipe 30-inches and smaller shall be tested for deflection by the mandrel test. Larger flexible pipe shall be tested by a method approved by the ENGINEER. Excessively deflected pipe shall be removed and replaced.

3.3 WATER EXFILTRATION TEST

A. Each section of sewer shall be tested between successive manholes by closing the lower end and the inlet sewers of the upper manhole with stoppers or inflatable plugs. The pipe and manhole shall be filled with water to a point 4-feet above the centerline of the sewer at the center of the upper manhole; or if ground water is present, 4-feet above the average adjacent ground water level, whichever is higher.

B. Water shall remain in the pipe for at least one hour or until the water level stabilizes, whichever is longer, before the test begins. The minimum test duration shall be 4 hours.

C. Unless indicated otherwise, the CONTRACTOR shall measure exfiltration. Measure the amount of water added to the upstream manhole to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.

D. The allowable leakage will be computed by the formula:

$$E = 0.000012\ LD\ (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of sewer tested.

L = Length of sewer and house connections tested, in feet.

D = Internal diameter of the pipe in inches.

H = Elevation difference in feet between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

3.4 WATER INFILTRATION TEST

A. The end of the sewer at the upper structure shall be closed to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

B. The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula above, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.

C. Unless otherwise indicated, infiltration shall be measured by the CONTRACTOR.

3.5 AIR PRESSURE TEST

A. The CONTRACTOR shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the ENGINEER.

B. The CONTRACTOR may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of the service laterals. Such tests will be considered to be for the CONTRACTOR's convenience and need not be performed in the presence of the ENGINEER.

C. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the pipe and the upper ends of all service laterals. Prior to insertion in the sewer, each plug shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released and the leaks eliminated or the plug replaced.

D. The test of the pipe and service laterals shall be conducted in the presence of the ENGINEER. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM F 1417 - Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air.

E. Air pressure in the sewer line shall be increased to 4.0 psi above groundwater pressure (1.0 psi for each 2.3 feet of water elevation above the highest point of the pipe). Do not allow the pressure at any point in the pipe to reach 9 psi under any circumstances. Allow the pressure to stabilize for 5 minutes, then reduce the pressure to 3.5 psi above groundwater pressure and start the test. Stop the air release and record the decrease in pressure over time.

F. **Pass/Fail Criterion**: The time taken for the pressure to decrease from 3.5 to 2.5 psi above groundwater pressure shall be equal to or greater than the time below

Nominal Pipe Diameter, inches	Minimum Time, min:sec	Length for Minimum Time, ft	Increased Time for Longer Lengths, seconds per foot
4	3:46	597	.0380
6	5:40	398	0.854
8	7:34	298	1.520
10	9:26	239	2.374
12	11:20	199	3.418
18	17:00	133	7.692
24	22:40	99	13.674
30	28:20	80	21.366

G. Testing criteria of pipe 12-inches and larger may be adjusted if the ENGINEER approves. The air pressure decrease may be 0.5 psi instead of 1.0 psi, and the corresponding minimum times will be one-half of the tablulated times.

H. For pipe larger than 24-inches, air pressure tests may be performed on each joint. The time for the pressure to fall from 3.5 to 2.5 psi, both above groundwater pressure, shall not be less than 10 seconds regardless of pipe diameter.

I. If the time is less than the allowable time, the pipe will be considered defective and shall be repaired and retested.

3.6 DEFLECTION TEST

A. Mandrel Test

1. The ENGINEER shall be allowed to test the mandrel with the proving ring at any time. The mandrel shall pass through the proving ring with no greater than 0.02-inch clearance, and if it does not, the mandrel will be considered defective and shall be replaced.

2. The CONTRACTOR shall test all flexible pipe 30-inches and smaller for deflection, joint displacement, and other obstructions by passing the mandrel through the pipe not less than 30 days after completion of the trench backfill, but prior to permanent pavement resurfacing.

3. Pipe with diameter less than the mandrel will be considered defective, and the CONTRACTOR shall replace it.

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SECTION 01656 - PRESSURE PIPE TESTING AND DISINFECTION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall test and disinfect potable water pipelines and appurtenant piping, in accordance with the Contract Documents.

B. The CONTRACTOR shall be responsible for obtaining permits for discharging excess testing and disinfection water and dechlorination of such water if required to satisfy permit limits.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule, including method for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval.

2. Name of certified bacteriological testing laboratory.

3. Resume of experienced technician, if liquid chlorine is proposed.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, and other water control equipment, and choice of disinfectant shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK for future conveyance of potable water.

B. Chlorine for disinfection may be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301 - Liquid Chlorine, and shall be used only when each of the following conditions are satisfied:

a. Appropriate gas flow chlorinators and ejectors are used.

b. An experienced technician directly supervises.

c. Appropriate safety practices are observed.

2. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300 - Hypochlorites.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 -- EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting water pipelines will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

B. All pressure pipelines shall be tested; those for potable water shall be disinfected. All chlorinating and testing operations shall be performed in the presence of the ENGINEER.

C. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the ENGINEER.

D. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the WORK is accepted by the OWNER. Bacteriological testing shall be performed by a certified testing laboratory accepted by the OWNER. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

3.2 HYDROSTATIC TESTING OF PIPELINES

A. Pipeline 30-inches diameter and larger shall be visually inspected that all debris has been removed prior to flushing.

B. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

D. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.

E. The maximum allowable leakage for distribution and transmission pipelines shall be 1.2 U.S. gallons per hour with rubber-gasketed joints. The maximum leakage for yard piping shall be as indicated on the Piping Schedule. Pipe with welded joints shall have no leakage. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

3.3 DISINFECTING PIPELINES

A. **General:** Potable water pipelines except those appurtenant to hydraulic structures shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains, using the Continuous-Feed Method as modified herein.

B. **Chlorination:** A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 mg/l. Care shall be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

C. **Retention Period:** Chlorinated water shall be retained in the pipeline for at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l. If testing does not demonstrate a residual of 25 mg/l or greater, the disinfection procedure above shall be repeated.

D. **Chlorinating Valves:** During the process of chlorinating the pipelines, valves and other appurtenances shall be operated from closed to full open to closed while the pipeline is filled with the heavily-chlorinated water.

E. **Sampling Ports:** The CONTRACTOR shall provide sampling ports along the pipeline as defined on AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

F. **Final Flushing:** After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. Any release of chlorinated water shall comply with federal, state, and local regulation and the permits for the project. Chlorine in excessive amounts shall be treated before discharge.

G. **Bacteriological Testing:** After final flushing and before the pipeline is placed in service, a sample, or samples shall be collected from the end of the line, and shall be tested for bacteriological quality in accordance with the requirements of the State

Department of Health or other appropriate regulatory agency. For this purpose the pipe shall be re-filled with fresh potable water and left for a period of 24 hours before any sample is collected. If testing does not demonstrate a free chlorine residual after the 24-hour period, the disinfection procedure above shall be repeated. If the initial disinfection treatment fails to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.4 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

- END OF SECTION -

SECTION 01660 - TESTING AND PLANT STARTUP

PART 1 -- GENERAL

1.1 GENERAL

A. Equipment testing and plant startup are prerequisites to satisfactory completion of the contract requirements and shall be completed within the Contract Times.

B. The startup of a pump station is a complex operation requiring the combined expertise of the CONTRACTOR, manufacturers' representatives, subcontractors, the ENGINEER, and the OWNER. The CONTRACTOR shall be responsible for coordinating all parties for a successful startup: the ENGINEER and OWNER will be available for technical and operational advice prior to and during startup.

C. Testing and startup activities shall be scheduled according to Construction Schedule. The 7-day test and the 8-day test shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the OWNER's calendar.

1.2 SUBMITTALS

A. **Schedule:** The schedule for testing and startup shall be submitted per Section 01300.

B. **Testing and Startup Plan:** Not less than 45-days prior to startup, submit for review a detailed Testing and Startup Plan. The Plan shall include schedules for manufacturers' equipment certifications, list of OWNER and CONTRACTOR-furnished supplies, electrical testing, and detailed schedule of operations to achieve successful system testing, startup, and performance and acceptance testing. The Plan shall include test checklists and data forms for each item of equipment and shall address coordination with the OWNER's staff. The CONTRACTOR shall revise the Plan as necessary based on review comments.

C. Records and Documentation

1. Equipment Installation Certification: Where required by the specifications, submit documentation from manufacturer's representative that the equipment has been properly installed and lubricated, is in accurate alignment, is free from undue stresses from connecting piping and anchoring, and has operated satisfactorily under full load conditions.

2. Records of testing and startup as indicated below.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 EXECUTION

A. **Prerequisites:** The following shall be completed before testing and startup begins.

1. Furnish all Technical Manual information required by the Contract Documents.

2. Provide all safety equipment, emergency shower and eyewash units, fire extinguishers, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the Contract Documents. Devices and equipment shall be fully functional, adjusted, and tested.

3. Manufacturer's certifications of proper installation have been accepted.

4. Leakage tests, electrical tests, and adjustments have been completed.

5. The ENGINEER has approved the CONTRACTOR's Testing and Startup Plan.

6. Functional verification of the individual instrumentation loops (analog, status, alarm, and control) from the field devices to the workstation display screen.

7. Adjustment of the pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and all other control devices to the settings determined by the ENGINEER or the equipment manufacturer.

8. Functional verification of the individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls.

B. Supplies

1. The CONTRACTOR shall furnish:

   a. Chemicals

   b. Oil and grease

   c. Other necessary materials not listed for the OWNER to furnish

2. The OWNER will furnish:

   a. Water

   b. Power

C. **Records of Testing and Startup:** The CONTRACTOR shall maintain the following during testing and startup and submit originals to ENGINEER prior to acceptance:

1. Lubrication and service records for each mechanical and electrical equipment item

2. Hours of daily operation for each mechanical and electrical equipment item

3. Equipment alignment and vibration measurement records

4. Logs of electrical measurements and tests

5. Instrumentation calibration and testing logs

6. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms

7. Factory and field equipment settings

8. Log of problems encountered and adjustments made

9. Other records, logs, and checklists as required by the Contract Documents

3.2 SYSTEM TESTING

A. After individual equipment items have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. All items of equipment shall be tested as part of a system to the maximum extent possible.

B. The CONTRACTOR shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water, to simulate the actual conditions of operation.

C. All systems testing activities shall follow the detailed test procedures and checklists in the Testing and Startup Plan. Completion of systems testing shall be documented by a report.

D. The CONTRACTOR shall system test the utility, chemical feed, safety equipment, and other support systems before testing the process system.

E. Furnish the ENGINEER at least 10 days written notice confirming the start of system testing. The OWNER's staff will observe systems testing.

F. The CONTRACTOR shall arrange for manufacturer's representative to revisit the Site as often as necessary to correct malfunctions to the ENGINEER's satisfaction.

G. Each system shall be tested for a continuous, 7-day, 24-hour/day period. If any system malfunctions during the test, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.

3.3 STARTUP AND ACCEPTANCE TESTING

A. The CONTRACTOR shall start up the pump station and operate it at rates directed by the ENGINEER without malfunction for a continuous 8-day, 24 hour/day acceptance test period. If any equipment item, sub system, or system malfunctions during the test period, the item shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.

B. Defects in material or workmanship which appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons which interrupt the test may, at the judgement of the ENGINEER, be cause for extending the test period an equal amount of time.

C. Acceptance testing shall not begin until all leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, disinfection, and system tests have been completed to the satisfaction of the ENGINEER.

D. The CONTRACTOR shall furnish the services of manufacturer's representatives, if necessary, to correct equipment malfunctions.

E. During acceptance testing, the CONTRACTOR shall:

1. Lubricate and maintain all equipment in accordance with the manufacturers' recommendations.

2. Clean or replace strainers, screens, and filter elements.

- END OF SECTION -

SECTION 01700 - PROJECT CLOSEOUT

PART 1 -- GENERAL

1.1 FINAL CLEANUP

A. The CONTRACTOR shall promptly remove from the vicinity of the completed WORK, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the WORK by the OWNER will be withheld until the CONTRACTOR has satisfactorily performed the final cleanup of the Site.

1.2 CLOSEOUT TIMETABLE

A. The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.3 TECHNICAL MANUAL SUBMITTAL

A. The CONTRACTOR's attention is directed to the condition that one percent of the Contract Price will be retained from any monies due the CONTRACTOR as progress payments, if at the 75 percent construction completion point, the approved Technical Manual complying with Section 01300 has not been submitted. The aforementioned amount will be retained by the OWNER as the agreed, estimated value of the approved Technical Manual. Any such retention of money for failure to submit the approved Technical Manual on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to the CONTRACTOR under Section 7 of the General Conditions.

1.4 FINAL SUBMITTALS

A. The CONTRACTOR, prior to requesting final payment, shall obtain and submit the following items to the ENGINEER for transmittal to the OWNER:

1. Written guarantees, where required.

2. Technical Manuals and instructions.

3. New permanent cylinders and key blanks for all locks.

4. Maintenance stock items; spare parts; special tools.

5. Bonds for roofing, maintenance, etc., as required.

6. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

7. Completed record drawings.

8. Mill certificates for casing materials

9. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

1.5 MAINTENANCE AND GUARANTEE

A. The CONTRACTOR shall comply with the maintenance and guarantee requirements contained in Section 7 of the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the CONTRACTOR which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the CONTRACTOR shall have obtained a statement in writing from the affected private owner or public agency releasing the OWNER from further responsibility in connection with such repair or resurfacing.

C. The CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from the OWNER. If the CONTRACTOR fails to make such repairs or replacements promptly, the OWNER reserves the right to do the WORK and the CONTRACTOR and its surety shall be liable to the OWNER for the cost thereof.

1.6 BOND

A. The CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Section 7 of the General Conditions.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 02100 - SITE PREPARATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The WORK of this Section includes measures required during the CONTRACTOR's initial move onto the Site to protect existing fences, houses and associated improvements, streets, and utilities from damage due to the construction process; clearing, grubbing and stripping; and regrading of certain areas to receive fill.

1.2 SITE INSPECTION

A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the existing site.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 CLEARING, GRUBBING, AND STRIPPING

A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the ENGINEER.

3.2 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require over-excavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be re-contoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The over-excavated volumes, to a level 1.0-foot below the existing ground contours, shall be backfilled.

- END OF SECTION -

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SECTION 02200 - EARTHWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform all earthwork indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR's attention is directed to 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 receipt 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 standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California.

B. The CONTRACTOR shall submit a copy of the excavation permit issued by the California Department of Industrial Safety.

C. The CONTRACTOR shall submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01300 - Contractor Submittals. Sample sizes shall be as determined by the testing laboratory.

PART 2 -- PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. **General:** Fill, backfill, and embankment materials shall be imported and shall be selected or processed clean, fine earth, rock, or sand, free from grass, roots, brush, or other vegetation.

B. Fill and backfill materials to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

C. **Suitable Materials:** Materials not defined as unsuitable below are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to the indicated limitations.

D. Suitable materials may be obtained from on-site excavations (top soil only) or shall be imported. The CONTRACTOR shall provide the imported materials at no additional expense to the OWNER, unless a unit price item is included for imported materials in the bidding schedule.

E. The following types of suitable materials are defined:

1. Type A (three-quarters inch minus granular backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum sand equivalent value of 28 and a minimum R-value of 78. If the sand equivalent value exceeds 35 the R-value requirement is waived.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 12

2. Type B (class 1 crushed stone): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements. The material shall have a minimum sand equivalent value of 75.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (sand backfill): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

4. Type E (pea gravel backfill): Not Used.

5. Type F (coarse drainrock): Crushed rock or gravel with the size gradation for Size Number 4 in ASTM C 33

6. Type G (aggregate base): Crushed rock aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for pavements. At the option of the CONTRACTOR, the grading for either the 1-1/2-inch maximum size or 3/4-inch maximum size gradation shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	1-1/2-inch Max. Gradation	3/4-inch Max. Gradation
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	50 - 85	90 - 100
No. 4	25 - 45	35 - 55
No. 30	10 - 25	10 - 30
No. 200	2 - 9	2 - 9

7. Type H (graded drainrock): Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying.

The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4-inch	90 – 100
3/8-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

The drainrock shall have a sand equivalent value not less than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The CONTRACTOR shall use, at its option, one of the asphalt types listed below:

	Type 1	Type 2	Type 3
Designation	SC-800	SC-250	RS-1
Spray Temperature (^{o}F)	175-255	165-200	70-120
Coverage (gal/sq yd)	0.50	0.50	0.50

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

8. Type I: Any other suitable material as defined herein.

9. Type J (cement-treated backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

10. Type K (topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

11. Type M (aggregate subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. The sand

equivalent value shall be not less than 18 and the material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
3-inch	100
2-1/2 inch	87 - 100
No. 4	35 - 95
No. 200	0 - 29

12. Type N (trench plug): Low permeable fill material, a non-dispersible clay material having a minimum plasticity index of 10.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include the materials listed below.

1. All soils excavated from the site are considered unsuitable for reuse as backfill.

2. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of Pt, OH, CH, MH, or OL.

3. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

4. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

5. Topsoil, except as allowed below.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. The CONTRACTOR shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, the ENGINEER shall be immediately notified. In case of conflict between types of pipe embedment backfills, the CONTRACTOR shall use the agency-specified backfill material if that material provides a greater degree of structural support to the pipe, as determined by the ENGINEER. In case of conflict between types of trench or final backfill types, the CONTRACTOR shall use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills shall be constructed of material Types B or G that can achieve the required compaction indicated in paragraph 3.8, E.

2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.

a. Mortar coated pipe, concrete pipe, and un-coated ductile iron pipe shall be provided with Type A or B material in the pipe zone.

b. Plastic pipe and vitrified clay pipe shall be provided with Type B material in the pipe zone.

c. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a Number 4 sieve, trench plugs of Type J, L, or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.

3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type I backfill material or any of Types A through H backfill materials or any mixture thereof, except:

   a. Type K material may be used for trench zone backfill in agricultural areas unless otherwise shown or specified.

4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that Type K material shall be used for final backfill in agricultural areas unless otherwise indicated.

5. Trench backfill and final backfill for pipelines under structures shall be the same material as used in the pipe zone, except where concrete encasement is required by the Contract Documents.

6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.

7. Backfill around structures shall be Type I material, or Types A through Type H materials, or any mixture thereof, except as shown.

8. Backfill materials beneath structures shall be as follows:

   a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.

   b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types G or H materials shall be used.

   c. Under structures where groundwater must be removed to allow placement of concrete, Type G material shall be used. Before the Type G material is placed, filter fabric shall be placed over the exposed foundation.

   d. Under all other structures, Type G or H material shall be used.

9. Backfill used to replace pipeline trench over-excavation shall be a layer of Type F material with a top filter layer of filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.

10. Filter fabric shall be **Mirafi 140 N, Mirafi 700X,** or equal.

2.4 MATERIALS TESTING

A. All soils testing of samples submitted by the CONTRACTOR will be done by a testing laboratory of the OWNER'S choice and at the OWNER'S expense. At its discretion, the ENGINEER may request that the CONTRACTOR supply samples for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. **Unified Soil Classification System:** References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The CONTRACTOR shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistively, and pH will be done in accordance with California Test Methods 532 and 643 of the California Department of Transportation.

2.5 IDENTIFICATION TAPE

A. Unless indicated otherwise, identification tape shall be placed above all buried pipelines which are not comprised at least in part of magnetic components. Identification tape shall be 6-inches wide, yellow in color, polyethylene, with integral metallic wire. Tape shall be labeled with CAUTION – BURIED UTILITIES.

PART 3 -- EXECUTION

3.1 EXCAVATION - GENERAL

A. **General:** Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the WORK. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, 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. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Removal and Exclusion of Water: The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least two feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE AND ROADWAY EXCAVATION

A. **Excavation Beneath Structures:** Except where otherwise indicated for a particular structure or ordered by the ENGINEER, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 8 inches of native material and where such subgrade is sloped, the native material shall be benched. When such over-excavation is indicated, both over-excavation and subsequent backfill to the required grade shall be performed by the CONTRACTOR. When such over-excavation is not indicated but is ordered by the ENGINEER, such over-excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 8 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. **Excavation Beneath Paved Areas:** Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

C. **Notification of ENGINEER:** The CONTRACTOR shall notify the ENGINEER at least 3 days in advance of completion of any structure excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. Exploratory Excavation

1. The CONTRACTOR shall excavate and expose buried points of connection to existing utilities where indicated on the Drawings. Excavation shall be performed prior to preparation of Shop Drawings for connections and before fabrication of pipe, and the data obtained shall be used in preparing Shop Drawings.

2. Data, including dates, locations excavated, and sketches, shall be submitted to the ENGINEER within one week of excavation.

3. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR.

B. **General:** Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

C. **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 bedding. Excavations for pipe bells and welding shall be made as required.

D. **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 meeting safety requirements shall be provided and maintained.

E. **Indicated Trench Over-Excavation:** Where trenches are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

F. Over-Excavation (Not Indicated)

1. When ordered by the OWNER to over-excavate trenches deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade of the bottom of the pipe bedding.

2. Payment

a. Over-excavation less than 8-inches more than the indicated trench depth and/or width shall be done at no increase in cost. Additional payment will be made for over-excavation 8 inches or more than the indicated depth and/or width.

b. Additional payment will be based on unit price bid items for over-excavation if such bid items were established; otherwise payment will be based on a negotiated price. Volumes of material will be based on survey measurements of the over-excavated area.

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

H. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVER-EXCAVATION NOT ORDERED OR INDICATED

A. Any over-excavation carried below the grade ordered or indicated, shall be backfilled and compacted to the required grade with the indicated material.

B. Explosives and Blasting

1. Blasting will not be permitted.

3.5 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the CONTRACTOR in accordance with laws and regulations regarding disposal of such material.

3.6 BACKFILL - GENERAL

A. 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 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.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally, The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.7 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill 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 6 inches in thickness.

B. Flooding and jetting methods are not permitted.

C. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

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

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

3.8 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type E, F, and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of 24-inches, measured in the uncompacted state. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24-inches or not.

C. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

D. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least two feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

E. **Compaction Requirements:** The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) for Type A, B, C, G, H, I, K, M, and N materials and in accordance with ASTM D 4253 - Standard Test Method; for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, for Type B, E, F, and J materials. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	95	70
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Pipe embedment backfill for rigid pipe	90	55
Pipe zone backfill portion above embedment for rigid pipe.	95	70

Pipe bedding and over-excavated zones under bedding for rigid pipe.	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	55
Trench zone backfill, beneath paved areas and structures, including trench plugs.	90	55
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	90	55
Embankments and fills.	90	55
Embankments and fills beneath paved areas or structures.	95	70
Aggregate base or subbase (Type G or M material)	95	N.A.

3.9 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone Backfill

1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated. The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe. The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

2. After compacting the bedding the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.

3. The pipe zone shall be backfilled with the indicated backfill material. The CONTRACTOR shall exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

B. **Trench Zone Backfill:** After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the

pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. **Final Backfill:** Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

D. Identification Tape: Install identification tape as indicated.

3.10 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 8 inches, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the ENGINEER, each layer shall not exceed 6 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 4:1, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12-inches normal to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers. Material thus cut shall be re-compacted along with the new material. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe. Heavy construction equipment shall maintain a minimum distance from the edge of the trench equal to the depth of the trench until at least 4 feet of fill over the pipe has been completed.

3.11 FIELD TESTING

A. **General:** All field soils testing will be done by a testing laboratory of the OWNER's choice at the OWNER's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. In case the test 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 paid by the CONTRACTOR.

D. The CONTRACTOR shall provide test trenches and excavations including excavation, trench support, and groundwater removal for the OWNER'S field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the OWNER.

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SECTION 02570 - STEEL PIPE, SPECIALS, AND FITTINGS (AWWA C200, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide steel pipe, specials, and fittings, complete and in place, in accordance with the Contract Documents.

B. A single pipe manufacturer shall be made responsible for furnishing steel pipe, specials, fittings, and appurtenances such as bolts and gaskets for the WORK.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals, and the following supplemental requirements:

B. Shop Drawings

1. Certified dimensional drawings of fittings and appurtenances.

2. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances; and other pertinent information required for the manufacture of the product.

3. Details for elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials that indicate amount and position of reinforcement. Fittings and specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated in the Contract Documents.

4. Material lists and steel reinforcement schedules that describe materials to be utilized. Submit metallurgical, chemical, and physical test reports from each heat of steel to verify the steel conforms to the Specifications.

5. Line layout and marking diagrams which indicate the specific number of each pipe and fitting, the location of each pipe, and the direction of each fitting in the completed line. In addition, the line layouts shall include:

a. The pipe station and invert elevation at every change in grade or horizontal alignment

b. The station and invert elevation to which the bell end of each pipe will be laid

c. Elements of curves and bends, both in horizontal and vertical alignment

d. The limits within each reach of restrained and/or welded joints or of concrete encasement

e. Location and dimensional allocations for each valve, fitting, and appurtenance identified in the Contract Documents

6. Full and complete information regarding location, type, size, and extent of welds shall be shown on the Shop Drawings. The Shop Drawings shall distinguish between shop and field welds. Shop Drawings shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

7. Rubber gasket joint design and details

8. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.

9. Details and locations of closures for length adjustment and for construction convenience.

10. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation.

C. **Certifications:** The CONTRACTOR shall furnish a certified affidavit of compliance for pipe and other products or materials as specified in AWWA C200 - Steel Water Pipe 6 in and Larger, AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in and Larger-Shop Applied, AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In Through 144 In, AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings, AWWA C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipe, AWWA C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines, AWWA C218 - Coating the Exterior of Aboveground Steel Water Pipelines and Fittings, AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe, AWWA C221 - Fabricated Steel Mechanical Slip-Type Expansion Joints, and the following supplemental requirements:

1. Physical and chemical properties of steel.

2. Hydrostatic test reports.

3. Results of production weld tests.

4. Sand, cement, and mortar tests.

5. Rubber gasket tests.

6. Coating adhesion test

7. Records of coating application

D. Performing and paying for sampling and testing necessary for certification are the CONTRACTOR's responsibility as part of the WORK.

E. **Manufacturer’s Qualifications:** Furnish a copy of manufacturer’s documentation of experience in fabricating AWWA C200 pipe.

F. **Design Calculations of Fittings and Specials:** Furnish a copy of design calculations for fittings and specials including miters, welds, and reinforcement, prior to manufacture of pipe, fittings, and specials

1.3 QUALITY ASSURANCE

A. **Pipe Manufacturer Qualifications:** The pipe manufacturer shall be experienced in fabrication of AWWA C200 pipe of similar diameters, lengths, and wall thickness to this WORK. Experience shall be in the production facilities and personnel, not the name of the company that owns the production facility or employs the personnel.

B. **Inspection:** Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200, C205, and C214 as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing start date not less than 14 Days prior to the start of any phase of the pipe manufacture.

C. **Tests:** Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200, C205, and C214 as applicable.

1. Joint gaskets shall be tested in accordance with AWWA C200.

2. After the joint configuration is completed and prior to lining with cement mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the yield strength of the steel. The test pressure shall be held for 2 minutes and the pipe visually inspected to confirm that welds are sound and leak-free.

3. In addition to the tests required in AWWA C200, weld tests shall be conducted on each 5,000-feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.

4. Fittings fabricated from straight pipe previously passing a hydrostatic test need not have an additional hydrostatic test provided welds are tested by nondestructive means and shown to be sound.

D. Shop Testing of Steel Plate Specials

1. If any special has been fabricated from straight pipe not previously tested and is of the type listed below, the special shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure: bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds.

2. Specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165 - Standard Test Methods for Liquid Penetrant Examination, Method A or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.

3. Reinforcing plates shall be tested by the solution method using approximately 40 psi air pressure introduced between the plates through a threaded test hole. Test hole shall be properly plugged following successful testing.

4. Any weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures. Weld defects shall be gouged out and rewelded. After corrections, the special shall be retested.

5. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with finished plate edges ground smooth, straight, and prepared for the field joint.

6. Testing shall be performed before joints have been coated or lined.

7. Ultrasonic examination shall be performed in accordance with the following:

   a. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:

      1) Any plate in the welded joint has a thickness exceeding 1/2-inch.

      2) Any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service.

   b. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.

   c. The ultrasonic examination shall be in accordance with ASTM A 578 - Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications with a Level I acceptance standard.

8. Plates that are not in conformance with the acceptance criteria in ASTM A 578 may be used in the WORK if the areas that contain the discontinuities are a distance at least 4 times the greatest dimension of the discontinuity away from the weld joint.

E. The CONTRACTOR shall be responsible for performing and paying for said material tests. The ENGINEER has the right to witness testing conducted by the CONTRACTOR; provided, that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.

F. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including mortar lining and coating for testing by the OWNER. The additional samples shall be furnished as part of the WORK.

G. **Field Testing:** Field testing shall conform to the requirements of Section 01656 - Pressure Pipe Testing and Disinfection.

H. **Welding Requirements:** Welding procedures used to fabricate and install pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code-Steel or the ASME Boiler and Pressure Vessel Code, Section 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.

I. **Welder Qualifications:** Welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME

Boiler and Pressure Vessel Code, Section 9 by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Lined and coated steel pipe and specials shall conform to AWWA C200, C205, C209, C214, and C218, subject to the following supplemental requirements. The pipe, specials, and fittings shall be of the diameter and class indicated and shall be provided complete with rubber gaskets or welded joints as indicated in the Contract Documents. For pipe, specials, and fittings 14-inches diameter and larger, the nominal inside diameter after lining shall not be less than the diameter indicated on the Drawings, allowing for tolerances according to AWWA C200 and C205. Pipe, specials, and fittings smaller than 14-inches diameter may be furnished in standard outside diameters. When indicated as a minimum, wall thickness tolerance shall be as allowed by AWWA C200 or the ASTM nominal sheet or plate tolerance, whichever is less.

B. **Markings:** The manufacturer shall legibly mark pipe, specials, and fittings in accordance with the laying schedule and marking diagram. Each pipe, special, and fitting shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. Each pipe, fitting, and special shall be marked at each end with top field centerline.

C. **Handling and Storage:** The pipe, specials, and fittings shall be handled by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe, specials, and fittings shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the pipe including coating and lining coating will not be damaged. Pipe, specials, and fittings shall not be rolled and shall be secured to prevent accidental rolling.

D. The CONTRACTOR shall replace or repair damaged pipe, specials, and fittings.

E. **Strutting:** Adequate strutting shall be provided on specials, fittings, and straight pipe so as to avoid damage to the pipe, specials, and fittings during handling, storage, hauling, and installation. For mortar-lined steel pipe, specials, or fittings the following requirements shall apply:

1. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe, special, or fitting is loaded, transported, unloaded, installed, and backfilled at the Site.

2. The strutting materials, size, and spacing shall be adequate to support the earth backfill plus any greater loads that may be imposed by the backfilling and compaction equipment.

3. Any pipe, special, or fitting damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. **Laying Lengths:** Maximum pipe laying lengths shall be 48-ft with shorter lengths provided as required.

G. **Lining:** The pipe, specials, and fittings shall have smooth, dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

H. **Closures and Correction Pieces:** Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated.

2.2 MATERIALS

A. **Mortar:** Materials for mortar shall conform to the requirements of AWWA C205; provided, that cement for mortar coating shall be Type II and mortar lining shall be Type II or V. Cement in mortar lining and coating shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement. Admixtures shall contain no calcium chloride.

B. **Steel for Cylinder and Fittings:** Pipe, specials, and fittings manufactured under AWWA C200 shall satisfy the following requirements:

1. Minimum yield strength of steel is 42,000 psi.

2. Be manufactured by a continuous casting process

3. Be fully killed

4. Be fine grain practice

5. Have maximum carbon content of 0.25 percent

6. Have maximum sulfur content of 0.015 percent

7. Have minimum elongation of 22 percent in a 2-inch gauge length.

8. Be in accordance with one of the following:

a. ASTM A 1011 - Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

b. ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates

c. ASTM A 572 - High Strength Low-Alloy Columbium-Vanadium Structural Steel

d. ASTM A 1018 - Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled Carbon, Structural, High-Strength Low-Alloy Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability

C. Steel equal to or greater than 1/2-inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products. Frequency of testing shall be one impact test (set of 3 specimens, transverse, not longitudinal) for each coil used in manufacturing the pipe. The frequency for sheets and plates shall be one

impact test (set of 3 specimens) and shall be made for each 200 tons of product. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 degrees F.

2.3 DESIGN OF PIPE

A. **General:** The pipe shall be suitable to transmit potable water under the conditions indicated in the Contract Documents. The steel pipe shall have rubber gasketed or field welded joints as indicated. The pipe shall consist of a steel cylinder, shop-lined with Portland cement mortar and an exterior coating of cement mortar in accordance with C205.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to AWWA C200.

C. **Pipe Dimensions:** Pipe shall be of the diameter and minimum wall thickness indicated.

D. **Fitting Dimensions:** Fittings shall be of the diameter and class indicated.

E. **Joint Design:** Unless indicated otherwise, the standard field joint for steel pipe shall be as indicated in the following table. Butt-strap joints shall be used only where required for closures or where indicated.

Pipe Diameter	Application	Joint Type
60-inches and less	Non-Restrained Areas	Rolled Gasket Joint Carnegie Gasket Joint
	Non-Restrained and Restrained Areas	Lap Welded Joint Butt Joint
	Closures, Restrained and Non-Restrained	Butt Strap Joint
Larger than 60-inches	Non-Restrained Areas	Carnegie Gasket Joint
	Non-Restrained and Restrained Areas	Lap Welded Joint Butt Joint
	Closures, Restrained and Non-Restrained	Butt Strap Joint

F. Lap joints prepared for field welding shall be in accordance with AWWA C200. The method used to form, shape, and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the ENGINEER, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. Faying surfaces of the bell and spigot shall be essentially parallel except for mitered bells, but the bell slope shall not vary more than 2 degrees from the longitudinal axis of the pipe.

G. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, it will provide watertight joints under all operating conditions. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted. Unless otherwise approved by the ENGINEER, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. No process will be permitted in which the bell is formed by rolling. Spiral weld seams shall be tested by the visible penetrant method of ASTM E 165 - Methods for Liquid Penetrant Inspection or magnetic particle inspection method of ASME Section VIII, Division 1, Appendix VI, for a minimum distance of 12-inches from each end of each joint after the spigot and bell are formed. Defects shall be repaired.

H. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the ENGINEER.

I. Restrained Joints

1. Located where indicated, restrained joints shall be field-welded joints, butt-straps as indicated. Designs shall include stresses created by the greater of:

   a. Temperature differential of 40 degrees F plus poisson's effect in combination with hoop stress, or;

   b. Thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.

2. For field welded joints, design hoop stresses shall not exceed or 21,000 psi.

2.4 SPECIALS AND FITTINGS

A. **Design:** Except as otherwise indicated, materials, fabrication and shop testing of specials and fittings shall conform to the requirements stated above for pipe and shall conform to the dimensions of AWWA C208. The minimum thickness of plate for pipe from which specials are to be fabricated shall be the greatest of those determined by the following 3 criteria:

1. Working and Transient Pressure Design

$$T = \frac{P_w D/2}{Y/S_w} \qquad T = \frac{P_t D/2}{Y/S_t}$$

Where:

T	=	Steel cylinder thickness in inches
D	=	Outside diameter of steel cylinder in inches
P_w	=	Design working pressure in psi
P_t	=	Design transient pressure in psi
Y	=	Specified minimum yield point of steel in psi
S_w	=	Safety factor of 2.5 at design working pressure
S_t	=	Safety factor at design transient pressure; for elbows 1.875 and 2.0 for other specials

2. Mainline Pipe Thickness: Plate thickness for specials shall not be less than for the adjacent mainline pipe.

3. Minimum Thickness Based on Pipe Diameter

Nominal Pipe Diameter, in	Pipe Manifolds Piping Above Ground Piping Structures
24 and under	3/16-in
25 to 48	1/4-in
over 48	5/16-in

B. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA Manual M11.

C. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M11. Reinforcement shall be designed for the design pressure indicated and shall be in accordance with the Drawings. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.

D. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less. Horizontal deflections or fabricated angles shall fall on the alignment.

E. Vertical deflections shall fall on the alignment and be at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures. The pipe angle points shall match the angle points indicated.

F. Outlets, Tees, Wyes, and Crosses

1. Outlets 12-inches and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters, i.e., 12-3/4 inch, 10-3/4 inch, 8-5/8 inch, 6-5/8 inch, and 4-1/2 inch. Minimum plate thickness for reinforcements shall be 10-gauge.

2. The design of outlet reinforcement shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M11 and the design pressures and factors of safety above.

3. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M11, pipe or specials with outlets may be fabricated entirely of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.

4. Where Manual M11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.

5. Outlets shall be fabricated so that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field welded joints. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field-welded joints.

6. Tees, wyes, crosses, elbows, and manifolds shall be fabricated so that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2-inches, whichever is greater. Longitudinal weld joints in adjacent cylinder sections shall be oriented so that there is a minimum offset of 5 times cylinder thickness or 2-inches, whichever is greater.

G. **Steel Welding Fittings:** Steel welding fittings shall conform to ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

H. **Ends for Mechanical-Type Couplings:** Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inches and smaller is furnished in standard schedule thickness and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

2.5 CEMENT-MORTAR LINING

A. **Cement-Mortar Lining for Shop Application:** Unless indicated otherwise, interior surfaces of pipe, specials, and fittings shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205. During the lining operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar WORK. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness and tolerance shall be in accordance with AWWA C205.

C. The pipe shall be left bare as indicated where field joints occur. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

D. Defective linings, as determined by the ENGINEER, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints.

E. The progress of the application of mortar lining shall be regulated in order that handwork, including the repair of defective areas, is cured in accordance with the provisions of AWWA C205. Cement mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

F. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM standards and this Section. Coating and lining applied in this manner shall provide protection equal to that for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-application.

G. **Cement-Mortar Lining for Field Application**; Unless otherwise indicated, steel pipe shall be mortar lined. The materials and design of in-place cement mortar lining shall be in accordance with AWWA C602 and the following supplementary requirements:

1. Pozzolanic material shall not be used in the mortar mix.

2. Admixtures shall contain no calcium chloride.

3. The minimum lining thickness shall be as indicated for shop-applied cement mortar lining, and finished inside diameter after lining shall be as indicated.

4. Temperature and shrinkage cracks in the mortar less than 1/16-inch wide need not be repaired. Pipe, specials, or fittings with mortar cracks wider than 1/16-inch shall be rejected.

H. **Protection of Pipe Lining/Interior:** For pipe, specials, and fittings with plant-applied cement-mortar linings, the CONTRACTOR shall provide a 12-mil polyethylene sheet or other suitable bulkhead on the ends of the pipe and on each opening to prevent drying out of the lining. Bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

A. **Exterior Coating of Exposed Piping:** The exterior surfaces of pipe, specials, and fittings that will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09800 - Protective Coating.

B. **Exterior Coating of Buried Piping:** Pipe for buried service, including bumped heads, shall be coated with a 1-inch minimum thickness of reinforced cement-mortar coating. Unless otherwise indicated, exterior surfaces of pipe or fittings passing through structure walls shall be cement-mortar coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting. The coating shall be reinforced with a spiral wire reinforcement or welded wire fabric in accordance with AWWA C205. The welded wire fabric shall be securely fastened to the pipe with welded clips or strips of steel. The wire spaced 2-inches on centers shall extend circumferentially around the pipe. The ends of reinforcement strips shall be lapped 4-inches and the free ends tied or looped to assure continuity of the reinforcement.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Division 15 of the Specifications. Access manholes with covers shall be as indicated, installed during fabrication, not in the field. Threaded outlets shall be forged steel suitable for 3000 psi service, and shall be as manufactured by **Vogt**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. **Handling and Storage:** Pipe, specials, and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the Site or elsewhere. Pipe, specials, and fittings shall be handled and stored at the Site in accordance with the requirements stated in Part 2, above. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks that may be harmful as determined by the ENGINEER. Such damaged lining and coating/interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided.

B. Pipe damaged prior to Substantial Completion shall be repaired or replaced.

C. The CONTRACTOR shall inspect each pipe, special, and fitting for damage. The CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

D. Before placement of pipe, specials, or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the WORK.

E. Pipe, specials, and fittings shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe, special, or fitting. Excavations shall be made as needed to facilitate removal of handling devices after the item is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

F. **Installation Tolerances:** Each section of pipe, special, or fitting shall be laid in the order and position on the laying diagram and in accordance with the following:

1. Each section of pipe, special, or fitting having a nominal diameter less than 48-inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus 1-inch vertical deviation.

2. Each section of pipe, special, or fitting having nominal diameter 48-inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.

3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.

4. After installation, pipe, specials, and fittings shall not show deflection greater than 1.5 percent for mortar-lined and mortar-coated pipe, specials, and fittings; 2.25 percent for mortar-lined and flexible-coated pipe, specials, and fittings; and 3.0 percent for flexible-lined and flexible-coated or bare pipe, specials, and fittings. The allowable deflection shall be based on the design inside diameter.

G. **Test Section:** At the beginning of pipe laying operations, the CONTRACTOR shall perform a test section to demonstrate that the methods and materials to be utilized will satisfy the pipe zone backfill compaction and pipe deflection criteria. The maximum length of the test section shall be 500-feet: The CONTRACTOR shall not proceed with production pipe laying beyond the test section without the ENGINEER's approval. The entire test section length that does not comply with the Contract Documents shall be reworked as necessary to comply. The ENGINEER will observe construction of the test section. The OWNER will take measurements and keep records for quality assurance purposes. Any change in means, methods, and trench conditions, including excavation, bedding, and pipe zone materials, insitu soils, water conditions, and backfill and compaction methods will require another successful test section before additional production pipe installation.

H. Where necessary to raise or lower the pipe, specials, or fittings due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in a joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening, before finishing with the protective mortar inside the pipe, shall be the controlling factor.

I. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill if on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be installed as indicated.

J. Struts in pipe 42-inches diameter and larger shall be left in place until backfilling operations have been completed. Struts in pipe smaller than 42-inches may be removed immediately after laying. A laboratory selected and paid by the OWNER may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed. Pipe deflection shall not exceed 3 percent 24 hours after the struts are removed. After the backfill has been placed, the struts shall be removed and shall remain the property of the CONTRACTOR.

K. **Cold Weather Protection:** No pipe, special, or fitting shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe, special, or fitting shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. **Pipe, Specials, and Fitting Protection:** The openings of pipe, specials, and fittings with shop-applied mortar lining shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe, specials, and fittings. The CONTRACTOR shall introduce water into the pipe to keep the mortar moist if moisture has been lost due to damaged bulkheads. Means shall be provided to prevent the pipe from floating due to water in the trench from any source. Pipe that has floated shall be repaired, including restoration to original condition and profile.

M. **Pipe Cleanup:** As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris. The CONTRACTOR shall completely clean the interior of the pipe

of sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

A. **Rubber Gasketed Joints:** Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with a non-toxic vegetable-based lubricant shall be placed in the spigot groove. The lubricant shall be a compound listed as in compliance with NSF Standard 61. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with the vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gauge shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. The joint shall be reassembled with a new gasket.

3.3 WELDED JOINTS

A. **General:** Field welded joints shall be in accordance with AWWA C206 - Field Welding of Steel Water Pipe.

B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

C. Butt straps shall be as indicated.

D. A heat resistant shield shall be draped over at least 24-inches of coating beyond the holdback on both sides of the weld during welding to avoid damage to the coating by hot weld splatter. Welding grounds shall not be attached to the coated part of the pipe.

E. After the pipe and joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one-foot above the top of the pipe. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.

F. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.

G. **Shrinkage Control Joints:** At intervals not exceeding 250-feet along welded reaches of the pipeline and at the first regular lap-welded field joints outside concrete encasements and structures, the pipe shall be laid with an initial lap of not less than 1-inch greater than the minimum lap dimension. The welding of each such shrinkage control joint shall be performed when the temperature is approximately the lowest during the 24 hour day, after at least 250-feet of pipe have been laid and the joints have been welded ahead of and in back of the shrinkage control joint, and after backfill has been

completed to at least 1-foot above the top of the pipe ahead of and in back of the shrinkage control joint. Where shrinkage control joints occur in a traveled roadway or other inconvenient location, the location of the shrinkage control joint may be adjusted, as acceptable to the ENGINEER.

H. Prior to the beginning of the welding procedure, any tack welds used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with AWWA C206. Where more than one pass is required, each pass except the first and final ones shall be peened to relieve shrinkage stresses, and dirt, slag, and flux shall be removed before the succeeding bead is applied.

I. Prior to butt welding, the pipe and joint shall be properly positioned in the trench using line up clamps so that, in the finished joint, the abutting pipe sections shall not be misaligned more than 1/16-inch.

J. Unless double fillet welds are indicated, field welded lap joints may, at the CONTRACTOR'S option, be made on either the inside or the outside of the pipe.

K. **Inspection of Field Welded Joints:** An independent testing laboratory acceptable to the ENGINEER but paid by the CONTRACTOR shall inspect the joints. Inspection shall be as soon as practicable after the welds are completed.

1. Fillet welds shall be tested by the Magnetic Particle Inspection Method in accordance with ASME Section VIII, Division 1, Appendix VI.

2. In addition, double fillet welds on butt strap joints shall be tested by the soap solution method using approximately 40 psi air pressure introduced between the plates through a threaded hole as indicated. Test holes shall be plugged by a threaded plug or welding following successful testing.

3. Butt welds shall be inspected by radiographic methods in accordance with API Standard 1104.

L. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these specifications after which backfilling may be completed.

M. **Repair of Welds:** Welds that are defective shall be repaired by the CONTRACTOR to meet the requirements of this Specification. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.4 JOINT COATING AND LINING

A. **General:** The interior and exterior joint recesses shall be thoroughly wiped clean and water, loose scale, dirt, and other foreign material shall be removed from the inside surface of the pipe.

B. **Joint Coating of Shop-Applied Tape-Coated Pipe:** Joints shall be coated in accordance with Section 09810.

C. Every joint will be tested by the ENGINEER with an electrical detector capable of at least a 12,000 volt output, furnished by the CONTRACTOR. The tests will be made using a voltage of 6,000 to 7,000 volts. Holidays shall be repaired by the CONTRACTOR.

D. **Coating Repair:** Coating repair shall be made using tape and primer conforming to AWWA C209. When visual inspection shows a portion of the tape-wrap system has sustained physical damage, the damaged area shall be subjected to an electrical holiday test of 6,000 to 7,000 volts.

E. Following repair of the damaged area, if the holiday test indicates a holiday still exists, the inner wrap shall be exposed and the exposed area shall be wiped clean with xylol solvent or equal, and the area coated with tape primer. A patch of 35-mil thick cold-applied tape of sufficient size to cover the damaged area plus a minimum lap of 2-inches in all directions shall then be applied. The patched area shall again be tested for holidays. If none are detected, a second layer of 35-mil thick tape shall then be applied over the first patch. The second layer of tape shall overlap the first layer a minimum of 2-inches in all directions.

F. When the area tests show no holiday, a notation shall be applied to the area indicating the test is satisfactory.

G. **Coating of Fittings and Specials:** Fittings and specials shall be coated in accordance with Section 09810.

H. **Joint Lining:** After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. Excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch. With pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

3.5 INSTALLATION OF PIPE APPURTENANCES

A. **Protection of Appurtenances:** Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with Section 09810.

B. **Installation of Valves:** Valves shall be handled in a manner to prevent any injury or damage to the valve or any part of it. Joints shall be thoroughly cleaned and prepared prior to installation. The CONTRACTOR shall adjust stem packing and operate each valve prior to installation to verify proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

D. Buried valves and flanges shall be coated and protected in accordance with Section 09800 - Protective Coatings.

E. **Installation of Flanged Joints:** Before the joint is assembled, the flange faces shall be thoroughly cleaned of foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. Bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable calibrated torque wrench. Clamping torque shall be applied to the nuts only. Full face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

F. **Insulated Joints:** Insulated joints and appurtenant features shall be provided as indicated. The CONTRACTOR shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test shall be performed by the CONTRACTOR. If the resistance test indicates a short circuit, the CONTRACTOR shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint. The insulated joint shall then be retested to assure proper insulation.

G. **Flexible Coupled Joints:** When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings, and gaskets are clean and free of dirt and foreign matter with special attention given to the contact surfaces of the pipe, gaskets, and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe. Bolts shall be tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable calibrated torque wrench set for the torque recommended by the coupling manufacturer. Clamping torque shall be applied to the nut only.

3.6 CORROSION CONTROL

A. **Joint Bonding/Electrolysis Test Stations:** Except where otherwise indicated, joints shall be bonded. The pipe shall be cleaned to bare bright metal at the point where the bond is to be installed. In addition, electrolysis test stations shall be installed where indicated.

B. **Cathodic Protection:** Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided where indicated.

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SECTION 02591 - POLYETHYLENE LARGE DIAMETER PROFILE WALL NONPRESSURE PIPE (ASTM F 894, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all 18- to 120-inch inside diameter polyethylene (PE) pipe of profile wall construction and with integral bell joints for use in low pressure (up to 25-ft hydrostatic head) and gravity flow applications and all appurtenant work, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM D 1248	Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 894	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. Shop Drawings

1. Certified dimensional drawings of pipe and fittings.

2. Layout drawings for pipe, joints, bends, special fittings, and appurtenances.

3. Material testing reports.

4. Report of testing required by ASTM F 894.

C. **Certificates:** Manufacturer's certificates for all materials indicating conformance to the Contract Documents.

1.4 QUALITY ASSURANCE

A. **Testing:** All materials testing shall be based upon applicable ASTM test methods referenced herein. A report of the test results shall be furnished.

B. Costs of such tests shall be borne by the CONTRACTOR as part of the WORK.

C. The pipe shall be tested for dimensions, ring stiffness constant (RSC), flattening, and joint tightness, in accordance with the requirements of ASTM F 894. A report of the test results shall be furnished.

D. **Mandrel Test:** A mandrel test shall be performed on all pipe smaller than 36-inch diameter after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel with a circular cross section having a diameter of at least 95 percent of the average inside diameter shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point the pipe shall be repaired and retested.

E. **Deflection Test:** Pipe 36-inches and larger shall be checked for deflection after backfilling and compacting but prior to final paving and prior to leakage testing. At every point within the pipe, the measured vertical inside diameter shall not be less than 95 percent of the average inside diameter.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pipe furnished under this section shall be marked in accordance with the requirements of ASTM F 894.

B. The CONTRACTOR shall furnish certification that the pipe was manufactured, sampled, tested, and inspected in accordance with ASTM F 894 and has met the requirements of that standard.

2.2 PIPE AND FITTINGS

A. All pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all of the requirements of ASTM F 894.

B. Pipe and fitting classifications shall have a minimum Ring Stiffness Class RSC of RSC 100.

C. Pipe and fittings shall be joined by the use of integral bell joints with a gasket compressed between the spigot and bell ends of the pipe or by thermal welding of the bell and spigot pipe ends. Elastomeric gaskets shall comply with the requirements of ASTM F 477. Material used for thermal welding shall meet the requirements established for the pipe base material.

PART 3 -- EXECUTION

3.1 GENERAL

A. All laying, jointing, testing for defects and for leakage, shall be performed in the presence of the ENGINEER, and shall be subject to its approval before acceptance. All

material found to have defects will be rejected and the CONTRACTOR shall promptly remove such defective material from the Site.

3.2 HANDLING AND STORAGE

A. **Handling:** Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

B. After unloading and before installation, pipe shall be stored on flat, level ground with no rocks, timbers or other objects under the pipe. The maximum stacking height for various diameters of pipe is:

18- to 21-inch diameter	4 rows
24- to 30-inch diameter	3 rows
33- to 48-inch diameter	2 rows
54-inch and larger	1 row

3.3 INSTALLATION

A. Installation shall conform to the requirements of ASTM D 2321 and the applicable requirements of Section 02200 - Earthwork, instructions furnished by the pipe manufacturer, and to the requirements herein. Wherever the requirements are in conflict, the more stringent shall apply.

B. The minimum backfill compaction in the pipe zone shall be 90 percent of maximum density per ASTM D 1557.

C. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with watertight plugs or bulkheads.

D. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where necessary and where indicated.

E. Where unstable trench walls or trench bottom is encountered, such as may be found by excavation below ground water, this condition shall be stabilized before laying the pipe. Depending on the severity of the condition, the CONTRACTOR may elect to use tight sheeting, stay bracing, a trench box, well points, an underdrain, removal of the unstable soil and replacement with a suitable foundation material, or a combination of methods.

3.4 FIELD JOINTING

A. With the gasket properly placed in the spigot groove, the gasket shall be stress-relieved by passing a screwdriver under the gasket and then around the circumference of the spigot.

B. The pipe ends shall be wiped clean and a thin coat of lubricant applied to both the outside surface of the spigot end with the gasket in place, and the inside surface of the bell end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall then be forced into the bell end of the adjoining pipe. A backhoe bucket or a cable winch may be used, but the force shall be steady, not an impact force, and shall be evenly distributed so as not to damage the pipe end.

C. The pipe shall not be deflected either vertically or horizontally in excess of the recommendations of the manufacturer.

D. If thermal welding is used to joint bell and spigot ends, the joint shall be assembled in accordance with the manufacturer's recommended procedure.

3.5 TESTING

A. Field testing of gravity sewer or drainpipe shall conform to Section 01655 – Gravity Pipeline Testing.

- END OF SECTION -

SECTION 03290 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

1.2 TYPES OF JOINTS

A. **Construction Joints:** When fresh concrete is placed against a hardened concrete surface, the joint between the pours is defined as a construction joint. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated.

B. **Contraction Joints:** Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour. 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 later pour. Waterstop and/or sealant groove shall also be provided where indicated.

C. **Expansion Joints:** To allow the concrete to expand freely, a space is provided between the two pours, and the joint shall be formed as indicated. The space is obtained by placing a joint filler material against the earlier pour to act as a form for the later pour. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop as indicated.

1. 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. The strip shall later be removed to form space for sealing material.

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

D. **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 indicated, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Placement drawings showing the location and types of joints for each structure.

2. Certified test reports from the sealant manufacturer on the actual batch of material supplied, indicating compliance with requirements. Furnish test report before using the sealant on the project.

3. Copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer. Every person who is to be involved with waterstop installation is required to have individual certification on file with ENGINEER, stating that the named individual is certified and trained to install waterstop per manufacturer's recommendations and specifications.

4. Manufacturer's information demonstrating compliance of the following with indicated requirements:

a. Bearing Pad

b. Neoprene Sponge

c. Preformed Joint Filler

d. Backing Rod

e. Waterstop

f. Slip Dowels

g. PVC Tubing

C. Samples

1. Prior to production of the material required under this Section, qualification samples of waterstops shall be submitted which represent accurately the material proposed. Such samples shall be extruded or molded sections of each size or shape to be installed. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples

D. **Certificates:** Written certification from the manufacturer as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the physical property requirements of the Contract Documents. Supplier certificates are not acceptable.

1.4 QUALITY ASSURANCE

A. **Waterstop Inspection:** Waterstop field joints shall be subject to inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections. Not less than 24 hours notice shall be given for scheduling such inspections.

B. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point. Defective joints shall

be replaced with material that passes inspection; faulty material shall be removed from the Site and destroyed.

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 cracking 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 cracking that 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 results 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.)

7. Visible signs of separation when the cooled splice is bent by hand at any sharp angle.

8. Any evidence of burned material.

D. **PVC Waterstop Samples:** Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided. Field samples of prefabricated fittings (crosses, tees, etc.) will also be selected at random by the ENGINEER for testing by a laboratory at the OWNER's expense. When tested, tensile strength across the joints shall be at least 1120 psi.

E. **Construction Joint Sealant:** The CONTRACTOR shall prepare adhesion and cohesion test specimens at intervals of 5 Days while sealants are being installed. 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-inches by 3-inches). Spacing between the blocks shall be 1-inch. Coated spacers (2-inches by 1-1/2 inches by 1/2-inch) shall be used to set and hold 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 be not less than 24 hours.

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

1.5 SPECIAL WARRANTY REQUIREMENTS

A. The CONTRACTOR shall furnish a 5 year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the CONTRACTOR agrees to repair or replace, to the satisfaction of the OWNER, any such defective areas which become evident within the 5 year period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Joint materials shall be listed as compliant with NSF Standard 61.

2.2 WATERSTOPS

A. **PVC Waterstops:** Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Section. No reclaimed or scrap material shall be used. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those listed herein.

1. Flatstrip and Center-Bulb Waterstops: Flatstrip and center-bulb waterstops shall be as manufactured by **Greenstreak Plastic Products Co., Profiles 646, 679, 732,** and **735; Tamms Horn/Durajoint Types 9,10, 11,** and **11A**; or equal, provided that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8-inch. Waterstop shall be provided with factory installed hog rings at 12-inches on centers along the waterstop.

2. Multi-Rib Waterstops: Multi-rib waterstops, where required, shall be as manufactured by **Greenstreak Plastic Products Co., Profiles 789 and 790, Tamms Horn/Durajoint Types 25 and 26,** or equal. Prefabricated joint fittings shall be used at intersections of the ribbed-type waterstops.

3. Retrofit Waterstops: Retrofit waterstops and batten bars shall be as manufactured by **Greenstreak Plastic Products Co.**, **Style #609**, or equal. Waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

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

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2000	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	600	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	plus 0.25/minus 0.10	------
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

B. **Preformed Hydrophilic Waterstop:** Hydrophilic (bentonite-free) waterstops shall be **Hydrotite CJ10202k** as manufactured by **Greenstreak Plastic Products Co**., **or Adeka Ultraseal MC2010** as manufactured by **Asahi Denka.**

1. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

2. Waterstop shall be manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties. Waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete. The minimum expansion ratio of modified chloroprene shall be not less than 2 to 1 volumetric change in distilled water at 70 degrees F (21 degrees C).

Physical Property, Chloroprene	Value	ASTM Std
Tensile Strength-min, psi	1275	D 412
Ultimate Elongation, min percent	350	D 412
Hardness, Shore A	55 plus and minus 5	D 2240

Physical Property, Modified Chloroprene	Value	ASTM Std.
Tensile Strength, min psi	300	D 412
Ultimate Elongation, min percent	600	D 412
Hardness, Shore A	55 plus and minus 5	D 2240

3. Bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

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

2.3 JOINT SEALANT FOR WATER-BEARING JOINTS

A. Joint sealant shall be polyurethane polymer designed for bonding to concrete that 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 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200 gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

C. 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 ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2 part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used. Such compounds shall conform to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920, Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I. 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 manufacturer.

D. Sealants shall be **PSI-270** as manufactured by **Polymeric Systems Inc., Sikaflex 2C,** as manufactured by **Sika Corporation,** or equal

E. Sealants for non-waterstop joints in concrete shall conform to Section 07920 - Sealants and Caulking.

2.4 JOINT MATERIALS

A. **Bearing Pad:** Bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness unless otherwise indicated.

B. **Neoprene Sponge:** Sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, type 2C5-E1.

C. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

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 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 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.7 PVC TUBING

A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated. Waterstops shall be fully continuous for the extent of the joint. Splices necessary to provide such continuity shall conform to printed instructions of manufacturer of the waterstops. The CONTRACTOR shall take suitable precautions and provide 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 progress. 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 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 time until the exposed portion of waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

A. Splices in PVC 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 80 percent of the unspliced material.

3. The continuity of the waterstop ribs and of its tubular center axis be maintained. No edge welding is allowed.

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

C. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon inspection and approval, 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 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. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed. Waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through hog rings at 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.

D. 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 a future concrete placement.

E. **Joint Location:** Construction joints and other types of joints shall be provided where indicated. If not indicated, construction joints shall be provided at 25-foot maximum spacing. Where joints are indicated spaced greater than 40-feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

F. **Joint Preparation:** Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required. Unless otherwise indicated, such bonding will be required at every horizontal joint in walls. Surfaces shall be prepared in accordance with Section 03300 - Cast-in-Place Concrete.

G. **Retrofit Joint Preparation:** Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material. Surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to application of epoxy and waterstop.

H. **Construction Joint Sealant:** Construction joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used to form 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, laitance and fins shall be removed, and the grooves shall be sand blasted. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter they shall be primed and filled with the construction joint sealant. The primer shall be furnished by the sealant manufacturer. No sealant shall 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.

I. 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. Sealant shall achieve final cure at least 7 Days before the structure is filled with water.

J. Sealant shall be installed by a competent waterproofing specialty contractor that has a successful record of performance in similar installations.

K. Thorough, uniform mixing of 2 part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application. Before any sealer is placed, the CONTRACTOR shall arrange to have the crew doing the WORK carefully instructed on the proper method of mixing and application by a representative of the sealant manufacturer.

L. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK shall be completely removed; the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer. The groove shall be re-sealed with the indicated joint sealant. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR's responsibility as part of the WORK.

M. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is called for in the Contract Documents, it shall be installed per the manufacturer's instructions and recommendations except as modified herein.

2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.

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

4. The hydrophilic 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.

5. Where the thickness of the concrete member to be placed on the hydrophilic 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 2-1/2 inches.

6. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6-inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.

7. The hydrophilic waterstop shall not be installed where the air temperature falls outside the manufacturer's recommended range.

8. The concrete surface under the hydrophilic waterstop shall be smooth and uniform. The concrete shall be ground smooth if needed. Alternately, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills 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.

9. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing. This shall be in addition to the adhesive recommended by the manufacturer.

N. **Retrofit Waterstop:** Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless steel anchors at 6-inches on center, staggered, and in accordance with the manufacturer's written recommendations.

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SECTION 03310 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide cast-in-place concrete, joints in concrete, reinforcement steel and appurtenant work, formwork, bracing, shoring, supports, and shall design and construct falsework, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

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

2. Details of the concrete reinforcing steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Details of reinforcing steel for fabrication and erection shall conform to ACI 315V and the requirements herein. 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. Include bar placement diagrams which clearly indicate the dimensions of each bar splice.

3. Where mechanical couplers are required or permitted to be used to splice reinforcing steel, submit manufacturer's literature 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 that show the location of each coupler with details of how they are to be installed in the formwork.

4. If reinforcement steel is spliced by welding at any location, submit mill test reports that contain the information necessary for the determination of the carbon equivalent per AWS D1.4 Structural Welding Code – Reinforcing Steel. 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. The CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure used and welder qualifications, for each welding procedure, and for each welder performing the WORK. Such qualifications shall be as specified in AWS D1.4.

5. Manufacturer's information demonstrating compliance with requirements of the following:

a. Bearing pads

b. Neoprene sponge

c. Preformed joint filler

d. Backing rod

e. Slip dowels

f. PVC tubing

g. Form ties and related accessories

h. Form gaskets

i. Form release agent

j. List of form materials and locations of use

k. Mill tests for cement

l. Admixture certification. Chloride ion content shall be included.

m. Aggregate gradation test results and certification

n. Materials and methods for curing

6. Placement drawings showing the location and type of joints for each structure.

C. **Mix Designs:** Prior to beginning the WORK, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. The mix designs shall be checked by an independent testing laboratory acceptable to the ENGINEER. Costs related to such checking shall be the CONTRACTOR's responsibility. When a water reducing admixture is to be used, the CONTRACTOR shall furnish mix designs for concrete both with and without the admixture.

D. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish certified delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring, and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amounts of water in the aggregate, added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each certificate shall state the mix number, total yield in cubic yards, and the time of day to the nearest minute, corresponding to the time when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

1.3 QUALITY ASSURANCE

A. Testing of Reinforcing Steel

1. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcing steel in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests, if material fails initial tests, shall be the CONTRACTOR's responsibility.

2. If requested by the ENGINEER, the CONTRACTOR shall furnish 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 ENGINEER, 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 that fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the OWNER; but the costs of tests that fail to meet requirements shall be the CONTRACTOR's responsibility.

B. Testing of Materials

1. Tests on component materials and for compressive strength of concrete will be performed as indicated herein. Tests for determining slump will be in accordance with the requirements of ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness in accordance with ASTM C33 - Concrete Aggregates.

3. The cost of laboratory tests on cement, aggregates, and concrete, will be paid by the OWNER. However, the CONTRACTOR shall pay the cost of any additional tests and investigations on WORK that does not meet the Specifications. The laboratory will meet or exceed the requirements of ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

4. Concrete for testing shall be furnished by the CONTRACTOR at no cost to the OWNER, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

C. **Inspections:** Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the ENGINEER will be required where necessary to conform with code requirements. Inspection reports shall be submitted to the ENGINEER. The special inspector shall observe the following WORK for conformance with the Drawings and Specifications:

1. During the preparation and taking of required test specimens.

2. Placing of concrete except sitework concrete fully supported on earth.

D. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each class of concrete herein and at intervals thereafter as selected by the ENGINEER 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 in accordance with Section 9.2 of ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field. Specimens will be 6-inches diameter by 12-inches high cylinders.

3. Compression tests will be performed in accordance with ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. 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.

E. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 318 - Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality", and as indicated herein.

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

3. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement as part of the WORK.

F. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so that the concrete is within the tolerances herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated. Where tolerances are not indicated, permissible deviations will be in accordance with ACI 117 - Standard Tolerance for Concrete Construction and Materials.

1. The variation from required lines or grades shall not exceed 1/4-inch in 10-feet and there shall be no offsets or visible waviness in the finished surface.

PART 2 -- PRODUCTS

2.1 FORM AND FALSEWORK MATERIALS

A. Except as otherwise expressly accepted by the ENGINEER, lumber for use as forms, shoring, or bracing shall be new material.

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

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard.

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

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade required. 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.

C. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to a 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

D. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf (minimum). The minimum design load for combined dead and live loads shall be 100 psf.

2.2 FORM TIES

A. Form ties 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 other removable form-tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and such fasteners shall be such as to leave holes of regular shape for reaming. Form ties shall be **Wrench Head Snap Ties by MeadowBurke, Snap Ties by Dayton/Richmond**, or equal.

B. Removable taper ties may be used when approved by the ENGINEER. Taper ties shall be **Taper Ties by MeadowBurke, Taper Ties by Dayton/Richmond**, or equal.

2.3 REINFORCEMENT STEEL

A. **General:** Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, for Grade 60 Billet Steel Reinforcement, unless otherwise indicated.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement, and the details indicated. 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. 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 - Steel Wire, Plain, for Concrete Reinforcement.

4. Bar and spiral reinforcement that is welded shall conform to ASTM A 706 - Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement, for Grade 60 reinforcement unless otherwise indicated. In addition, the carbon equivalent in reinforcing that is welded shall not exceed 0.55 percent

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. 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 than required for the concrete in which they are located. Where concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.4 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the ENGINEER. Couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice.

2.5 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the ENGINEER. Welded splices of reinforcement steel shall develop a tensile strength exceeding 125 percent of the yield strength of the reinforcing bars that are connected.

B. Materials required to perform the welded splices to the requirements of AWS D1.4 shall be provided.

2.6 CONCRETE MATERIALS

A. 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. Cement shall be used in the sequence of receipt of shipments.

B. Materials for the WORK shall comply with the requirements of Sections 201, 203, and 204 of ACI 301- Structural Concrete for Buildings, 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 - Portland Cement for Type II or Type V.

2. Water 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 ENGINEER, shall be non-reactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as indicated. Lightweight sand for fine aggregate will not be permitted.

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

5. Air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. 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. Air entraining agent shall be **Micro-Air** by **Master Builders, Daravair** by **W.R. Grace, Sika AEA-15** by **Sika Corporation,** or equal.

6. Admixtures: Admixtures may be added at the CONTRACTOR's option to control the set, affect water reduction, and increase workability. In either case, the addition of an admixture shall be at the CONTRACTOR's expense. The use of an admixture shall be subject to acceptance by the ENGINEER. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall conform to the requirements of ASTM C 494 - Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, shall be non-toxic after 30 Days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.

   a. Concrete shall not contain more than one water-reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER.

   b. Set controlling admixture may 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 such as **Sika Corporation Plastocrete 161 MR, Master Builder Pozzolith 300R Dartard** by **Grace Construction Products,** or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees, a set accelerating admixture such as **Sika Corporation Plastocrete 161FL, Master Builder Pozzutec 20, Polarset** by **Grace Construction Products,** or equal shall be used.

   c. Normal range water reducer shall conform to ASTM C 494, Type A. It shall be **WRDA 79 by Grace Construction Products, Pozzolith 322-N by Master Builders Plastocrete 161 by Sika Corporation,** or equal. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

7. Calcium Chloride: Calcium chloride will not be permitted in concrete.

2.7 CURING MATERIALS

A. Materials for curing concrete shall conform to the following requirements and ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete:

1. Curing compounds shall be white-pigmented and resin-based. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be **Kurez VOX White Pigmented** by **Euclid Chemical Company, Cure R-2 by L&M Construction Chemicals, 1200-White by W.R. Meadows,** or equal. When curing compound must be removed for finishes or grouting, curing compounds shall be **Kurez DR VOX** by **Euclid Chemical Company, Masterkure-100W** by **ChemRex MBT, L&M Cure R by L&M Construction Chemicals, 1100-Clear by WR Meadows,** or equal. Curing compounds shall meet local VOC requirements.

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 - Standard Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

3. Evaporation retardant shall be a material such as **Confilm** by **ChemRex MBT, Eucobar** by **Euclid Chemical Company, E-CON by L&M Construction Chemicals, Inc.,** or equal.

2.8 JOINT MATERIALS

A. Materials for joints in concrete shall conform to the following requirements:

1. Joint filler material 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. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction; for Type I, except as otherwise indicated.

2. Elastomeric joint sealer shall conform to the requirements of Section 07920 - Sealants and Caulking.

3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the ENGINEER.

2.9 MISCELLANEOUS MATERIALS

A. Dampproofing agent shall be an asphalt emulsion such as **Hydrocide 600** by **ChemRex Sonneborn, Emulsified Asphalt** by **Euclid Chemical Company, Sealmastic** by **W. R. Meadows Inc.**, or equal.

B. Epoxy adhesives shall be the following products:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive** by **Sika Corporation, Concresive Liquid (LPL)** by **Chem Rex MBT**, **BurkEpoxy MV** by **Burke** by **Edoco,** or equal.

2. For bonding hardened concrete or masonry to steel, **Sikadur 31 Hi-Mod Gel** by **Sika Corporation, BurkEpoxy NS** by **Burke** by **Edoco, Concresive Paste (LPL)** by **Chem Rex MBT**, or equal.

C. Epoxy grout 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 in Section 03315 - Grout.

2.10 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. 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. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER. Mix changes shall be subject to review by the ENGINEER.

2. The CONTRACTOR is cautioned that the limiting parameters below are **NOT** a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability.

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

Type of Work	Class of Concrete Min 28-Day Compressive Strength, psi	Max Size Aggregate in	Cement Content Per cu yd, lbs	Max W/C Ratio (by weight)
Structural concrete	4,000	1	564 to 600	0.45
Sitework concrete	3,000	1	470 (min)	0.50
Lean concrete	2,000	1	376 (min)	0.60

2.11 CONSISTENCY

A. 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 indicated otherwise	3-inches plus or minus 1-inch
Ductbank and pipe encasement	5-inches plus or minus 1-inch

2.12 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 ENGINEER; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

2.13 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 ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

2.14 READY-MIXED CONCRETE

A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, placing, the supplementary requirements as required herein, and is in accordance with ASTM C 94.

B. Ready-mixed concrete shall be delivered to 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 comes first. In hot weather, under conditions contributing to quick stiffening of the concrete, or 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.

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 counter shall be actuated at the time of starting the mixer at mixing speed.

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. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

E. Each batch of ready-mixed concrete delivered to the WORK shall be accompanied by a delivery ticket furnished to the ENGINEER in accordance with the requirements above.

F. 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 ENGINEER.

PART 3 -- EXECUTION

3.1 GENERAL FORMWORK REQUIREMENTS

A. 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 forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. A sufficient number of forms of each kind shall be available 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. Design, construction, maintenance, preparation, and removal of forms shall be in accordance with ACI 347 - Guide to Formwork for Concrete and the requirements herein.

B. 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.

3.2 CONSTRUCTION

A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members 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 indicated, except as may be acceptable to the ENGINEER. 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: 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, 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 or regular cement grout. Exposed faces of walls shall have at least 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.

3.3 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view.

3.4 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. Members which must support their own weight shall not have their forms removed until they have attained at least 75 percent of the 28-Day strength of the concrete. Forms for vertical walls and columns shall remain in place at least 48 hours after the concrete has been placed. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347.

3.5 GENERAL REINFORCEMENT REQUIREMENTS

A. 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 indicated herein.

3.6 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

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

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner that will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

3.7 PLACING

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that 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. 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 provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. The portions of accessories in contact with the formwork shall be made of concrete, plastic, or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

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

D. Bars additional to those indicated which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR as part of the WORK.

E. Unless otherwise indicated, 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 Building Code.

F. The minimum spacing requirements of ACI 318 shall be followed for reinforcing steel.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs. Slab bolsters shall be spaced not more than 30-inches on centers, shall extend continuously across the entire width of the reinforcing mat, and shall support the reinforcing 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.

3.8 SPLICING

A. **General:** Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be reviewed and accepted by the ENGINEER.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.

2. Welded splices shall be performed in accordance with AWS D1.4.

3. 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.

3.9 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conductive to corrosion until concrete is placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of 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, reinforcing shall be reinspected and, if necessary recleaned.

3.10 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 ACI 301.

C. **Slump:** Slumps shall be as indicated herein.

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

3.11 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:** 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 ENGINEER, 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 bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, and foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. **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 ENGINEER.

D. Embedded Items

1. No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been

completed and accepted by the ENGINEER at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

2. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated or by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

E. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting (exposing aggregate) prior to the application of an epoxy bonding agent. Application shall be according to the bonding agent manufacturer's instructions and recommendations.

F. No concrete shall be placed in any structure until 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, shall be subject to the review of the ENGINEER.

G. **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.

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

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

3.12 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 during or before placing is found not to conform to the requirements indicated 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.

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

D. Placement in Wall and Column Forms

1. 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 in walls and 8-feet in columns 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 wall 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 wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.

2. 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.

E. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and 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 a type acceptable to the ENGINEER. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the required 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. Conveyor belts and chutes shall be covered.

F. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. 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 required minimum temperature. 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.

G. Cold Weather Placement

1. Placement of concrete shall conform to ACI - 306.1 - Cold Weather Concreting, and the following.

2. Earth foundations shall be free from frost or ice when concrete is placed upon or against them.

3. Maintain the concrete temperature above 50 degrees F for at least 72-hours after placement.

3.13 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

1. The pumping equipment shall 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.

2. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R - Placing Concrete by Pumping Methods.

3. Pumping equipment and hose conduits that are not functioning properly, shall be replaced.

4. Aluminum conduits for conveying the concrete shall not be permitted.

3.14 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. Vibrators shall be high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

B. 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. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact 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.

3.15 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 indicated are defined as tolerances and are indicated above. These

tolerances are to be distinguished from irregularities in finish as described herein. 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 1/2-inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

C. **Unformed Surfaces:** After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Whenever the air temperature exceeds 85 degrees F or the wind speed exceeds 25 mph at the time of placement, the concrete shall be treated as follows. 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 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 indicated or as determined by the ENGINEER.

3. Finish U3 - After the Finish U2 surface 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 irregularities.

4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. 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 to be covered with built-up roofing	U2

Interior slabs and floors to receive architectural finish	U3
Slabs	U4
Top surface of walls	U3

3.16 CURING AND DAMPPROOFING

A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
Concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Buried slabs and backfilled walls	5

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 4 below.

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. 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 that will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is 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.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

4. Curing compound 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. 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.

5. During the curing period, no traffic of any nature and no depositing of any materials, temporary or otherwise, shall be permitted on surfaces coated with curing compound. Foot traffic and the depositing of materials may be allowed after 3 Days if the surface is covered with 5/8-inch plywood placed over polyethylene sheets.

F. **Method 5:** This method applies to both buried slabs and walls to be backfilled.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 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 through 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 substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. 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 above.

6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

7. Dampproofing: The exterior surfaces of buried roof slabs and backfilled walls shall be dampproofed as follows.

   a. Immediately after completion of curing, the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated above.

   b. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be

used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

G. The CONTRACTOR may submit alternate methods of curing which maintain the concrete in a continuously wet condition for acceptance by the ENGINEER.

3.17 PROTECTION

A. The CONTRACTOR shall protect concrete against injury until final acceptance.

B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.18 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days, 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.19 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, exposed concrete 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 ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing

extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. Repairs and replacements shall be performed promptly.

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 laitance or soft material, plus not less than 1/32-inch depth of the surface film from 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 underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair 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. 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 repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

3.20 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. 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, which may have been originally defective, which becomes defective at any time prior to the final acceptance of the completed WORK, 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.

- END OF SECTION -

SECTION 03315 - GROUT

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents

B. The following types of grout are covered in this Section:

1. Cement Grout

2. Non-Shrink Grout - Class I (cement-based)

3. Non-Shrink Grout - Class II (cement-based)

4. Non-Shrink Epoxy Grout

5. Epoxy Anchor Grout for Adhesive Anchors

6. Topping Grout and Concrete/Grout Fill

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.

4. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.

5. Manufacturer’s certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.

6. Submit manufacturer's written warranty as indicated herein.

7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

1.3 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. A set of 3 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 topping grout and concrete/grout fill will be performed in accordance with Section 03310 - Cast-in-Place Concrete, at intervals during construction selected by the ENGINEER.

4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings and Polymer Concretes, Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.

6. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03310 unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Cement and Epoxy-Based Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based non-shrink and epoxy grouts to be used on the project, before any installation of grout is allowed.

b. Training session shall use a minimum of 5 bags of cement-based non-shrink class I grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates and tie holes to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.

c. The manufacturer shall mix enough cement-based non-shrink class II grout for a minimum of 15 tie holes and shall train the CONTRACTOR'S employees in how to perform the WORK and cure the grout. The CONTRACTOR shall have the employees assisting in the mixing and sealing of the tie holes.

d. If the project includes patching, throughbolt holes, epoxy anchors, and/or blockouts, the manufacturer shall also train the CONTRACTOR'S employees in the mixing and curing of the epoxy grouts for each of these applications.

e. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.

2. Epoxy Anchor Grout for Adhesive Anchors

a. Special inspection as recommended by the ICBO/ES report or as required by the building department shall be required for adhesive anchor installations. Cost of special inspection of adhesive anchors will be paid by the OWNER.

b. Before installing adhesive anchors in the WORK, adhesive anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1) Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading/torquing.

2) Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension and shear loading. A minimum of 3 anchors shall be tested for each installation position.

3) Anchors shall be tested at 2 times the published allowable load in tension and in shear as indicated in the ICBO/ES report.

4) If any of the 3 test bolts in any installation position fail to reach the test loads, the installer shall be re-tested with the same procedure. Re-testing is required only for the failed installation position.

5) An installer who has 3 consecutive successful bolt tests in the first or second trial is considered qualified for adhesive anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the CONTRACTOR and be submitted to the ENGINEER.

6) The test anchor size shall be the largest size adhesive anchor used on the project. The embedment length shall be long enough to develop the allowable steel strength per AISC Manual of Steel Construction.

7) Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

8) The certification of each qualified installer shall be available for verification at the Special Inspector's request.

9) Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for WORK provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 -- PRODUCTS

2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts and reinforcing steel required to be set in grout in which the average working or operating temperature will be over 100 degrees F or in high fire risk areas.	Non-Shrink - Class I
Anchor bolts and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.	Epoxy Anchor Grout
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink - Class I
Column base plates (greater than 2 story or larger than 16-inches in the least dimension)	Non-Shrink - Class II
Storage tanks and other non-motorized equipment and machinery under 30 horsepower	Non-Shrink - Class I
Pumps over 1000 horsepower, unless indicated otherwise	Non-Shrink Epoxy
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time exceeds 20 min.)
Under precast concrete elements	Non-Shrink - Class II
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout

Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete per 03310
Surface repairs	Cement Grout
Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I
Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II
Any application not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise

2.2 CEMENT GROUT

A. Cement grout shall be composed of one part cement, 3 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 03310

2.3 NON-SHRINK GROUTS (cement-based)

A. General

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

2. 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 shall be as recommended by the manufacturer for the particular application.

3. Grout shall not contain chlorides or additives that may contribute to corrosion.

4. Grout shall be formulated to be used at any consistency from fluid to plastic.

5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:

a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.

b. Minimum flexural strength of 1000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

c. Minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

B. Class I Non-Shrink Grout

1. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency.

2. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.

3. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures. The grout when tested shall not bleed or segregate at maximum allowed water.

4. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.

5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.

6. Class I Non-Shrink Grout shall be **Masterflow 713 Plus** by **MBT/Degussa Building Systems, Five Star Grout** by **Five Star Products, Sikagrout 212** by **Sika Corporation, Premier** by **L&M Construction Chemicals; High-Flow Grout** by **Euclid Chemical Company, CG 200 PC** by **Hilti,** or equal.

C. Class II Non-Shrink Grout

1. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7500 psi, when mixed at a fluid consistency.

2. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.

3. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.

4. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.

5. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.

6. The grout when tested shall not bleed or segregate at maximum allowed water content.

7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.

8. Class II non-shrink grout shall be **Masterflow 928** by **MBT/Degussa Building Systems, Five Star Fluid Grout 100** by **Five Star Products, Crystex** by **L&M Construction Chemicals,** or equal.

2.4 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each 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.

B. Epoxy grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).

C. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.

D. The epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C 579, method B.

E. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.

F. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C 1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts, for bearing area and flow.

G. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

H. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3000 psi per ASTM C 882 modified.

2. Minimum bond strength to steel of 1700 psi per ASTM C 882 modified.

3. Minimum flexural strength of 2500 psi per ASTM C 580.

4. Minimum tensile strength of 2000 psi per ASTM C 307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.

I. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout** by **Five Star Products, Inc., Masterflow 648 CP Plus** by **MBT/Degussa Building Systems, Sikadur 42 Grout-Pak** by **Sika Corporation,** or equal.

2.5 EPOXY ANCHOR GROUT

A. Epoxy anchor grout shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class B & C, Grade 3 with the exception of gel time.

B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.

C. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.

D. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

E. Epoxy anchor grout shall be capable of being used in submersed applications once cured.

F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.

G. If the average working or operating temperature will be over 100 degrees F or in a high fire risk area, use cement based non-shrink grout and oversized holes.

H. Overhead anchors and anchors in fire-resistive construction shall be cast-in anchors.

I. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.

J. Epoxy anchor grout shall be **Epcon C6** by **ITW Ramset/Red Head; Power-Fast Epoxy Injection Gel** by **Powers Fasteners; RE 500** by **Hilti,** or equal.

2.6 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill is thicker than 3-inches, structural concrete, as indicated in Section 03310 - Cast-in-Place Concrete, may be used when accepted by the ENGINEER.

B. Grout for topping of slabs and concrete/grout 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 be mixed as indicated. Materials and procedures indicated for normal concrete in Section 03310 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 800 pounds of cement per cubic yard with a maximum water cement ratio of 0.42.

D. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03310, except that drying shrinkage tests are not required.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03310.

G. **Strength:** Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 4000 psi.

2.7 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03310 and as recommended by the manufacturer of prepackaged grouts.

2.8 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 defined 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 indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

2.9 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03310. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. **General:** 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. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if 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 through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted for acceptance by the ENGINEER.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Drilled anchors and Reinforcing Bars

1. General

a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

2. Epoxy Adhesive Anchors

a. Grout shall be proportioned and mixed with automatic equipment.

b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.

c. Holes shall be dry.

3. Cement Based Non-Shrink Grout

a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.

b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.

c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.

d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.

e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

D. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively where accepted by the ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout 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 to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough 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. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

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 or 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.

6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.5 CURING

A. Cement based grouts shall be cured per 03310 and per the manufacturer's recommendations.

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SECTION 04232 - REINFORCED CONCRETE BLOCK MASONRY

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide concrete masonry and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Samples

1. If the required product is a colored and textured unit, the samples shall be colored and textured units. Submit samples of concrete masonry units illustrating colors and textures available for the ENGINEER to choose. Full size samples of the blocks selected shall be submitted for final approval after color selection, if requested.

2. Samples of mortar colors for color selection.

3. A minimum 4-ft square free-standing sample panel shall be prepared for approval before starting masonry WORK. The panel shall remain at the Site for reference until masonry WORK is completed.

C. Documentation

1. Reports from testing masonry units

2. Reports from mortar and grout testing.

3. Reports from prism testing.

D. Grout and mortar mix design

1. Proportions for components

2. Mill tests for cement

3. Admixture certification. Include chloride ion content.

4. Aggregate graduation and certification

5. Lime certification

1.3 QUALITY ASSURANCE

A. **Applicable Standards:** Concrete masonry shall conform to the Uniform Building Code (UBC), American Concrete Institute ACI 530 - Building Code Requirements for Masonry Structures, ACI 530.1 - Specification for Masonry Structures, and other applicable codes and standards of the governing authorities.

B. WORK shall conform to the standard of quality established by the approved free-standing sample panel.

C. Concrete block masonry units shall be sampled and tested in accordance with ASTM C 140 - Test Methods of Sampling and Testing Concrete Masonry and Related Units.

D. **Testing of Mortar and Grout:** The CONTRACTOR shall have the mortar and grout tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory approved by the ENGINEER. Test reports shall be submitted to the ENGINEER.

1. Tests shall be taken at the following times:

   a. At commencement of masonry WORK, at least 2 test samples each of mortar and grout shall be taken on 3 successive Days.

   b. At any change in materials or job conditions, at least 2 samples of each modified material, grout, and mortar shall be tested.

   c. Four random tests each of mortar and grout shall be made. The random test samples shall be taken when requested by the ENGINEER.

   d. Additional samples and tests may be required whenever, in the judgment of the ENGINEER, additional tests beyond the four random tests are necessary to determine the quality of the materials.

   e. The costs of tests and test reports, except for any additional tests requested by the ENGINEER, shall be paid by the CONTRACTOR as part of the WORK. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents, will be paid by the OWNER. When tests or reports do not verify compliance, the cost of every additional test and report shall be paid by the CONTRACTOR.

2. Samples shall be stored in a moist environment until tested, unless directed otherwise by the ENGINEER or the testing laboratory. Testing for mortar shall be in accordance with ASTM C 270 - Mortar for Unit Masonry. Grout shall be tested per ASTM C 1019 - Standard Test Method for Sampling and Testing Grout.

E. **Test of Masonry Prisms**: The OWNER will test masonry prisms to assure compliance with the Specifications and the governing Codes. Testing will be by a recognized testing laboratory.

1. Tests will be made of the following items:

   a. At the time of the construction of the sample panel above, at least 5 masonry prisms shall be made for each type of block herein, except separate prisms are not required for block which only varies by texture.

   b. At any change in materials during construction, at least 5 masonry prisms shall be made for each type of block affected.

c. One set of at least 5 masonry prisms shall be made for each masonry structure, besides the structure that the sample is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.

d. Additional sets of at least 5 masonry prisms may be required whenever, in the judgement of the ENGINEER, additional tests are necessary to determine the quality of the materials.

2. The prisms shall be constructed by the CONTRACTOR in the presence of the ENGINEER. The same individuals who lay the block in the structure shall construct the masonry prism.

3. The masonry prism shall be constructed and tested in accordance with ASTM C 1314 - Test Methods for Compressive Strength of Masonry Prisms.

4. Compression tests made on sets of specimens made during construction shall include 2 prisms tested at 7 Days after grouting and 3 prisms tested at 28 Days after grouting.

5. The average compressive strength of prisms tested at 28 Days after grouting, multiplied by the appropriate correction factor as given in ASTM C 1314, shall not be less than the indicated masonry compressive strength.

6. If the tested compressive strength with correction factor of the prisms fails to meet or exceed the required strength, adjustments shall be made to the mix designs for the mortar or grout, or both, as needed to produce the required strength. The masonry units shall also be retested to verify compliance to the requirements of ASTM C 90.

7. If the tested compressive strength with correction factor of the prism fails to meet or exceed the required strength, prisms or cores shall be cut from the walls in sufficient numbers and in sufficient locations to adequately determine the strength of the walls. Those portions of the walls represented by specimens failing to meet the required compressive strength are subject to being removed and replaced.

F. **Inspection:** Whenever required under the provisions of the Building Code, WORK hereunder will be subject to inspection by a Special Inspector selected by the ENGINEER and approved by the local Building Code representative having jurisdiction. Costs of such inspection will be paid by the OWNER. The Special Inspector will work under the supervision of the ENGINEER. Special inspection will be per specification Section 01540 - Special Inspections.

G. **Extreme Weather Construction:** Cold weather construction shall be per the more stringent of ACI 530.1, UBC Section 2104.3, and local Code requirements. Hot weather construction shall be per the more stringent of ACI 530.1 or local Code requirements.

H. **Product Storage:** Cement, lime, and other cementitious materials shall be delivered and stored in dry, weather-tight sheds or enclosures, in unbroken bags, barrels, or other approved containers, plainly marked and labeled with the manufacturers' names and brands. Mortar and grout shall be stored and handled in a manner that prevents the inclusion of foreign materials and damage by water or dampness. Masonry units shall be handled with care to avoid chipping and breakage, and shall be stored as directed in ACI 530.1. Materials stored on newly constructed floors shall be stacked in such manner that the uniformly distributed loading does not exceed 30 psf. Masonry

materials shall be protected from contact with the earth and exposure to the weather and shall be kept dry and clean until used.

PART 2 -- PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete masonry units shall conform to ASTM C 90 - Load-Bearing Concrete Masonry Units. Units shall be medium weight units unless indicated otherwise.

B. Concrete masonry units shall be 8-inch by 8-inch by 16-inch modular size, with smooth and split faces. Units shall be integrally-colored with color as indicated on the Drawings.

C. Bond beam, corner, lintel, sill, and other specially shaped blocks shall be provided where required or necessary. Specially shaped non-structural blocks may be constructed by saw cutting. Color and texture shall match that of adjacent units.

D. Concrete masonry units hidden from view entirely may be natural color units the same size as other adjacent masonry units.

E. Concrete masonry units at interior walls shall be normal weight block 8-inch by 8-inch by 16-inch modular size of color matching the integrally colored block.

2.2 MATERIALS

A. Portland cement shall be Type I or II, low alkali, conforming to ASTM C 150 - Portland Cement.

B. Hydrated lime shall be Type S conforming to ASTM C 207 - Hydrated Lime for Masonry Purposes.

C. Aggregate for mortar shall conform to ASTM C 144 - Aggregate for Masonry Mortar. Aggregate for grout shall conform to ASTM C 404 - Aggregates for Masonry Grout.

D. Water for mixing shall be clear potable water.

E. Reinforcing steel shall be deformed bars conforming to ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Grade 60.

F. Admixture for mortar shall be **Master Builders PS-235** or **Rheomix-235, Sika Co., Sika Red Label,** or equal. The admixture shall not be detrimental to the bonding or help the process of efflorescence.

G. Admixture for grout shall be **Sika Co., Sika Grout Aid, Type II**, **Master Builders Pozzolith,** normal, or equal.

2.3 MORTAR

A. Mortar for concrete block masonry shall conform to ASTM C 270 for cement-lime Type S, with a minimum 28 Day compressive strength of 1800 psi.

B. Mortar color shall match block color.

2.4 GROUT

A. Grout shall conform to ASTM C 476 - Grout for Masonry and have a minimum 28 Day compressive strength of 2000 psi. Where the grout space is less than 4-inches, coarse aggregate shall be omitted.

B. Admixtures may only be used when approved by the ENGINEER. If approved for use, admixtures shall be used in accordance with the manufacturer's published recommendations for the grout.

PART 3 -- EXECUTION

3.1 GENERAL

A. Measurements for mortar and grout shall be accurately made. Shovel measurements are not acceptable. Mortar proportions shall be accurately controlled and maintained.

B. WORK shall be performed in accordance with the provisions of ACI 530 and 530.1, the UBC, and the local codes for reinforced concrete hollow-unit masonry.

C. The CONTRACTOR shall set or embed anchors, bolts, reglets, sleeves, conduits, and other items as required.

D. Block cutting shall be by machine.

E. Masonry units shall be supported off the ground and shall be covered to protect them from rain. Only clean, dry, uncracked units shall be incorporated.

F. Reinforcing steel shall be cleaned of loose rust and scale, oil, dirt, paint, laitance, or other substances that may be detrimental to or reduce bonding of the steel and concrete.

G. Immediately before starting WORK, concrete upon which the masonry will be laid shall be cleaned with water under pressure.

H. Full mortar joint for first course shall be provided.

I. Units shall be shoved tightly against adjacent units to assure good mortar bond.

J. Equipment for mixing and transporting the mortar and grout shall be clean and free from set mortar, dirt, or other foreign matter.

3.2 MIXING

A. Mortar shall be mixed by placing 1/2 of the water and sand in the operating mixer, after which the cement, lime, and remainder of the sand and water shall be added. After ingredients are in the mixer, they shall be mechanically mixed for not less than 5 minutes. Retempering shall be done on the mortar board by adding water within a basin formed within the mortar, and the mortar reworked into the water. Mortar that is not used within one hour shall be discarded.

3.3 ERECTION OF CONCRETE BLOCK MASONRY

A. Masonry WORK shall be erected in plane, plumb, level, straight and true to dimensions, and be executed in accordance with acceptable practices of the trade and the tolerances of ACI 530.1.

B. Unless indicated otherwise, masonry shall be laid up in straight uniform courses with running bond.

C. Masonry shall be erected to preserve the unobstructed vertical continuity of the cells measuring not less than 3-inches by 3-inches in cross-section. Walls and cross webs shall be full bedded in mortar. Head (or end) joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells.

3.4 JOINTS

A. Vertical and horizontal joints shall be uniform and approximately 3/8-inch wide. Exterior joints and interior exposed block joints shall be concave-tooled to a dense surface. Special care shall be used in tooling joints so as to match existing construction. Interior or exterior non-exposed masonry and masonry behind plaster shall have flush joints.

3.5 CLEANOUTS

A. Cleanout openings shall be provided at the bottoms of cells to be filled at each lift or pour of grout where such lift or pour is over 4-ft in height. Any overhanging mortar or other obstructions or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed before grouting and after inspection. Cleanout openings shall match the finished wall in exposed masonry.

3.6 REINFORCEMENT

A. Deep cut bond beam blocks shall be used where horizontal reinforcing steel is embedded. H-block bond beams may be used at locations other than openings.

B. Knock-out openings shall have no steel or joint reinforcing running through the opening. Head, jambs, and sill blocks shall be used to provide an even finish surface to install windows when blocks are removed. Joints at heads, jambs, and sills shall be stacked and continuous.

C. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 112 diameters of the reinforcement.

3.7 GROUTING

A. Cells and bond beam spaces shall be filled solidly with grout unless indicated otherwise. Grouting shall not be started until the wall has cured for 24 hours. Grout shall not be poured in more than 5-ft lifts.

B. Grout shall be consolidated at time of pouring by puddling or vibrating. If the grouting operation has been stopped for one hour or longer, horizontal construction joints shall be formed by stopping the grout pour 1-1/2 inches below the top of the uppermost unit.

3.8 PIPE OR CONDUITS EMBEDDED IN MASONRY

A. Pipes, conduits, and sleeves passing vertically or horizontally through the masonry shall not be placed closer than 3 diameters on center, nor shall they impair the strength of the construction. Pipes, conduits, and sleeves passing vertically shall not be placed in the same cell as the vertical reinforcing. Pipes, conduits, and sleeves passing horizontally shall not be placed in a bond beam.

3.9 PROTECTION

A. Wall surfaces shall be protected from droppings of mortar or grout during construction.

3.10 FINISHING AND CLEANING

A. Masonry shall not be wet-finished unless exposed to extreme hot weather or hot wind and then only by using a nozzle-regulated fog spray sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

B. Finish masonry shall be cleaned and pointed in a manner satisfactory to the ENGINEER, based upon the standards established by the approved sample panel.

C. Interior and exterior colored masonry WORK exposed to view shall be cleaned by whip light sandblasting to remove stains and other imperfections.

D. Exposed masonry surfaces of openings and window and door openings such as sills, heads, and jambs shall be finish block surfaces, not formed surfaces, unless indicated otherwise. Closed bottom bond beam blocks shall be used at heads and sills. Pour holes may be used at the sill under window frame and where approved by the ENGINEER.

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SECTION 05500 - MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

MIL-G-18015 A (3)	(Ships) Aluminum Planks. (6063-T6)
MIL-A-907E	Antiseize Thread Compound, High Temperature

B. Commercial Standards

AA-M32C22A41	Aluminum Assn.
AASHTO HS-20	Truck Loading
AISC	Manual of Steel Construction
AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
ASTM A 36	Carbon Structural Steel
ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing

ANSI/AWS D1.1 Structural Welding Code - Steel

ANSI/AWS D1.2 Structural Welding Code - Aluminum

ANSI/AWS QC1 Qualification and Certification of Welding Inspectors

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings**: Shop Drawings shall conform to AISC recommendations and specifications and shall show holes, etc. required for other parts of the WORK. Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

1. Layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Load and deflection tables shall be submitted for each style and depth of grating used.

2. An ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor. CONTRACTOR shall submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review by ENGINEER, these instructions shall be followed specifically.

3. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.

B. Welding shall be inspected by a CONTRACTOR-furnished inspector qualified in accordance with AWS requirements and approved by the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A 500 Grade B

B. **Corrosion Protection:** Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09800 - Protective Coating and shall not be galvanized prior to coating. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. **Stainless Steel:** Unless otherwise indicated, stainless steel metalwork and bolts shall be of Type 316 stainless steel. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.

D. **Aluminum:** Unless otherwise indicated, aluminum metalwork shall be of Alloy 6061-T6. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with Section 09800.

E. **Cast Iron:** Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B or better.

2.2 ALUMINUM RAILINGS

A. **General:** Aluminum handrails and railings shall be component systems complete with anchors, attachments, balusters, brackets, caps, fasteners, gates (swing with self-latching hardware or be removable), posts, sleeves, trim, and any other related items required or necessary for a complete installation. Gates and removable rail sections shall be complete with hardware such as self-closing hinges, self-latching latches, hasps, etc. Railings shall conform to the Building Code and OSHA General Industry Occupational Safety and Health Standards (29CFR1910).

B. **Materials:** Materials shall conform to the following:

1. Aluminum: Aluminum shall be U.S. Alloy 6063 T-5 or T-6. Aluminum pipe rail shall not be less than 1-1/2 inch diameter Schedule 40 pipe.

2. Electrolysis Protection: Electrolysis protective material shall be in accordance with Section 09800.

3. Sleeves: Sleeves shall be of galvanized steel or PVC.

4. Grout: Grout for handrail posts shall consist of an inorganic, non-shrink, non-metallic premixed grout in accordance with Section 03315 - Grout with a minimum 28 Day compressive strength of 4,000 psi.

5. Fasteners: Fasteners, screws, and bolts shall be concealed and shall be of stainless steel or aluminum.

6. Welding Rods: Aluminum welding rods shall be of a type recommended by the aluminum manufacturer for anodized finished products.

7. Kickplates: Kickplates shall be provided on railings, not set in curbs.

C. **Finishes:** Pipe railing system including handrails, railings, tube caps, and other miscellaneous parts of rails shall be provided with a clear anodized finish, AA-M32C22A41.

D. Manufacturers or Equal

1. **C-V Pipe Rail** by **Crane Veyor Corp.**

2. **Connectorail** by **Julius Blum and Co.**

2.3 LADDERS

A. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be entirely of Type 316 stainless steel. Other ladders shall be aluminum or as indicated.

B. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension. Pop-up extension device shall be manufactured of the same material and finish as the ladder and have telescoping tubular section that locks automatically when fully extended. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.4 METAL GRATING

A. **General:** Metal grating shall be of the design, sizes, and types indicated. Grating shall be completely banded at edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Grating shall be supported around an opening by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used, unless indicated otherwise. Such angles shall be mitered and welded at corners.

1. Pieces of grating shall be fastened in 2 locations to each support.

2. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing, width equal to that of the stairway.

3. Where grating depth is not given, grating shall be provided that will be within allowable stress levels and which shall not exceed a deflection of 1/4-inch or the span divided by 180, whichever is less. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HS-20.

B. Material

1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum as follows: Bearing and banding bars, alloy 6061-T6; cross bars, alloy 6063-T5.

2. Safety grating shall be fabricated of aluminum alloy 5052-H32.

3. Plank grating shall be fabricated of aluminum alloy 6063-T6.

4. Grating that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.

2. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.

D. Safety Grating

1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and be formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inches by 11/16-inch in size. Safety grating shall be **Grip Strut** by **Metal Products Division, United States Gypsum Company, Deck Span** by **IKG Industries**, or equal.

E. Plank Grating

1. Plank grating shall be extruded in 6-inch widths with a minimum of 6 integral 1-bar type bearing bars per plank. The top surface shall be solid with raised ribs, unless indicated otherwise. Where punched grating is required, the top surface shall be provided with a pattern of 3-inches by 19/32-inch rectangular openings spaced at 4-inches on center. The planks shall have continuous tongue and groove type interlock at each side, except that interlocking planks shall be arranged so that any 4-foot wide section may be removed independently from the other grating sections.

2.5 CHECKERED PLATE

A. Checkered plate shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of one-inch in length and raised a minimum of 1/2-inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

B. Where no plate material is indicated, aluminum shall be provided. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4-inch or the span divided by 240, whichever is less.

2.6 HATCHES

A. Where access hatches are mounted on a floor slab (including top slabs that are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated.

B. Hatches mounted on a roof surface that has a membrane or other roofing material covering it shall be the integral raised curb type in accordance with Section 07720 - Roof Accessories.

C. Hatches shall be fabricated from aluminum 5086 H34, 6063-T5 or 6061-T6, unless otherwise indicated. Hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type; **Bilco Type J** or **JD, Babcock-Davis Type B-FGA** or equal.

D. The design live load shall be 300 psf, unless indicated otherwise.

E. Hatch opening sizes, number and swing direction of door leaves, and locations, shall be as indicated. Sizes are for the clear opening. Where the number of leaves is not given, openings larger than 42-inches in either direction shall have double-leaf doors. Unless indicated otherwise, hinges shall be located on the longer dimension side. Unless indicated otherwise, ladder hatches shall be a minimum of 30-inches wide by 36-inches long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.

F. Door leaves shall be a minimum of 1/4-inch thick checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening from both inside and outside.

G. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter and moat-type edge drain. A minimum 1-1/2 inch diameter drain connection shall be provided, located by the manufacturer.

2.7 IRON CASTINGS

A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shotblasting.

B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finished surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.

C. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is given, a minimum of 300 pounds per square foot.

2. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

2.8 BOLTS AND ANCHORS

A. **Standard Service (Non-Corrosive Application):** Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated. 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, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following:

1. Structural connections: ASTM A 307, Grade A or B, hot-dip galvanized.

2. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized.

3. High strength bolts where indicated: ASTM A 325.

4. Pipe and equipment flange bolts: ASTM A 193, Grade B-7.

B. **Corrosive Service:** Bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated.

1. Buried locations.

2. Submerged locations.

3. Locations subject to seasonal or occasional flooding.

4. Inside hydraulic structures below the top of the structure.

5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

6. Chemical handling areas.

7. Inside trenches, containment walls, and curbed areas.

8. Locations indicated by the Contract Documents or designated by the ENGINEER to be provided with stainless steel bolts.

C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

2. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology,** Franklin Park, IL, 60131, AS-470 by **Dixon Ticonderoga Company,** Lakehurst, NJ, 08733, or equal.

D. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. 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.

3. Bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers fabricated of material matching the bolts shall be installed where indicated.

4. The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts, which shall be flush with the face of the nut before tightening.

E. **Adhesive Anchors:** Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered unless accompanied with ICBO report verifying strength and material equivalency.

1. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars. Epoxy shall comply with Section 03315 - Grout. Threaded rod shall be galvanized for general purpose applications and stainless steel Type 316 for corrosive applications. Epoxy anchors shall not be permitted in areas where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer, whichever is lower. Epoxy anchors shall not be used where anchors are subject to vibration or fire. Embedment depth shall be as the manufacturer recommends for the load to be supported.

F. **Expanding-Type Anchors:** Expanding-type anchors if indicated or permitted, shall be galvanized steel expansion type **ITW Ramset/Redhead Trubolt** anchors, **McCullock Industries Kwick-Bolt,** or equal. Lead caulking anchors will not be permitted. Size shall be as indicated. Embedment depth shall be as the manufacturer recommends for the load to be supported. Expansion type anchors that are to be embedded in grout may be steel. Non-embedded buried or submerged anchors shall be stainless steel.

G. **Non-Shrink Grouted Anchors**: Anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendation. Embedment depth shall be as the manufacturer recommends for the load to be supported. Non-shrink grout material shall be Class B or C in accordance with Section 03315 - Grout.

2.9 POWDER-DRIVEN PINS

A. **Materials:** Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they will be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.10 IMPACT ANCHOR

A. Impact anchors shall be an expansion type anchor in which a nail type pin is driven to produce the expansive force. The pin shall have a zinc sleeve with a mushroom style head and stainless steel nail pin. Anchors shall be **Metal Hit Anchors,** manufactured by **Hilti, Inc., Rawl Zamac Nailin,** manufactured by the **Rawlplug Company,** or equal.

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

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. **Aluminum Railings:** Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned. Electrolysis protection of materials shall be provided.

C. **Floor Hatches:** Unless otherwise indicated, the CONTRACTOR shall provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

D. **Powder-Driven Pins:** Powder-driven pins shall be installed by a craftsperson 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 Minimum Thickness	Pin 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

3.2 WELDING

A. **Method:** Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. **Quality:** In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, 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 that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.3 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, 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, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

B. Field repairs to damaged galvanizing shall be made by preparing the surface and applying a coating.

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush off blast cleaning (SSPC SP7), over an area extending at least 4-inches into the undamaged area.

2. Coating shall be applied to at least 3-mils dry film thickness. Use **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, or **Galvite** by **ZRC Worldwide**.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dry. Drilled anchors shall not be installed until the concrete has reached the required 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.

- END OF SECTION -

SECTION 06100 - ROUGH CARPENTRY

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct rough carpentry and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

B. The WORK shall include, at least the following items:

1. Wood framing, including plates, studding, joists, rafters, purlins, and similar framing elements.

2. Wood blocking, furring, stripping, backing, and nailers, as indicated, or otherwise required for securing other WORK.

3. Plywood sheathing, board sheathing, sidings, and starter boards.

4. Rough hardware appurtenant to the WORK of this Section, as defined below.

1.2 CONTRACTOR SUBMITTALS

A. Furnish the following in accordance with Section 01300 - Contractor Submittals.

1. Manufacturers' catalogs showing rough hardware conforming to or equivalent to hardware indicated.

2. Engineering calculations for design of all glued laminated beams and wood trusses or joists, signed and stamped by a professional engineer registered in the State of California.

3. Fabrication and erection drawings for glued laminated beams and wood trusses or joists.

4. Certificates of compliance.

5. Certificate of Conformance indicating conformance and grade compliance with AITC A 190.1 - Structural Glued Laminated Timber, Production Requirements for Glulam, by the American Institute of Timber Construction.

PART 2 -- PRODUCTS

2.1 UNTREATED LUMBER

A. **Grading:** Lumber shall be graded in accordance with the rules of one of the following associations: "Grading Rules for Southern Pine Lumber" of the Southern Pine Inspection Bureau; "Standard Grading and Dressing Rules No. 17" of the West Coast Lumber Inspection Bureau (WCLIB); "Grading Rules for Western Lumber" published by Western Wood Products Association; or “Standard Specification for Grades of California Redwood Lumber” of the Redwood Inspection Service (RIS).

B. **Grade Marking:** Each piece of lumber shall bear the official grade mark of one of the above-mentioned grading rules. The association standards selected for grading and grade marking of the lumber shall be as acceptable to the ENGINEER.

C. **Size Dressing:** Lumber, except as otherwise indicated, shall be dressed to size in accordance with the standards of the association under which the lumber is graded. Lumber shall be S4S unless otherwise indicated.

D. **Drying:** Lumber incorporated in the WORK, except where otherwise indicated, shall be air or kiln dried to a moisture content of not more than 19 percent and not less than one percent.

E. **Framing Lumber Grades:** Grades of framing lumber for various uses shall conform to the following:

West Coast Lumber			
Use	**WCLIB Grade**	**Grading Rule**	**Stress F_b**
Joists and Planks – Rafters,	Select Structural	Para. 123-a	1450 psi
Joists, studding 2 by 6 and framing, ledgers, etc.	No.1	Para. 123-b	1000 psi
Structural Light Framing	No. 1	Para. 124-b	1000 psi
Studding and plates, 2 by 4 to 4 by 4	No.1	Para. 124-b	1000 psi
Beams and Stringers	Select Structural	Para. 130-a	1600 psi
Posts and Timbers	Select Structural	Para. 131-a	1500 psi

2.2 TREATED LUMBER

A. **Marking:** Each piece of treated lumber shall bear the approval mark of an approved testing agency.

B. **Kiln Drying:** Kiln-dried lumber shall be treated with a water-borne preservative and shall have a maximum moisture content of 15 percent after treatment.

C. **Pressure-Treated Lumber:** Pressure-treat in accordance with AWPA C1 - Manual of Recommended Practice, Standard for Preservative Treatment by Pressure Process – All Timber Products. Preservative shall conform to American Wood Preservers Assn. P5 – Standard for Waterborne Preservatives. Creosote shall not be used.

D. **Preservative:** Two thorough coats of preservative, **Zehrung "Zerpel"; Sherwin Williams, "Kemwood Penta,"** or equal, shall be applied at least 2 hours before installation, to surfaces that come in contact with, or are set close to concrete and plaster, except lumber indicated to be pressure-treated. Tank dipping or pressure-treating may be used.

E. **Cuts:** Wherever necessary to cut, notch, dap, drill, or frame treated lumber, newly cut or bored surfaces shall be treated with 2 heavy coats of the same preservative used in the original treatment. The minimum penetration depth shall be 1/4-inch.

F. **Fire-Retardant Treated Lumber:** Where required, fire-retardant treatment for lumber shall conform to the requirements of the governing building code and shall be redried after treatment in accordance with AWPA C1. Allowable values shall be adjusted in accordance with AF&PA.

2.3 PLYWOOD AND HARDBOARD

A. **Plywood:** Plywood shall conform to the requirements of U.S. Product Standard PS-1 - Construction and Industrial Plywood, and be as indicated herein. Plywood panels shall be marked with grade mark of the American Plywood Association. The mark shall identify the plywood as to species, glue type, and grade in compliance with the applicable commercial standard. Except as otherwise indicated, plywood shall be Douglas Fir, Exterior, C-D, S1S. Plywood for other specific applications shall be as follows:

1. Plywood for use in concrete forms shall conform to the requirements of Section 03310 - Cast-in-Place Concrete.

2. Plywood for back-up boards behind telephone equipment, electrical equipment, or communication equipment shall be Douglas Fir, A-C INT grade for interior locations and A-C-EXT for exterior locations.

3. Plywood tool boards and protective wall paneling shall be Douglas Fir N-D-INT grade.

B. **Hardboard:** Hardboard shall be temper-treated panels manufactured from interfelted ligno-cellulose fibers consolidated under heat and pressure in a hot press to produce a smooth, hard-surfaced material which is resistant to water and stains. Hardboard shall conform to the requirements of AHA A 135.4 – Basic Hardboard, by the American Hardboard Association.

C. **Used Lumber:** For concealed, non-load-bearing applications, used form lumber (except plywood) which is undamaged and complies with requirements herein may be reused if permitted by the ENGINEER. Form plywood shall not be reused.

2.4 ROUGH HARDWARE

A. **General:** The term "rough hardware" shall include nails, screws, lag screws, bolts, nuts, washers, plates, metal fasteners, and framing anchors; anchor bolts which are to be embedded into concrete, concrete masonry, or brick masonry; and similar items employed in erection and construction of the rough carpentry WORK. Rough hardware shall be of standard manufacture, approved by a recognized agency for the intended applications and shall be provided with laboratory test results on capabilities when requested by the ENGINEER. Hardware items shall be steel unless otherwise indicated.

Specially fabricated rough hardware shall be provided in accordance with Section 05500 - Miscellaneous Metalwork and shall be hot-dip galvanized after fabrication.

B. **Anchors and Fasteners:** Anchors and fasteners for securing wood items, unless otherwise indicated, shall be as follows:

1. Bolts, nuts, and studs shall conform to the requirements of Section 05500 and the following:

   a. ASME B18.5 - Round Head Bolts

   b. FF-N-836E – Nut: Square, Hexagon, Cap, Slotted, Castle. Knurled, Welding, and Single Ball Seat

   c. FF-S-1362 – Stud, Plain, General Purpose

   d. FF-B- 575C – Bolts, Hexagon and Square

2. Nails and staples shall conform to ASTM F1667 – Driven Fasteners - Nails, Spikes and Staples, and shall be the type and size best suited for the intended application. Nails shall be galvanized steel, aluminum, or stainless steel, as appropriate, where exposed to weather. Nails used for fastening plywood to nailers on steel beams shall be of wire gauge noted for common nails, but of 1/2 length. Nails used for exterior (exposed to view) plywood siding, siding, or trim shall be stainless steel.

3. Wood screws shall conform to the requirements of Federal Specification FF-S-111D(1) – Screw, Wood, for the style and material as indicated or be best suited for the purpose. Wood screws shall be galvanized where exposed to view or to weather.

4. Lag screws or lag bolts shall conform to the requirements of ASME B18.2.1 - Square and Hex Bolts and Screws, for the type and grade best suited for the purpose. Lag screws or lag bolts shall be galvanized where exposed to view or weather.

5. Toggle bolts shall conform to the requirements of Federal Specification FF-B-588D – Bolt, Toggle: and Expansion Sleeve, Screw, for the type and grade best suited for the purpose.

6. Expansion shields shall be in accordance with Section 05500.

7. Power-driven pins shall be in accordance with Section 05500.

C. **Metal Framing Devices:** Metal framing devices shall be specially-designed joist hangers, header hangers, framing anchors, post anchors, and structural framing connectors fabricated from steel, hot-dip galvanized after fabrication, and be designed to conform to code requirements. Documentation of load tests by an independent testing laboratory shall be submitted if requested by the ENGINEER. The framing devices shall be as manufactured by **Silver Metal Products, Inc.; Easy Ardes Rib, Simpson Co.; Heckmann Building Products;** or equal. The framing devices shall be equal or superior to those indicated as per design, friction, and loading. The framing device shall be provided complete with the proper sized nails, bolts, lag bolts, or other required fasteners called for in the design calculations for the framing devices.

D. **Plyclips:** Plyclips shall be extruded aluminum clips, manufactured from 6063-T6-aluminum alloy and be designed for intended use. Size shall be as required for plywood or shall be as indicated.

2.5 MISCELLANEOUS PRODUCTS

A. **Building Paper:** Building paper or felt shall be non-perforated, asphalt-saturated organic felt conforming to ASTM D 226 – Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing, 15 lb/100 sq ft.

B. **Termite Shields:** Termite shields shall be not less than 26-gauge, zinc-coated steel or 30-gage, terne steel coated with 40 lb of coating material per 100 square feet.

2.6 GLUED LAMINATED MEMBERS

A. **Gluelam Timbers:** Glued laminated wood timbers shall be designed to meet the requirements of AITC A 190.1 and Forestry Products Laboratory Bulletin 1069 - Fabrication and Design of Glulam Timbers, and comply with applicable codes and AITC requirements.

B. **Gluelam Beams:** Gluelam beams shall conform to the following requirements:

1. Glued laminated wood beams shall be AITC "Architectural Appearance Grade" S4S and shall bear the quality mark of the AITC.

2. Glue-laminated beams shall be continuous unless otherwise indicated and shall be provided with arches and/or curves as necessary or required, where indicated.

3. Lumber for glued laminated wood beams shall be Coast Region Douglas Fir meeting the requirements of AITC A 190.1 and applicable local codes, and shall be stress graded for combination 24F in accordance with AITC 117 – Standard Specification for Structural Glued Laminated Timber of Softwood Species, dry condition of use. Thicknesses of lumber for laminations shall be in accordance with standard practice of the approved manufacturer.

4. Adhesives shall conform to AITC A 190.1 requirements for wet use beams.

5. Beams shall receive one coat of an approved sealer and shall be individually wrapped for shipment to the Site.

6. Glued laminated wood beams shall be designed by an engineer registered in the State of California. Stamped and signed calculations shall be submitted.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Preliminaries:** Rough carpentry shall be as indicated and as necessary for complete WORK. The CONTRACTOR shall verify drawing dimensions with actual field conditions and shall inspect related WORK and adjacent surfaces, and shall report to the ENGINEER conditions that could prevent proper execution of this WORK.

B. **Work Coordination and Performance:** The CONTRACTOR shall coordinate the subcontractors and trades doing related WORK. WORK of this section shall be carefully

planned and laid out. Work shall be performed under the direction of a capable, experienced supervisor.

C. **Rough Hardware:** Rough hardware not otherwise indicated that is necessary for the satisfactory execution of framing, including nails, spikes, dowels, fasteners, and similar incidentals shall be provided by the CONTRACTOR. Rough hardware shall be coordinated, furnished, installed, and embedded as indicated and as required for completeness.

D. **Framing:** Framing members and assemblies shall be closely fitted, accurately set, and rigidly secured to required lines, levels, and arrangements indicated. Framing shall be accurately and neatly cut and shall be securely nailed, spiked, or otherwise fastened in place in a workmanlike manner. Timber connectors and installation thereof shall conform to applicable requirements of AITC 104 – Typical Construction Details and AITC OT-01 – Timber Construction Manual.

3.2 FASTENERS AND FRAMING DEVICES

A. **Nailing:** Where nail spacing is not otherwise regulated by the Building Code, nails shall not be driven closer together than 1/2 their length unless driven in drilled holes, nor driven closer to the edge of a member than 1/4 of their length. Where necessary to prevent splitting, holes shall be drilled slightly smaller than nail diameters. The nails shall penetrate the second or farther member not less than 1/2 the nail length. **Common** nails shall be used unless otherwise indicated

B. **Bolts and Nuts:** Malleable or cut-steel washers shall be provided under bolt heads and nuts except where bearing on steel plates or other steel attachments or where flat-head countersunk bolts are indicated. Bolt holes shall be drilled 1/32-inch to 1/16-inch larger diameter than the bolts they are to accommodate and shall be bored true-to-line. Members shall be clamped together and bolts shall be driven in place and nuts shall be drawn up tightly. Bolts shall be drawn tight again immediately prior to enclosing with finish or, if left exposed, upon completion of other WORK. Holes at anchor bolts embedded in concrete may be 1/16-inch larger than bolt diameter.

C. **Screws:** Lag and wood screws shall be screwed, not driven, into place. Holes to receive lag screws shall be bored first of the same diameter and depth as shank, then continued to depth equal to length of screw, with diameter equal to the base of the screw thread. Screws shall penetrate into the farther member a distance equal to a least 7 times the diameter of the screw shank. Washers shall be installed under each lag screw head bearing on wood.

D. **Metal Framing Devices:** Metal framing devices shall be provided where indicated. Nails for the framing devices shall be as furnished or recommended by the manufacturer of the anchor device. Nails shall be driven to their full depth at holes in anchors. Bolt and lag fasteners shall be drawn tight.

3.3 FRAMING

A. **Strength Considerations:** Structural wood framing members shall not be spliced between bearing points or supports. Approval shall be obtained from the ENGINEER before cutting of any wood members that may weaken the structure. Due care shall be exercised in placing framing so that structural and other important members do not require cutting for openings, pipes, vents, conduits, or ducts. Bearing surfaces on which wood structural members are to rest shall be finished to give full, true, and even support.

Wedges or shims shall not be used to correct faulty WORK. Wood members that have been split or otherwise damaged to such an extent as to impair their strength shall be removed and replaced by the CONTRACTOR as part of the WORK.

B. **Cutting and Notching:** Only skilled workers shall be used for cutting and framing of wood members required to accommodate structural members, for routing of piping, conduit, ducts, and for the installation of mechanical, electrical, or other apparatus or equipment. Members shall not be cut, notched, or bored more than 1/4 of their depth without adequate and approved reinforcing.

C. **Plate/Sill Material:** Wood nailing blocks, sills, and plates resting on or embedded in concrete or masonry within 18-inches of grade shall be pressure treated.

D. **Plate and Sill Installation:** Bottom plates and sill plates which are secured to concrete shall be located as indicated. The anchor bolts shall be located as indicated or as required by referenced standards if not indicated. The plates and sills shall be leveled with shims. Washers shall be placed and nuts shall be tightened to level bearing, after which the space (1/2-inch minimum) between the sill and concrete shall be dry-packed with concrete in accordance with Section 03310 - Cast-in-Place Concrete.

E. **Wall Framing:** Studs shall be installed at a spacing of 16-inches on centers unless otherwise indicated. A single plate shall be provided at the bottom and a double plate at the top of wall framing unless otherwise indicated. Joints in upper and lower members of the top plate shall be staggered not less than 4-feet. Stud walls and partitions shall have a continuous row of blocking or firestopping to form a complete and effective separation for the entire width of the wall or partition. Blocking shall be located so that there will be no concealed air spaces greater than 7-feet in horizontal or vertical dimension. Defective materials, including crooked, warped, or bowed materials shall be replaced by the CONTRACTOR as part of the WORK.

F. **Blocking and Backing:** Blocking and backing in walls and ceilings shall be nominal 2-inch thick material of a depth as needed and shall be accurately located around light fixtures, ceiling registers, grilles, and other required mechanical and electrical items. The blocking shall fit snugly and shall be spiked into the supporting framing members. Wood blocking (backing) to receive sheathing, siding, metal lath, and gypsum board shall be provided wherever necessary for securing the facing materials.

G. **Backing for Specialties and Accessories:** Backing shall be accurately located and installed for building specialties, toilet accessories, and finish hardware items as required.

H. **Concrete-Embedded Blocks:** Where required and approved, nominal 2-inch thick nailing blocks (dovetail type) shall be provided in concrete to receive superimposed wood stripping, grounds, and backing. Applied grounds or stripping shall be securely nailed into wood nailing blocks, using nails of approved length.

I. **Rafters and Joists:** Rafters and joists shall be placed crown up and supported firmly on the framing below. Care shall be used in selection and placing of members. Positive and secure attachment shall be provided. The CONTRACTOR shall provide double joists and double headers to receive trimmers at openings which cut or interrupt normal rafter spacing.

J. **Roofs:** Roofs shall be erected level or shall be sloped as indicated or approved.

K. **Plywood Sheathing:** Plywood sheathing shall be installed with face grain across supports, and end joints shall be over joists and be staggered. Blocking shall be provided at unsupported edges.

L. **Fire Stops:** Fire stops shall be not less than 2-inch nominal thickness and of the same width as the studs. Strips of full-thickness fiberglass or rock wool shall be installed around pipes, ducts, conduits, and other penetrations through fire stops.

M. **Sleepers:** Sleepers for mechanical equipment and curb openings shall be provided and coordinated with appropriate trades for locations and sizes. Sleepers shall be ripped to conform to roof slope if necessary.

N. **Sand Blasting:** Members required to be sandblasted shall be lightly sandblasted. Field sandblasting shall conform to requirements of governing authorities.

- END OF SECTION -

SECTION 06172 - WOOD TRUSSES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wood trusses, 2X joists, bridging, bracing, and appurtenances, complete and in place, in accordance with the Contract Documents.

B. **Single-Source Engineering Responsibility**: Provide trusses engineered by the truss fabricator to support superimposed dead and live loads indicated. Design shall be approved and certified by a qualified professional engineer.

C. **Single-Source Responsibility for Connector Plates**: Provide metal connector plates from one manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals. Also submit design drawings and calculations of the proposed roof system to the Building Department.

B. Calculations and drawings shall be stamped by a Professional Engineer licensed in the State of California.

C. Submit

1. Truss Shop Drawings shall show the following for each type of truss:

a. Location, configuration, and dimensions of joists

b. Slope or depth, span, camber, and spacing

c. Required bearing widths

d. Design loads as applicable

e. Top chord live load (including snow loads) and dead load

f. Bottom chord live and dead loads

g. Concentrated loads and their points of application

h. Controlling wind and seismic loads, including axial loads in top and bottom chords

i. Adjustments to lumber and metal connector plate design values for conditions of use

j. Each reaction force and direction

k. Metal connector plate type, size, thickness or gauge, and the dimensioned location of each metal connector plate.

l. Lumber size, species, and grade for each member

m. Connection requirements

n. Calculated deflection ratio and/or maximum deflection for live and total load

o. Maximum axial compression forces in the truss members

p. Required permanent truss member bracing locations

q. Handling and erection recommendations

2. Approved ICBO reports for truss connector plates to be used, showing allowable design loads on the plates.

3. Product certificates signed by officer of truss fabricating firm, certifying that metal-plate-connected wood trusses comply with indicated requirements and Shop Drawings.

4. Qualification data for firms and persons to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information indicated.

5. Material test reports from a qualified independent testing agency listing and interpreting test results for compliance of fire-retardant-treated wood products with indicated requirements.

6. Material certificates for dimension lumber required to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee (ALSC) Board of Review

1.3 QUALITY ASSURANCE

A. **Materials:** Materials and assembly shall be inspected to determine compliance with the Building Code. Every material shall be graded, marked, or labeled.

B. **Certificate:** At completion of fabrication of the trusses, the approved fabricator shall submit a certificate of compliance to the ENGINEER stating that the WORK was performed in accordance with the Contract Documents.

C. Qualifications

1. General: The items in this Section shall be furnished by firms having at least 5 years experience with similar products and having a record of successful installations

2. Metal-Plate Connector Manufacturer: A manufacturer that is a member of Truss Plate Institute (TPI) and that complies with TPI quality control procedures for manufacture of connector plates published in TPI 1- National Design Standard for Metal-Plate-Connected Wood Truss Construction.

3. Fabricator: Engage a firm that:

    a. Complies with the following requirements for quality control and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated and with a record of successful in-service performance:

    b. Trusses shall be manufactured on the premises of a fabricator that is registered and approved to perform such WORK without special inspection. Registration and approval shall be based upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved inspection agency. Approved inspection agency shall be SPIB; Timber Products Inspection, Inc; TPI, or other independent inspecting and testing agency acceptable to the ENGINEER and local authorities having jurisdiction. Proof of registration and approval shall be submitted to the ENGINEER.

    c. The truss manufacturer shall retain an approved agency having no financial interest in the plant being inspected to make nonscheduled inspections of truss fabrication and delivery operations. The inspections shall cover the entire truss operation, including lumber storage, handling, cutting fixtures, presses or rollers, fabrication, bundling and banding, handling and delivery.

4. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice where the Site is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing metal-plate-connected wood trusses similar to those indicated and with a record of successful in-service performance.

5. Installer: An experienced Installer who has completed wood truss installation similar in material, design, and scope to that indicated and with a record of successful in-service performance.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Design and Fabrication:** The design and fabrication of metal plate connected wood trusses shall be in accordance with TPI 1, applicable portions of TPI DSB - Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses, and the AF&PA - National Design Specification for Wood Construction and Supplements.

B. The roof shall be designed to withstand the following vertical uniform loads:

    1. Dead Load

        a. Top chord 10 psf + chord wt.

        b. Bottom chord 12 psf + chord wt.

        c. Actual truss weight

        d. Air conditioning units as indicated

2. Live Load 20 psf basic

3. Wind loading criteria shall be as indicated on the Drawings.

4. Seismic loading criteria shall be as indicated on the Drawings.

C. Design trusses to withstand design loads without deflections greater than the following:

1. Vertical deflection of 1/360 of the span due to the live load.

2. Vertical deflection of 1/240 the span due to the total load.

D. Individual roof elements shall be designed to resist additional lateral loads as indicated. These additional loads are due to wind and/or seismic loading conditions, and building code load duration factors may be used in calculating stresses.

E. As a minimum, the following load conditions with appropriate building code prescribed load duration factors shall be considered in the roof design:

1. Dead Load + Live Load

2. Dead Load + Seismic

3. Dead Load + Wind Load (Up or Down)

F. The maximum spacing of the trusses shall be 24-inches unless otherwise indicated on the Drawings.

G. Joist hangers, anchors, and other connectors to connect the wood trusses to the walls or other structural systems shall be designed by the manufacturer.

H. The truss manufacturer shall coordinate the design with the HVAC Drawings and Shop Drawings to provide space and support for HVAC equipment to be supported on or from the bottom or top truss chords.

2.2 TRUSSES

A. Lumber shall conform to the species and be fully recognized nominal sizes according to the manufacturer's design. Members shall be cut from lumber bearing the proper grade mark stamps of a recognized grading association or licensed lumber inspection agency. No lumber shall be used that does not appear to conform to the proper dimensions and/or grades.

B. **Grading:** Lumber shall be graded in accordance with the rules of one of the following associations: "Grading Rules for Southern Pine Lumber" of the SPIB; "Standard No.17" of the WCLIB; or "Grading Rules for Western Lumber" published by WWPA.

C. **Grade Marking:** Each piece of lumber shall bear the official grade mark of one of the above-mentioned grading rules.

D. **Size Dressing:** Lumber, except as otherwise indicated, shall be dressed to size in accordance with the standards of the association under which the lumber is graded. Lumber shall be S4S unless otherwise indicated.

E. **Marking:** Each truss shall be legibly branded, marked, or otherwise have permanently affixed thereto the following information located within 2-feet of the center of the span on the face of the bottom chord:

1. Identity of the company manufacturing the trusses and the address

2. The design load

3. The spacing of the trusses

F. **Moisture Content:** At the time of fabrication, the moisture content of lumber shall be within the proper limits as stated in the referenced specifications and the appropriate load duration factors shall account for any variations in this moisture content.

G. Connector Plates

1. Connector plates shall be designed by the manufacturer.

2. Connector plates shall be structural-quality steel sheet, zinc coated by hot-dip process complying with ASTM A 653 - Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, G60 coating designation; Grade 33, and shall not be less than 0.0359-inch thick.

3. Connector plates shall be clearly marked with the manufacturer's name.

4. Connector plates shall be provided on both sides of the truss (2 plates per joint), and connector plated truss joints shall be designed in accordance with the methods in the TPI Standards.

H. **Bracing:** Permanent lateral bracing shall be 2 by 4 lumber minimum and be as shown on the truss manufacturer's drawings.

I. **Painting and Tagging:** Prior to shipment, similar ends of trusses shall be painted to show erection orientation. Florescent red and green Truss Joist Institute safety and specialty tags cautioning against cutting trusses or altering trusses and indicating bearing locations, orientation, permanent lateral bracing, and field splices shall be affixed to trusses.

2.3 FASTENERS

A. **General**: Provide fasteners of size and type indicated that comply with the manufacturer's requirements

B. **Nails, Wire, Brads, and Staples**: ASTM F 1667 - Driven Fasteners: Nails, Spikes, and Staples.

C. **Power-Driven Fasteners**: CABO NER-272 - Power Driven Staples and Nails for Use in All Types of Building Construction.

D. **Wood Screws**: ASME B18.6.1 - Wood Screws (Inch Series).

E. **Lag Bolts and Screws**: ASME B18.2.1. - Square and Hex Bolts and Screws (Inch Series).

F. **Bolts**: Steel bolts complying with ASTM A 307 - Wood Screws (Inch Series), Grade A with ASTM A 563 - Carbon and Alloy Steel Nuts, hex nuts and, where indicated, flat washers.

2.4 METAL FRAMING ANCHORS

A. **General:** Provide metal framing anchors of structural capacity, type, size, metal, and finish that comply with requirements, including the following:

1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that demonstrate compliance with Building Code.

2. Allowable Design Loads: Provide products with published allowable design loads that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and be demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. **Galvanized Steel Sheet**: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

2.5 OTHER FRAMING MEMBERS

A. Simple framing members shall be designed in accordance with Section 06100 - Rough Carpentry.

B. Joist hangers, anchors, and other connection hardware shall be of standard manufacture, approved by a recognized agency for the intended applications. Specially fabricated hardware shall be provided in accordance with Section 05500-Miscellaneous Metalwork, hot-dip galvanized after fabrication.

PART 3 -- EXECUTION

3.1 TRUSS FABRICATION

A. The top and bottom chords shall have a minimum size of 2-1/2 inches by 6-inches with a top chord extension as indicated.

B. Trusses and other roof structural components shall be fabricated in a properly equipped manufacturing facility of a permanent nature. They shall be manufactured by experienced workmen, using precision cutting and truss fabricating equipment and meeting the requirements of TPI 1, under the direct supervision of a qualified foreman. Trusses shall be fabricated under strict rules of inspection and quality control as required by the Building Code and shall be open to the ENGINEER or its representative at all times.

C. Truss members shall be accurately cut to length and angle and shall be true to line to assure tight joints for the finished truss. Tolerances shall be per TPI 1.

D. Truss members and connector plates shall be properly placed in special jigs, and the members tightly clamped in place, remaining in that position until the connector plates have been installed.

E. Camber shall be built into the trusses as noted on manufacturer's designs.

3.2 HANDLING, ERECTION, AND BRACING

A. Handle and store trusses with care and comply with manufacturer's written instructions and TPI recommendations to avoid damage and lateral bending.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

C. The CONTRACTOR shall be responsible for field erection of the trusses and other roof framing components, including items such as proper handling, safety precautions, temporary bracing to prevent toppling like dominoes of the trusses during erection, and any other safeguards or procedures which are consistent with good workmanship and building erection practices.

D. The CONTRACTOR shall comply with applicable requirements and recommendations of TPI HIB - Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses.

E. The CONTRACTOR shall comply with engineered drawings, truss layout plans, and TPI HIB when erecting the truss. Fabricated trusses and sub-components shall be handled and stored so that they are not subject to damage. If the trusses are to be stockpiled prior to erection, sufficient bearing points and/or bracing shall be provided to prevent excessive lateral bending or tipping over or other damage.

F. Framing anchors and/or truss hangers shall be provided by the CONTRACTOR in accordance with the manufacturer's recommendations and the Contract Documents.

G. During the construction period, the CONTRACTOR shall provide means for adequate distribution of any concentrated loads, so the carrying capacity of any one truss and/or other component is not exceeded.

H. The CONTRACTOR shall install proper erection bracing to hold the trusses true and plumb and in safe condition until the permanent truss bracing and bridging is solidly nailed in place, forming a structurally sound roof framing system. Erection and permanent bracing shall be installed and components shall be firmly fastened before any loads are applied to the roof.

1. The CONTRACTOR shall install erection bracing in accordance with TPI HIB. Brace trusses as they are erected by forming 2 by 4 triangles within each of the three planes in a truss system. Attach bracing with two 16D double-headed nails at each crossing truss minimum. Short cleats or spacer pieces of lumber between adjacent trusses shall not be used.

I. The plywood sheathing shall be installed in accordance with the Drawings. Full bundles of plywood sheathing shall not be stacked on trusses.

J. The CONTRACTOR shall not attempt to field repair, cut, or otherwise alter trusses without consulting the truss manufacturer.

- END OF SECTION -

SECTION 06200 - FINISH CARPENTRY AND MILLWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct all finish carpentry and millwork and appurtenant work, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Government Standards

Fed. Spec. FF-B-561D	Bolts, (Screw), Lag
Fed. Spec. FF-B-588D	Bolts, Toggle and Expansion Sleeve, Screw
Fed. Spec. FF-N-105B(3)(A)	Nails, Brads, Staples and Spiles; Wire, Cut and Wrought
Fed. Spec. FF-S-111D(1)	Screw, Wood
Product Std. PS 1	Construction and Industrial Plywood
ANSI/AHA	Basic Hardboard

B. Commercial Standards

AWI	Architectural Woodwork Casework Details, Architectural Woodwork Institute
NEMA LD-3	High Pressure Laminated Plastic
WCLIB	Standard Grading and Dressing Rules No. 16, West Coast Lumber Inspection Bureau
WWPA	Standard Grading Rules for Western Lumber, Western Wood Products Associates
WIC	Manual of Millwork, Woodwork Institute of California

1.3 CONTRACTOR SUBMITTALS

A. **Submittals:** The submittal of material samples, manufacturer's literature, results of required tests, testing reports, etc., shall be submitted in accordance with Section 01300 - Contractor Submittals.

B. **Doors:** Samples of doors when requested by the ENGINEER shall be submitted by the CONTRACTOR, showing face veneer and finishes including shop drawings and certificates of compliance with fabrication and test requirements, signed by authorized representative of the door manufacturing company.

C. **Cabinet and Casework:** Shop drawings, samples of hardware and literature shall be submitted. Color samples and literature on laminated plastic (where it is used) shall be submitted for review and color selection.

D. **Modular Casework:** Shop drawings, literature, color samples, and certificates of compliance with fabrication and test requirements signed by an authorized representative of the cabinet manufacturing company shall be submitted by the CONTRACTOR.

1.4 QUALITY ASSURANCE

A. The CONTRACTOR shall issue, before delivery to the jobsite, a [letter] [WIC Certified Compliance Certificate], indicating that the millwork products that will be furnished will fully meet all requirements for the grade(s) specified.

B. Shop drawings for the casework shall [bear the WIC Certified Compliance Label indicating that the shop drawings meet the requirement of the grade or grades specified.] [be complete and show all details, lumber sizes, and type and grade of materials to be used.]

C. Each unit of casework shall [bear the WIC Certified Compliance Label indicating] [conform] to fully meet the requirements of the grade specified.

D. Each plastic laminated countertop, splashes, and box curbs shall [bear the WIC Certified Compliance Label] [be provided with a letter] indicating that the items being provided fully meet the requirements of the grade specified.

PART 2 -- PRODUCTS

2.1 WOOD PRODUCTS

A. **Softwoods:** Softwoods shall be vertical grain Douglas fir or white pine, meeting [WIC Custom Grade] [AWI Premium Grade] requirements. [Douglas fir shall conform to WCLIB Standard Grading and Dressing Rules No. 16.]

B. **Hardwoods:** Hardwood shall be ash or birch, with a transparent finish conforming to [WIC] [AWI] [Custom] [Premium] Grade. Hardwood species shall not be mixed within a project.

C. **Plywood:** Softwood plywood shall conform to the requirements of the U.S. Product Standards PS-1, Grade A for pine plywood. Hardwood plywood shall conform to the requirements of HPVA HP-1. Plywood backboards and plywood wainscot shall be APA Grade trademarked A-C-INT-APA. Backing for countertops shall be 3/4-inch thick particle board or plywood in accordance with written recommendations of the laminated plastic manufacturer.

2.2 FASTENERS

A. Nails for exterior millwork and siding shall be stainless steel where exposed to the elements and galvanized where concealed.

B. Lag screws shall conform to FS FF-B-561D.

C. Wood screws shall conform to FS FF-S-111D(1). Cadmium plated screws, bolts and washers shall be used on exposed interior work. Screws for exterior use shall be stainless steel.

2.3 GLUE

A. Glue shall be Type II water-resistant which will not penetrate final finish.

2.4 PLASTIC LAMINATES

A. Laminated plastic shall be high-pressure-laminated plastic conforming to NEMA LD-3.

B. Chemical resistant high-pressure laminated plastic shall meet the requirements of NEMA LD-3 and shall show essentially no effect when left in contact with the following reagents for a period of 16 hours, either when reagents are allowed to evaporate or when they are kept liquid by covering.

Acids		**Solvents**
Acetic Acid	98%	Acetone
Citric Acid	10%	Amyl Alcohol
Hydrochloric Acid	37%	Benzene
Formic Acid	90%	Ethyl Alcohol
Nitric Acid	30%	Carbon Tetrachloride
Sulfuric Acid	77%	Chloroform
Perchloric Acid	60%	Dioxane
Phosphoric Acid	85%	Ethyl Acetate
Phenol	85%	Ethyl Alcohol
		Ethyl Ether
Alkalies		Ethylacetoacetate
		Formaldehyde
Ammonium Hydroxide	28%	Furfural
		Gasoline
Salts		Kerosene
		Naptha
Calcium Hypochlorite, saturated		Toluene
Potassium Permanganate		Trichlorethylene
Sodium Bisulfite		Xylene
Sodium Bisulfate		
Sodium Chloride		
Zinc Chloride		
Silver Nitrate	1%	
Other Reagents		
Cresol		
Chlorobenzene		
Detergent (Dreft)		
Hydrogen Peroxide		
Iodine, 1% in Alcohol		
Mercurochrome		
Mineral Oil		
Urea	6.6%	

The chemical resistant laminated plastic shall be **Wilson-Arts "Chem-Surf and Soli-Core", or equal.** At least 10 different colors shall be submitted for selection by the ENGINEER.

2.5 ALUMINUM TRIM

A. Aluminum trim where specified or shown, shall be extruded aluminum with clear anodized finish as manufactured by **Trimedge; Kinkead; or equal.**

2.6 FINISH HARDWARE

A. Finish hardware shall be top quality hardware as itemized below, and shall be provided with US 26D finish unless otherwise specified:

1. Hinges shall be heavy duty wrap-around 2-1/4-inch minimum width, butts of 0.083-inch thick steel (US 26D), off-set for overlay door installation with a minimum of 5 No. 8 full thread screws to the jamb and 4 No. 8 full thread screws to the door. Loose pin butts of 0.083-inch-thick steel, shall be **National B-377; McKinny 2743; or equal.** Tight pin butts of 0.083-inch-thick steel, shall be **National B-851 or B-852; Stanley HT 1592;** or equal**.** Doors over 48 inches in height shall have 3 hinges.

2. Door and drawer pulls shall be Quality No. 179; National Lock B244; Builders Brass No. 79; Jaybee 534, Institutional Type; or equal.

3. Magnetic catches shall be EPCO 591; McKinney No. 2911; National Lock 224A; National C221-28; Amerock V9765; Jaybee 3776; or equal.

4. Drawer locks shall be National Lock C8138; Russwin Corbin 0738; or equal.

5. Drawer guides shall be **KV 1300, KV 1330, KV 1336; Washington 2300; Grant 336; or equal** for all drawers except file drawers which shall have **KV 1460; Grant 329; Accuride 4037;** full extension drawer guides, or equal**.**

6. Adjustable shelf standard shall be KV 255; Garcy U373; Grant 125, or equal.

7. Adjustable shelf clips shall be **KV 256, KV 239; Grant 212; or equal. KV 346** use with drilled holes.

8. Hanger rods shall be 1-1/16-inch minimum diameter, 0.120-inch walled heavy duty metal tubing, stainless steel clad, **KV 660;** heavy wall stainless steel tubing **KV 770; or equal.**

9. Hanger rod flanges shall be KV 757; or flanges KV 734; KV 735; Ronther Reiss R44-55; or equal.

10. Base adjusters (leveling feet) for fixed cabinets shall be of the adjustable screw type having a floor bearing surface of at least 9 square inches at each foot, and shall provide for leveling the cabinet from the inside of the case through holes provided in the cabinet bottom. Where corner bracket type adjusters are specifically specified or shown, the following may be substituted for the leveling foot type; **National D6009 Corner Brackets with D6005 stem screw-type leveler; or equal.**

11. Base adjuster covers shall be Fastener Supply 51026; Dot Plug Bottom SS-48172; Handy Button No. 78; KV 731; or equal.

B. Other finish hardware required hereunder may be specified in Section 08710 - Finish Hardware.

PART 3 -- EXECUTION

3.1 CABINET AND CASEWORK

A. Millwork, cabinets and casework shall be manufactured and fabricated in accordance with the Reference Standards for Millwork.

B. Cabinet and casework shall conform to WIC grade, with face frame and flush overlay type door and drawer construction. Cabinet work shall receive laminated plastic finish unless otherwise shown.

C. Laboratory casework shall be modular casework. Modular casework shall conform to [WIC] [AWI] "Standards Laminated Plastic Covered Laboratory Grade." Cabinet work shall be of standard manufacturers' sizes approximately equal to those shown with filler panels where required or shown. The gross storage area of the casework shall be within 5 percent of the gross area of the casework shown. Base cabinets shall be provided with all finish hardware as specified in Section 08710 - Finish Hardware.

D. Laminated plastic countertops, splashes, and paneling shall be of the same grade as cabinet and casework.

E. Concealed casework shall be APA plywood, grade trademarked A-D INT-APA.

F. Solid stock shall be used for all frames, jambs, heads, stops, and edging. Plywood shall be used for body construction of all cabinet members over 12-inch wide.

G. Shelves over 12-inch wide shall be of 3/4-inch plywood. Shelves less than 12 inches wide may be of solid stock. All shelving in bookcases or open storage shelving casework exceeding a span of 3 ft shall be not less than 7/8-inch thick and spans of more than 4 ft shall be at least 1-inch thick. No span of shelving shall exceed 4 ft unless approved by the ENGINEER.

H. Laminated plastic countertops shall have: self-edged edge covering; square butt joint back splash; waterfall top of back splash. Side splashes shall be provided where there are adjacent side walls. Laminated plastic countertops, splashes, and casework, within the laboratory rooms or areas, shall be chemical resistant high-pressure-laminated plastic.

I. Finish hardware shall be furnished and installed. Hardware shall be provided with US 26D finish unless otherwise specified. Locks shall be installed as shown, and shall be master keyed if so specified. Hardware shall consist of all hardware needed for complete construction.

J. All drawers shall be provided with metal drawer guides.

3.2 INSTALLATION

A. The CONTRACTOR shall verify drawing dimensions in the field, and shall inspect related work and adjacent surfaces. Any conditions which will prevent proper execution of the work shall be reported to the ENGINEER.

B. Insofar as practicable, all work shall be shop-fabricated and assembled after taking field dimensions and shall be delivered to the job site ready for installation. All work shall be installed in accordance with these Specifications and manufacturers' recommendations and instructions.

C. Wood grounds and blocking of the sizes and shapes required for installation of casework and millwork shall be provided. Cabinet work shall be coordinated with framing and blocking work, and with installation of mechanical, electrical and other equipment.

D. All work shall be true and straight, with edges clean cut, and assembled with members properly housed together and tightly jointed. Joints subject to strain shall be reinforced with screws or bolts to assure their tightness. The method of joining and reinforcing shall be as indicated on the shop drawings. Work shall be accurately positioned and installed plumb and level, with separate parts fitted and properly aligned. Single lengths of wood shall be used whenever practicable. Trim shall have plowed backs unless otherwise shown.

E. Work shall be neatly scribed to other construction and securely attached in place with concealed fastenings where possible or with finish nails. Flathead screws shall be used where required or necessary for premium construction.

F. Exposed nail heads and screw heads shall be set or countersunk before putty is applied.

G. All exposed surfaces shall be dressed and well sanded to smooth, uniform finish, free of marks or other blemishes and ready for finish work.

H. Countertops, splashes, and ends shall be installed true, level, straight and aligned. Sections shall be properly housed together, tightly jointed, and clamped. Shop drawings shall show the jointing pattern, method of jointing, and reinforcement. Countertops shall be installed in sections as large as possible with the fewest joints. They shall be accurately positioned and installed plumb and level with hairjoints and no rises or bumps at joints.

I. Plywood tool boards and backing panels shall be screw-mounted with flat head stainless steel wood screws at 16 inches on center both ways, and within 1-inch of edges. All screws shall be countersunk. Plywood shall have glue beads applied to back before installation. Panels up to 4 feet in height shall be installed in horizontal sheets. Panels over 4 feet in height shall be installed vertically with vertical joints at 4-foot corners.

- END OF SECTION -

SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all steel doors, frames, and related items, complete and operable, including all finish hardware and all appurtenant work, all in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM A 366	Steel, Carbon, Cold-Rolled Sheet, Commercial Quality
ASTM B 117	Method of Salt Spray (Fog) Testing
ASTM D 1735	Method for Water Fog Testing of Organic Coatings
ASTM E 413	Classification to Rating Sound Insulation
ANSI A115 Series	Door and Frame Preparation
UL	Underwriters' Laboratories, Inc.

B. Trade Standards

National Association of Architectural Metal Manufacturers (NAAMM).

C. Manufacturers' Standards: In addition to the standards listed above, the steel doors and frames and their installation shall be in accordance with the manufacturer's published recommendations and specifications.

1.3 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 – Contractor Submittals.

B. **Shop Drawings:** Shop drawings shall show details of the products and systems and connections to adjoining materials. Schedules showing sizes and types shall be submitted along with manufacturer's installation instructions.

C. **Manufacturer's Literature:** Manufacturer's literature and any engineering calculations that may be required elsewhere in this Section shall be submitted. Calculations by a registered civil or structural engineer shall be submitted showing that the doors, frames, and their structural connections are designed to meet code requirements and loads.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Doors and frames shall be shipped and stored with temporary stiffeners and spacers in place to prevent distortion.

B. Doors and frames shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Doors and frames shall be carefully stored on wood blocking in an area that is protected from the elements. Storage shall be in a manner that will prevent damage or marring of finish.

PART 2 -- PRODUCTS

2.1 MATERIALS AND FABRICATION - GENERAL

A. **Shop Fabrication and Assembly:** All steel doors and frames shall be shop fabricated and shop assembled, where possible. Temporary stiffeners, spacers, and other accessories necessary to facilitate handling and accurate erection shall be provided. After fabrication, all tool marks and other surface imperfections shall be filled and ground smooth.

B. **Materials for Doors and Frames:** All exterior doors and frames shall be fabricated entirely of galvanized steel. Other doors and frames, unless otherwise specified or shown, shall be fabricated from prime quality, commercial grade, cold-rolled steel conforming to ASTM A 366, Type II or III.

C. **Priming and Painting:** Doors and frames shall be chemically treated to ensure maximum paint adhesion and shall have all exposed surfaces painted with a rust-inhibitive primer after fabrication. Prime coat shall be capable of passing a 120-hour salt spray test in accordance with ASTM B 117 and a 250-hour humidity test in accordance with ASTM D 1735.

D. **Hardware:** Doors and frames shall be reinforced and drilled or tapped for fully templated mortised hardware; and shall be reinforced with plates for surface-mounted hardware, meeting ANSI A115 Series requirements. Hardware shall be as specified in Section 08710 - Finish Hardware, and/or as shown.

2.2 METAL FRAMES

A. **Pressed Metal Frames:** Pressed steel frames for doors and other openings shall be combination buckled frame and trim of type and sizes as shown. Metal shall not be lighter than 16-gage steel. Frames shall be of the welded unit type. Special frames, oversized frames, and frames with transom shall be provided where shown.

B. **Frame Jamb Depths, Trim Profile, Stops, and Backbends:** Frame jamb depths, trim profile, stops, and backbends shall be as shown and on the CONTRACTOR approved shop drawings reviewed by the ENGINEER.

2.3 FRAME ANCHORS

A. **Floor Anchors:** Floor anchors shall be welded inside each frame jamb head, and holes shall be provided for floor anchorage. Minimum thickness of floor anchors shall be 14-gage.

B. **Anchors for Masonry/Concrete Installations:** Frames for installation in masonry and/or concrete walls shall be provided with adjustable jamb anchors of the T-strap,

stirrups and strap, or wire type. The number of anchors provided per frame jamb and head shall be as follows:

1. Frames up to 7 feet 6 inches in height: 3 anchors.

2. Frames over 7 feet 6 inches to 8 feet 0 inches in height: 4 anchors.

3. Frames over 8 feet 0 inches in height: One anchor for each 2 feet 0 inches or fraction in height.

4. Frame head anchors shall be not less than those required by the Reference Standards.

2.4 DUST COVER BOXES AND MORTAR GUARDS

A. Dust cover boxes or mortar guards of not less than 24-gage steel shall be provided at all hardware mortises on frames to be set in masonry, concrete, or plaster walls.

2.5 SILENCER HOLES

A. Appropriate holes for silencers shall be provided in the door frames which are not designated to receive weatherstripping, seals, or sound seals.

2.6 STEEL DOORS

A. **Design and Construction:** Steel doors shall be of hollow metal construction and shall be of full flush design with no visible seams. Face sheets shall be not less than cold-rolled, stretcher-levelled, 18-gage steel. All doors shall continuously and fully welded seam edges. Doors shall be rigid and neat in appearance, and shall be free from warpage or buckle. Corner bends shall be true and straight and shall be of not less than the minimum radius for the gage of metal used. The door top and bottom shall be internally reinforced by steel members welded in place. Tops of exterior doors shall be provided with flush, water and weather tight, top enclosures.

B. **Door Cores:** Doors and cores shall be water-resistant polystyrene with minimum R of 7.

C. **Double Doors:** Double doors shall be provided with a "T" type steel astragal unless otherwise specified in Section 08710 - Finish Hardware.

D. Manufacturers, or Approved Equal

1. **Ceco Door Products**;

2. **Overly Manufacturing Co**.;

3. **North American Door Corp**.

PART 3 -- EXECUTION

3.1 CONSTRUCTION

A. **General:** All work shall be in accordance with manufacturer's published recommendations and specifications.

B. All work shall be coordinated with appropriate related subcontractors work to assure a proper installation. Field conditions and dimensions shall be verified prior to fabrication.

3.2 FRAME INSTALLATION

A. Frames shall be set plumb and square in a true plane, and be securely anchored to the adjoining construction. Steel shims shall be provided and shall be set tight and rigidly attached between frame anchors and structure. All finished metal frames shall be strong and rigid; neat in appearance; and square, true, and free of defects, warp, or buckle.

B. Molded members, trims, and stops, shall be clean cut, straight, and shall be of a uniform profile throughout their lengths.

C. Corner joints shall have all contact edges tightly closed with all trim faces mitered, welded, and finished smooth. The use of gussets will not be permitted.

3.3 DOOR INSTALLATION

A. Doors shall be installed plumb, square, and level. Doors shall operate freely, but not loosely. They shall be free from rattling while in a closed position.

B. The door clearances shall be plus 3/32-inch or minus 1/32-inch and shall not exceed the limits specified in the manufacturer's printed recommendations.

C. Any door that becomes warped more than 3/16-inch out-of-plane shall be replaced by the CONTRACTOR.

D. Doors and door's finish hardware shall have hardware protected prior to painting as specified in Section 08710.

3.4 FINISH HARDWARE

A. Finish hardware shall be installed in accordance with hardware manufacturer's standard templates and printed instructions. Operable parts shall be adjusted for correct function and operation.

- END OF SECTION -

SECTION 08710 - FINISH HARDWARE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all finish hardware and appurtenant work, complete, all in accordance with the Contract Documents.

B. The work hereunder shall include all fabrication and mounting templates as needed for fabricators and for control of application of metal items.

C. In addition thereto, the CONTRACTOR shall provide all trim, attachments, and fastenings specified or required for proper and complete installation. The work of this Section shall include all hardware that is not specified in other sections, whether or not such hardware is herein specifically scheduled.

D. The CONTRACTOR shall protect the finish hardware from damage during construction, painting, and clean-up.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

Underwriters' Laboratories, Inc.	requirements and approvals.
Hardware Institute (DHI)	"Recommended Procedure for Processing Hardware Schedules and Templates" and "Architectural Hardware Scheduling and Format"
BHMA	Builders' Hardware Manufacturers' Association

B. **Manufacturers' Standards:** In addition to the standards listed above, the finish hardware and its installation shall be in accordance with the manufacturer's published recommendations and specifications.

1.3 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Samples:** The samples of all items requested by the ENGINEER shall be furnished by the hardware supplier no later than 10 days after said request is received.

C. **Manufacturer's Information:** The CONTRACTOR shall submit a complete detailed hardware list and a schedule along with manufacturer's literature on each item for approval. No hardware shall be delivered until the hardware schedule has been approved by the ENGINEER.

D. The hardware schedule submitted by the CONTRACTOR shall list the actual product series numbers. Manufacturer's catalog requirements for actual size of door closers, brackets, and holders shall be observed. All door sizes shall be noted on the hardware schedule and all hardware shall be in strict accordance with height, width, and thickness requirements.

E. The schedule shall indicate groups, type, manufacturer's name, catalog number, location, and finish of each item to be provided, all in accordance with the DHI "Architectural Hardware Scheduling Sequence and Format."

F. The schedule shall also include a complete template list showing template references and data for each item requiring preparation of metal doors and frames.

G. Hardware for aluminum doors may be included in a separate section of the schedule.

1.4 PROPRIETARY DESIGNATIONS

A. Manufacturer's product names, numbers, and models are given herein for the purpose of indicating the requirements for the type, general construction, material, and operation of the specific item, not with the intention of limiting the item to the manufacturer's listed product. Substitution of another manufacturer's product that is fully equivalent in all respects may be made subject to the approval of the ENGINEER. It shall be the CONTRACTOR's responsibility to supply detailed and complete data to the ENGINEER as required to facilitate appropriate evaluation of all proposed substitute items.

1.5 PACKING, MARKING, AND DELIVERY

A. All locks, exit devices, door closers, overhead door holders, hinges, kickplates, pulls and push plates, thresholds, and other similar items shall be individually packed in separate, suitable, original, containers as furnished by the hardware manufacturers. Each container shall be clearly marked with item numbers, article numbers, and names corresponding to those listed in the hardware schedule.

B. Small miscellaneous items that would not require specific location identifications, such as door stops, coat and hat hooks, and door silencers may be quantity packed if properly labeled with item numbers and other identification.

C. CONTRACTOR shall check the hardware upon delivery with the aid of a representative of the hardware supplier's firm. The CONTRACTOR shall be responsible for the proper storage of all hardware until ready for application.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Finish hardware shall be coordinated with all other work requiring builder's hardware or attaching to it. Copies of schedules, templates, etc., shall be furnished in ample time to avoid fabrication and construction delays. Each item of hardware shall be identified according to the approved list and schedule. All hardware shall be made to template.

B. All hardware furnished in connection with doors bearing Underwriters' Labels or where necessary to meet special requirements shall be in strict accordance with conditions established by the authority having jurisdiction and shall be subject to approval of that authority.

C. Hand of lock shall be as shown. If door hand is changed during construction, the CONTRACTOR shall make necessary changes at no extra cost to the OWNER.

D. Exit doors shall be openable at all times from the inside without the use of key or any special knowledge or effort.

E. The CONTRACTOR shall provide the hardware supplier with approved shop drawings from those trades with which hardware must be coordinated. After checking these shop drawings, the CONTRACTOR shall promptly supply necessary template information to all concerned as may be required to facilitate the progress of the job. All procedures for template information shall be in accordance with the handbook, "Recommended Procedure for Processing Hardware Schedules and Templates."

F. Finish of all hardware shall be 630 (brush stainless steel) unless otherwise specified in the hardware schedule.

G. Manufacturer, or Equal

1. **Adams Rite**, Los Angeles, CA
2. **Builders Brass**, Los Angeles, CA
3. **Door Control**, Ann Arbor, MI
4. **Dor-O-Matic**, Chicago, IL
5. **Glynn-Johnson**, Chicago, IL
6. **Grant,** West Nyak, NY
7. **Hager,** St. Louis, MO
8. **Knape Vogt**, Grand Rapids, MI
9. **LCN-Closers**, Princeton, IL
10. **McKinney**, Scranton, PA
11. **Norton,** Charlotte, NC
12. **Pemko Mfg. Co**., Emeryville, CA
13. **Quality Hardware**, Hawthorne, CA
14. **Rixson-Firemark**, Franklin Park, IL
15. **Corbin Russwin,** Berlin, CT
16. **Sargent**, New Haven, CT
17. **Schlage,** San Francisco, CA
18. **The Stanley Works**, New Britain, CT
19. **Trimco,** Los Angeles, CA
20. **Von Duprin Inc**., Indianapolis, IN

21. **Zero Weatherstripping**, Burbank, CA

2.2 KEYING

A. All locks and cylinders shall be master-keyed to the OWNER'S requirements as directed by the ENGINEER.

B. All lock cylinders shall be construction master-keyed or provided with construction cylinders and construction keys. Five construction master keys shall be obtained by the CONTRACTOR, of which 3 may be retained by the CONTRACTOR for use during construction, and the remaining 2 construction keys shall be provided to the ENGINEER for its use.

C. The CONTRACTOR shall furnish 5 keys per cylinder keying combination. All keys along with 5 master keys shall be delivered to the ENGINEER at the completion of the job.

D. All keying (except when matching existing keying system or when less than 10 locksets are required) shall be done at the factory unless otherwise approved by the ENGINEER.

E. A keying schedule shall be worked out between the OWNER, the CONTRACTOR, and the hardware supplier. The CONTRACTOR shall have the hardware supplier submit a keying schedule for approval prior to placing an order for the locks and keying of cylinders.

2.3 FASTENERS

A. The CONTRACTOR shall provide all necessary screws, bolts, and other fasteners of suitable size and type to secure the hardware into position. The fasteners shall match the hardware in material and finish.

B. The hardware provided, such as expansion bolts, sex bolts, toggle bolts and other approved anchorage shall be coordinated with the job and to each setting condition.

C. Phillips head screws shall be used at exposed conditions. Machine screws shall be used at metal doors and frames.

2.4 HINGES AND PIVOTS

A. Two hinges or pivots shall be provided for each door leaf up to and including 5 feet in height, and an additional hinge shall be added for each 2-1/2 feet or fractions thereof of additional door height. Width of hinges shall be determined by trim conditions.

B. Ball-bearing hinges shall be furnished on all doors having door closers and/or exit devices. All ball-bearing hinges shall have flush tips.

C. All hinges on exterior doors shall be provided with non-removable pins and security studs.

D. Hinges shall be 630 (brush finished) stainless steel unless otherwise specified in the finish hardware schedule.

E. Hinges and sizes shall be as follows:

Door Thickness (inches)	Door Width (inches)	Hinge Width	Hinge Height (inches)
1-3/8	36 and under	Reg. Wt., interior use only	3-1/2
1-3/8	37 and over	Reg. Wt., interior use only	4
1-3/4	30 and under	Reg. Wt., interior use/exterior use	4-1/2
1-3/4	30 to 39	Reg. Wt., interior use Hvy. Wt., exterior use	4-1/2
1-3/4	40 and over	Reg. Wt., 4 ball bearing, interior use Hvy. Wt., 4 ball bearing, exterior use	4-1/2

F. Hinges shall be plain bearing type (regular weight) conforming to BHMA No. A 2133; ball bearing hinges (regular weight) conforming to BHMA No. A 2112 or No. A 5112; and/or ball bearing hinges (heavy weight) conforming to BHMA No. A 2111 or No. A 5112. Hinge manufacturers design options such as 3-knuckle hinges and concealed ball bearing hinges are acceptable. Plain hinges shall be provided with self lubricating bushings.

2.5 OVERHEAD CLOSERS

A. All overhead closers shall be the product of one manufacturer. Closers shall have high-strength cast-iron cases with rectangular covers, adjustable spring power and adjustable back-check, and full rack and pinion action. Closers shall have back-check regulating screws, with separate screws for closing and latching speeds.

B. Surface door closers shall be spray painted to match door hardware.

C. Soffit shoes shall be provided where corner brackets or regular arm closers are not used and where they are necessary for proper function of the hardware.

D. Where door closers or other items have lever or similar arms, attachment to doors shall be with sex bolts only.

E. Closers for outswinging exterior doors shall be surface mounted.

F. Closers shall be Corbin Russwin DC6000 series; Sargent 250; LCN 4040; or equal.

G. The CONTRACTOR and its hardware supplier shall be responsible to provide the right arm with the closers. Arms shall be parallel with the closed door whenever possible.

H. Closers shall be provided with sex bolts for fastening through doors, frames and transoms.

2.6 LOCKSETS AND LATCHSETS

A. All locksets and latchsets shall be mortise type with anti-friction 2-piece latchbolts with a minimum 3/4-inch-throw and 1-inch-throw dead bolts with hardened roller inserts. Locksets and latchsets at fire rated doors shall meet code requirements and shall be modified as necessary. All locksets, latchsets, privacy sets, and passage sets shall be provided with lever handles. All locksets and latchsets shall be provided with satin stainless steel finish 630 (US 32D) unless otherwise specified.

B. Function of locksets or latchsets shall be appropriate for doors use.

Lever Type Hardware
(Meeting Handicap
Requirements)

Mfr.	Series	Trim Solid Flat-Round Design
1. **Corbin Russwin**	**CL3300**	**Newport**
2. **Sargent**	**15-18-8100**	**LNL**
3. **Schlage**	**L9000**	**06A**
(or equal)		

C. Hardware for aluminum entrance doors shall be **Adam Rite** hardware **or equal,** as specified in schedule. The hardware face plate design shall be coordinated with doors provided.

D. Where knob type trim is specified for locksets, latchsets, and privacy sets the trim shall be cast spherical knobs of 2-inch diameter minimum, 2-1/4 inch wrought roses (screwless attached) and thru-bolted trim. The knob and trim mounting (rose, escutcheon) shall be similar and equal to the following shank spindle assembly designs:

1. **Corbin Russwin, "NZD"**

2. **Sargent, "BC".**

E. Mortise deadlocks shall be of weight and quality comparable to locksets and latchsets specified.

F. Lock strikes shall be boxed type of sufficient length and having curved lips to protect the trim and jambs and be so shaped as to avoid the possibility of tearing clothing. All strikes shall be provided with metal strike boxes.

G. All locks shall be provided with the same cylinder and keyway for master keying. They shall be the product of the same manufacturer as the locksets unless otherwise specified. The correct cylinders with all necessary modifications and components such as cams, collars, rings, retainers, plates, fasteners, etc., shall be provided for other specialty hardware such as exit devices, store front locksets, and sliding door locks where the hardware manufacture specified is different than cylinder manufacturer.

2.7 DOOR STOPS

A. Door stops shall be of the type specified in the hardware schedule and shall be provided with the proper fasteners.

B. Stops shall be provided with machine screws and anchors at concrete and masonry conditions, and toggle bolts at plaster, gypsum board, and wood conditions.

	Floor Stop w/Holder	**Floor Stop Dome**	**Wall Stop w/Holder/ EB**	**Wall Stop w/Holder/ FHWS**
BBW	F-823X	F-8061X	W-141X	W-140
QUALITY	139	431 ES	136	36
GOV'T #	1329E	7330 E	1321 E	1321
	Wall Dome Stop w/EB	**Wall Dome Stop w/TB**	**Wall Stop/ Base/ EB**	**Wall Stop/ Base**
BBW	W9X	W9T	W-145X	W-145
QUALITY	W 307S	307 TB	138	38
GOV'T #	1326	1326E	1320E	1320

C. Aluminum door stops shall be used with aluminum, chrome, and stainless steel finishes.

D. Bronze door stops shall be used with brass and bronze finishes.

2.8 HOLDERS

A. Overhead type door holders shall be concealed type of correct size for door, 90 degree openable unless 180 degree opening shown, and allowing for checkmating. Interior doors shall be provided with overhead stops if wall type stops can not be used and floor stops make a tripping hazard. Finish shall be chrome plated bronze with satin finish, US 26D, unless otherwise specified. Door holders shall be one of the following, or equal:

Concealed Overhead	Surface Overhead
FS type 1164	**FS type 1161**
Glynn-Johnson 320 Series	**Glynn-Johnson 90M**

2.9 SILENCERS OR MUTES

A. All interior doors shall be provided with rubber silencers, 3 for each single door and 2 for each pair of doors. Silencers or mutes shall be one of the following, or equal:

Metal Frames	Wood Frames
GJ 64	**GJ 65**
Sargent 3446	**Sargent 3445**

2.10 THRESHOLDS

A. All doors so detailed shall receive a threshold similar to that specified with a maximum of 1/2-inch rise at entry ways. Return miters shall be furnished at thresholds on floor closers.

2.11 WEATHERSTRIPPING AND SEALS

A. Weatherstripping and seals shall be as manufactured by **Pemko Manufacturing Co.; National Guard Products Inc. (NGP); Zero Weatherstripping Co.;** or equal.

B. Exterior doors (except for roll-up doors and entrance doors) shall have head, jambs, and astragals weatherstripped with not less than 5/16-inch by 5/8-inch closed cell, neoprene sponge rubber, unless otherwise specified or shown.

C. Interior doors shall have head, jambs, and astragals sealed with self-adhesive bubble configuration door seal designed against smoke, air, sound, and weather infiltration. The seals shall be fire tested and labeled as a gasketing for use on steel frames with wood or steel doors for 20-minutes C-label, 1 hour B-label, and 1-1/2-hour B-label doors. Seals shall be **S88D by Pemko; #TM 181 by NGP: or equal.**

PART 3 -- EXECUTION

3.1 GENERAL

A. All required items of hardware, including cylinders for locks, and all fitting, adjusting, and securing of each item neatly and firmly in place, shall be in perfect working order. Any work less than this shall form a basis for corrective measures.

B. All finish hardware shall be fitted and dismantled before painting work and shall be reinstalled after finish painting work.

3.2 HARDWARE SCHEDULE

A. The hardware schedule is arranged for convenience of locating hardware and does not preclude in any way the requirements that all necessary hardware shall be furnished and properly installed. Hardware not specifically called out shall be similar to that required for similar uses.

B. The catalog numbers referred to in the hardware schedule are taken from catalogs of the manufacturers listed. They are used only to establish the quality and type of hardware to be used. Hardware equal in quality and utility will be accepted provided it conforms in operation, quality, weight, size, workmanship, and finish to the products hereinafter described. All component parts of locksets shall be the product of one manufacturer.

FINISH HARDWARE SCHEDULE ABBREVIATIONS
(Not Standard With Industry)

CA	=	Clear anodized BHMA 628
DBA	=	Dark bronze anodized (313)
PMD	=	Paint to match door and/or frame BHMA 600
F#	=	ANSI, hardware function number
W/SS	=	With security studs
NRP	=	Non-removable pins
DW+3	=	Door width plus 3-inches
DW+2	=	Door width less 2-inches
EB	=	Expansion bolts
TB	=	Toggle bolts
SB	=	Sex bolts
Mfr	=	Manufacturer
WS	=	Weatherstripping, 5/16-inch by 5/8inch closed cell sponge neoprene
F/S	=	Fire seals

HW-1
PAIR EXTERIOR DOORS
DOOR NO. 01 & 02

Per Spec	Hinges		Per Spec
1 Ea.	Lockset	F-20 @ active leaf	Per Spec
1 Ea.	Cylinder	Coordinate w/Owner	Per Spec
1 Ea.	Coordinator	#3093	Per Spec
2 Ea.	Closer	Overhead 110° HO, PMD Coordinate arm with holder	Per Spec
1 Ea.	Automatic bolts	Inactive leaf	Per Spec
2 Ea.	Holders	180°, PMD, coordinate installation with closer	Per Spec
1 Ea.	WS	Head and jambs	Per Spec
1 Ea	Door Bottom	DW-1, PMD, #216AU	Pemko
1 Ea.	Astragal	Exterior of active leaf	Pemko
1 Ea.	Threshold	2005 BS	Pemko

HW-2
SINGLE SWING EXTERIOR DOOR
DOOR NO. 03 & 05

Per Door Mfr.	Hinges	Per Spec
Per Door Mfr.	Compression Seals S-88	Pemko
1 Ea.	Lockset, Lever, F-20	Per Spec
1 Ea.	Closer, Overhead 110	Per Spec
1 Ea.	Bottom of Door Drip DW-2	Pemko 345A
1 Ea.	Threshold, 2005 BS	Pemko

HW-3
SINGLE SWING INTERIOR DOOR
DOOR NO. 04

Per Door Mfr.	Hinges	Per Spec
Per Door Mfr.	Compression Seals S-88	Pemko
1 Ea.	Lockset, Lever, F-20	Per Spec
1 Ea.	Closer, Overhead	Per Spec

3.3 LATCHES AND BOLTS

A. Latches and bolts shall be installed to automatically engage in keepers, whether activated by closers or by manual push. In no case should additional manual pressure be required to engage latch or bolt in keepers.

3.4 CLOSERS AND HINGES

A. Closers and hinges shall be carefully adjusted to operate the doors noiselessly and evenly, and hinges shall be installed so as not to bind. Closers, closer arms, and hold-open arms shall be attached with sex bolts.

B. Except at exterior doors, closers shall not be mounted on corridor or vestibule side of door.

3.5 WEATHERSTRIPPING AND SEALS

A. All doors shall be provided with weatherstripping or seals unless mutes, product weatherstripping or other special seals are specified. Whenever two types of seals are shown on the Finish Hardware Schedule on a given door they both are to be provided.

3.6 PROTECTIVE TAPE AND COATINGS

A. The CONTRACTOR shall provide a strippable coating or removable tape protection or other approved means to prevent any damage or staining of hardware during construction. Such protective measures shall be removed prior to final cleaning and the hardware polished before OWNER'S acceptance of project.

- END OF SECTION -

SECTION 09200 - LATHING AND PLASTERING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide lathing, plastering, stucco, and all related work, complete, all in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

FF-N-105B(3) INT AMD 4	Nails, Brads, Staples and Spikes: Wire, Cut and Wrought
QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated).
UU-B-790A INT AMD 1	Building Paper, Vegetable Fiber, (Kraft, Waterproofed, Water Repellant and Fire Resistant)

B. Commercial Standards

ASTM C 5	Quicklime for Structural Purposes
ASTM C 6 & C 206	Lime
ASTM C 37	Gypsum Lath
ASTM C 150	Portland Cement
ASTM C 206	Finishing Hydrated Lime
ANSI A42.4-1955 & 2.6.73	California Lathing and Plastering Contractors Association, Metal Lath, Wire Lath, Wire Fabric Length and Metal Accessories

C. Trade Standards

1. "Lathing and Plastering Reference Specifications" as compiled by the California Lathing and Plastering Contractor's Association (CLPCA).

D. **Manufacturers' Standards:** In addition to the standards listed above, the lathing and plastering products and their installation shall be in accordance with the manufacturer's published recommendations and specifications.

1.3 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with the requirements of Section 01300 – Contractor Submittals.

B. **Samples:** Samples of integral color exterior plaster shall be submitted for color selection. When requested by the ENGINEER, a 12-inch by 12-inch sample panel of

exterior cement plaster in the selected color(s) shall be submitted for approval. Samples of metal lath, metal furring devices, trim, and plastering accessories shall be submitted for approval.

C. **Manufacturer's Information:** Manufacturer's literature, specifications, installation instructions, technical data, and general recommendations for the lathing and plastering materials shall be submitted.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Manufactured products shall be delivered in original, unbroken, packages, containers or bundles bearing the name of the manufacturer.

B. **Storage:** All products shall be carefully stored as recommended in the Trade Standards in an area that is protected from the elements. Storage shall be in a manner that will prevent damage to the products or marring of their finishes.

PART 2 -- PRODUCTS

2.1 PLASTER MATERIALS

A. **General:** The materials for lath and plaster work shall conform to the applicable requirements of ASTM C 841 and ASTM C 842.

B. **Exterior Plaster:** Exterior plaster surfaces shall be a combination of portland cement scratch and brown coats and prepared integral colored finish coat. Thickness of exterior plaster shall be not less than 7/8-inch.

C. **Plasters:** Plasters shall conform to the following requirements:

1. Cement for portland cement plaster shall be Type I or Type II portland cement as specified in ASTM C 150.

2. Integral colored finish coat plaster shall be factory-prepared, colored plaster, "Finish Coat Portland Cement (Stucco)," complying with ASTM C 150.

3. Lime or hydrated lime shall conform to ASTM C 206 and quicklime shall conform to ASTM C 5. Lime putty shall weigh no less than 33 lb/cu ft and shall be made of hydrated lime or quicklime.

4. Bonding agents shall be a non-water-deteriorating, non-oxidizing, non-crystallizing, liquid, resinous water-emulsion designed for exterior use. Bonding agent shall provide a permanent bond for gypsum, lime putty, cement, or acoustical plaster finishes to gypsum, cement plaster, concrete, masonry, wood, or steel, whether the surfaces are painted or unpainted, old or new, damp or dry. It shall be free from any tendency to harden or craze crack. It shall be non-toxic, vermin proof, and non-combustible. Bonding agents shall be certified to be non-deteriorating as shown by minimum 2 year controlled laboratory test. Bonding agents shall be **"Weldcrete" by Larsan Products Corporation; "Enco Weld" by Enco Products**; or equal.

5. Cement shall conform to ASTM C 61, or Federal Specification SS-C-161A.

6. Finish coat sand for exterior cement plaster finish coat shall be No. 30. Sand for interior cement plaster finish coat shall be No. 200

2.2 METAL LATH AND WIRE PRODUCTS

A. **Rib Lath:** Rib lath shall be 3.4 lb/sq yd with 3/8-inch metal rib and shall be expanded from copper-bearing-steel and coated with rust-inhibitive paint after fabrication. Galvanized metal lath shall be used for construction within 1-mile of oceans.

B. **Flat (or Self-Furring) Diamond Mesh:** Flat or self-furring diamond mesh shall be 3.4 lb/sq yd and shall be expanded from copper-bearing steel sheets either coated with rust-inhibitive paint or hot-dip galvanized after fabrication.

C. **Welded Wire Fabric:** Welded wire fabric, with backing, shall be fabricated from minimum 16-gage galvanized wire, with openings not to exceed 2-inch by 2-inch, and welded at all intersections. Backing shall comply with Federal Specifications UU-B-790A, Int. Amd. 1.

D. **Paper Backing (Weather-Resistive Barrier):** Paper backing for use as a weather-resistive barrier with metal plaster bases shall comply with Federal Specifications UU-B-790A, Int. Amd. 1, Class B or UBC Standard 17-1, Class B. It shall be either Building Paper or Vegetable Fiber which is waterproofed, water repellent, and fire resistant and of the style and grade applicable or specified for the intended use. Paper shall be securely held in place by or attached to the metal plaster base. Paper shall permit full 1/8-inch plaster embedment, for not less than 1/2 of the total length of the wire strands and 1/2 of the total weight of the metal.

2.3 ACCESSORIES

A. Metal and welded wire shapes used as base screeds, casing beads, ventilating screeds, weep screeds, control joints, etc., shall be of such size and dimension as to provide for the full required plaster thickness. Accessories shall be fabricated of minimum 24-gage galvanized steel or minimum 19-gage galvanized wire.

1. Corner beads, control joints, and ventilating expansion screed with short or expanded flanges shall be fabricated from minimum 26-gage galvanized steel.

2. Drip screed or weep screed and casing beads shall be fabricated from minimum 24-gage galvanized steel.

3. Expansion joint trim shall be either No. J-4-U by Superior; No. 40 by Inryco; or equal.

4. External corner reinforcement for Portland cement plaster applications shall be fabricated either from large-opening, expanded metal or from welded, minimum 18-gage, copper-bearing wire and shall be galvanized after fabrication.

5. Extruded aluminum vent screeds and reveal shall be as specified or shown.

2.4 MISCELLANEOUS MATERIALS

A. **Nails:** Nails shall conform to Federal Specifications FF-N-105B(3) Int. Amd. 4.

B. **Staples:** Staples shall be USS 14-gage, flattened, galvanized wire staples conforming to Federal Specifications FF-N-105B(3) Int. Amd. 4.

C. **Unspecified Materials:** Unspecified materials and fasteners shall meet or exceed the requirements of UBC and other referenced standards. In case of conflict, the most stringent requirements shall govern.

PART 3 -- EXECUTION

3.1 GENERAL

A. The application and finishing of lath and plaster work shall conform to the applicable requirements of ASTM C 842 and ASTM C 841 and other referenced standards.

3.2 INSTALLATION

A. **General:** The applied methods procedures and materials shall reflect job conditions such as temperature, humidity, ventilation, and surface type and condition and shall conform to the requirements of the referenced specifications, codes, and standards.

B. **Metal Accessories:** Metal accessories shall be set plumb, level, and true and shall be shimmed where necessary for a true, tight, and secure application. Corners shall be mitered and exposed joints shall be accurately and tightly fitted. Sections shall be installed in the maximum practical lengths and splices shall be held to a minimum. Corner beads and casing beads shall be securely fastened at spacings of not more than 12 inches.

C. **Edges and Boundaries:** All plaster surfaces shall be finished to metal casings, sheet metal shapes, or wood grounds. (Wood grounds may be used only where covered by other finish work.) Where joining other materials in locations exposed to view, the edges or boundaries of all plaster surfaces shall be finished with metal casing beads.

3.3 PLASTER FINISHES

A. **Exterior:** Exterior (Stucco) plaster finish texture shall be float finish, as indicated in the referenced standards, and approved by the ENGINEER, unless otherwise specified or shown.

B. **Cement:** Cement plaster shall be given a fine float finish.

C. **Keene's Cement:** Keene's cement plaster shall have a smooth, putty coat finish.

- END OF SECTION -

SECTION 09250 - GYPSUM BOARD

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide gypsum board and appurtenances, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

B. Commercial Standards

ASTM C 36	Gypsum Wallboard
ASTM C 475	Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 754	Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM D 2626	Asphalt – Saturated and Coated Organic Felt Base Sheet Used in Roofing
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials

C. Trade Standards

GA-203-71 (Gypsum Assn.)	Installation of Screw-Type Steel Framing Members to Receive Gypsum Board
GA-216-85 (Gypsum Assn.)	Recommended Specifications for the Application and Finishing of Gypsum Board
GA-600-78 (Gypsum Assn.)	Fire Resistance Manual

D. **Manufacturers' Standards:** In addition to the standards listed above, gypsum board products and their installation shall be in accordance with the manufacturer's published recommendations and specifications.

1.3 CONTRACTOR SUBMITTALS

A. Manufacturers' literature, installation instructions, and samples of metal trim and furring devices shall be submitted in accordance with Section 01300 - Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Labelling:** Fire-rated materials shall bear testing agency labels and required fire classification numbers.

2.2 GYPSUM BOARD

A. **General:** Gypsum board shall be fire-rated unless otherwise indicated.

B. **Gypsum Wall Board:** Gypsum wall board shall be 5/8-inch thick with tapered edges unless otherwise indicated.

1. Regular gypsum boards shall conform to ASTM C 36, unless otherwise indicated.

2. Fire-rated gypsum board shall conform to ASTM C 36, type "x", unless otherwise indicated.

C. Manufacturers, or Equal

1. **Flintkote Co.**

2. **Laticrete International**

3. **National Gypsum Co.**

4. **United States Gypsum Co.**

2.3 TAPE AND COMPOUND

A. Joint reinforcing tape and joint compound shall conform to ASTM C 475.

2.4 FASTENERS

A. Nails shall conform to ASTM C 514 and shall be of the length recommended by the Gypsum Association referenced standards and the Building Code for various gypsum board thicknesses. Nails for nailing tile backing board to wood studs shall be 1-1/4 inch galvanized roofing nails unless otherwise required by code and board manufacturer.

B. Screws shall be self-drilling, self-tapping, bugle head for use with power tools, length as recommended by Gypsum Association referenced standards and the Building Code.

1. Type "S" for board to sheet metal application.

2. Type "W" for board to wood application.

3. Type "G" for board to board application.

4. Type "S" or "S-12", 1-1/4-inch for tile backing board to metal studs application.

C. Resilient channels shall be metal channels designed for use with sound wall construction. They shall be as recommended and approved by the gypsum board manufacturer and code.

2.5 ADHESIVES

A. Adhesives for fastening gypsum board to gypsum board shall be in accordance with the printed recommendations of the gypsum board manufacturer.

2.6 ACCESSORIES

A. Metal trim, corner beads, edge, casing beads, and accessories shall be manufactured from galvanized sheet steel unless otherwise indicated and shall be manufacturer's standard products. Special shapes shall be provided where indicated.

2.7 ACCESS PANELS

A. Access panels shall be provided where indicated and/or where required for access to valves and equipment. Access panels shall be **MILCOR "Type DW", BOICE "Type C",** or equal, for flush installation. Cylinder locks shall be provided where indicated.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. **Delivery of Materials:** Manufactured materials shall be delivered in original unbroken packages, containers, or bundles bearing the manufacturer's label with manufacturer's name and product description and rating intact and legible.

B. **Storage:** Materials shall be carefully stored in an area which is protected from the elements in a manner recommended by the material manufacturer. Storage shall be in a manner that will prevent damage to the material and its finish.

3.2 GENERAL

A. Provide gypsum board over framing and furring.

B. Gypsum board installation and fire-rated gypsum wallboard construction shall conform to applicable codes, reference standards, manufacturers' printed recommendations, and Gypsum Association's printed recommendations.

1. Gypsum board shall be screw fastened to metal framing and furring and/or nail or screw fastened to wood framing and furring. Fastener spacing shall be per reference standards.

2. Gypsum wallboard surface finish shall be three coat work.

3.3 INSTALLATION OF METAL ACCESSORIES

A. Metal edge trim shall be applied at all discontinued edges, where abutting with another material, and where indicated. Corner beads shall be applied at all exterior corners.

B. Metal accessories shall be set plumb, level, and true and shall be shimmed where necessary. The accessories shall be mitered at corners; exposed joints shall be accurately and tightly fitted. Sections shall be installed in lengths as long as practicable, and splices shall be held to a minimum.

C. Accessories, trim, and beads shall be securely fastened to framing members.

3.4 EDGE SEALING

A. Cut, broken, or exposed edges of moisture-resistant gypsum board shall be sealed with a sealer recommended in the printed standards of the gypsum board manufacturer.

3.5 SURFACE FINISH

A. Gypsum board joints shall be taped, and all joints, end trim, corner beads, fastener, and other depressions shall be treated with joint and finishing compounds applied per manufacturer's printed recommendations for three coat work.

B. The gypsum board shall be sanded smooth, dusted, and provided with a textured orange peel finish coat.

- END OF SECTION -

SECTION 09800 - PROTECTIVE COATING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

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, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness, without any negative tolerance.

C. The following surfaces shall not be protective coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

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, unless specifically indicated to be coated.

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 or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

E. Where protective coatings are to be performed by a subcontractor, the subcontractor shall provide 5 references which show that the painting subcontractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the painting subcontractor provided the protective coating.

F. **Architectural Coatings:** Wood, drywall and plaster surfaces shall be coated in accordance with Section 09900 - Architectural Paint Finishes. All other surfaces of buildings shall be coated as indicated in this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals, unless indicated otherwise below.

B. Submittals shall include the following information and be submitted at least 30 days prior to protective coating work:

1. Coating Materials List: Eight copies of a coating materials list showing the Manufacturer and the coating number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submittal of samples.

2. Paint Manufacturer's Information: For each coating system to be used, the following data:

a. Paint Manufacturer's data sheet for each product proposed, 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. Paint Manufacturer's instructions and recommendations on surface preparation and application.

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.

C. Samples

1. Samples of all paint, finishes, and other coating materials shall be submitted on 8-1/2-inch by 11-inch sheet metal. Each sheet 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 ENGINEER 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 ENGINEER. The color formula shall be shown on the back of each color sample.

3. One fifteen pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

1.3 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. **Warranty Inspection:** 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 is not relieved of its responsibilities under the Contract Documents.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Suitability:** The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. **Material Sources:** Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does comply. Unless indicated otherwise, proposed substitute materials will be considered as indicated above. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. **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.

D. **Containers:** Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. **Colors:** All colors and shades of colors of all coats of paint shall be as indicated or selected by the ENGINEER. 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 ENGINEER.

F. Substitute or "Or-Equal" Products

1. To establish equality under Section 01600 - Products, Materials, Equipment and Substitutions, the CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better 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

2. 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 ENGINEER with the names of not less than 10 successful applications of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear all such costs involved as part of the WORK.

2.2 INDUSTRIAL COATING SYSTEMS

A. **System 1 - Not Used**

B. **System 2 - Not Used**

C. **System 3 - Not Used**

D. **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, **Ameron 385, Carboline 893, Tnemec 69**, or equal.

2. Finish coat (one or more, DFT = 3 mils), **Ameron 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.

E. **System 5 - Not Used**

F. **System 6 - Not Used**

G. **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.

H. **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 coats (2 or more, DFT = 6 mils), **Ameron 385, Tnemec 69,** or equal.

4. Total system DFT = 9 mils.

I. **System 9 - Not Used**

J. **System 10 - Acrylic, Concrete:** The acrylic coating material shall be a single component, industrial grade, high molecular weight, waterborne acrylic material with a solids content of at least 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 surfacer 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.

K. **System 11 - Aliphatic Polyurethane, Concrete:** Two component aliphatic 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 contain 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 is 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.

L. **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 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 will be considered as indicated above.

B. **System 100 - Amine Cured Epoxy:** High build, amine cured, 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 municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61 - Drinking Water System Components - Health Effects.

1. Prime coat and finish coats (3 or more, DFT = 16 mils), **Ameron 395, Tnemec 139,** or equal.

2. For coating of valves and non-submerged equipment, DFT = 12 mils.

C. **System 101 - Not Used**

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 - Not Used**

F. **System 104 - Not Used**

G. **System 105 - Not Used**

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 - 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 or 206N,** or equal.

2. For coating of valves, DFT - 12 mils.

3. Liquid Epoxy: For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the powder epoxy manufacturer.

I. **System 107 - Not Used**

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 80 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. A 100 percent solids epoxy surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Filler-sealer: Plasite 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 (2 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 - Not Used**

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 - Not Used**

D. **System 204 - Not Used**

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, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all edges and joints 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 - Not Used**

J. **System 210 - Not Used**

K. **System 211 - Not Used**

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as may be necessary to resolve field problems attributable or associated with the manufacturer's products.

3.2 WORKMANSHIP

A. Skilled craftsmen and experienced 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 surfaces resulting from the WORK shall be cleaned, repaired, and refinished to original condition.

3.3 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.

3.4 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 that 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 coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

3.5 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.

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.

3.6 METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated 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 higher 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 Grit.

C. All oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC-SP1 - Solvent Cleaning 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 coating manufacturer's recommendation for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.

F. The abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

G. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

H. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

I. 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.

J. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

K. Damaged or defective coating shall be removed by the specified blast cleaning to meet the clean surface requirements before recoating.

L. 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 be used.

M. Shop applied coatings of unknown composition shall be completely removed before the indicated 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.

N. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

3.7 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.

3.8 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 indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC-SP6. Areas of tightly adhering coatings shall be cleaned to SSPC-SP7, 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 indicated 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 specified 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.

3.9 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.

3.10 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.

3.11 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.

3.12 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, all 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 selected 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. The interior surfaces of steel water reservoirs, except for Part A surfaces, shall have all surface preparation and coating work performed in the field.

D. 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 indicated 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.

E. For certain small pieces of equipment the manufacturer may have a standard coating system that 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.

F. 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 being topcoated, or less time if recommended by the coating manufacturer.

G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

H. 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.

3.13 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC-PA1 - Paint Application Specification No. 1.

B. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the ENGINEER 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 that 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 that 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 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. Unburied 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.

3.14 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 most 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.

3.15 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 15005 - 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 OSHA Occupational Safety and Health Standards 29CFR1910.1200.

C. All unburied pipes in structures and in chemical pipe trenches shall be color-code painted. Colors shall be as selected by the ENGINEER, or as indicated.

3.16 SHOP AND FIELD INSPECTION AND TESTING

A. General: The CONTRACTOR shall give the ENGINEER 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 ENGINEER, unless the ENGINEER has granted prior approval to perform such work in its absence.

C. Inspection by the ENGINEER, 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 ENGINEER 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 gages shall be made available for the ENGINEER'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 ENGINEER.

F. **Holiday Testing:** The CONTRACTOR shall holiday test all coated ferrous surfaces inside a steel reservoir, 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 that contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested.

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 specified 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 gage 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 gage.

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 standards TM-01-70 and TM-01-75.

3.17 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	(4) aliphatic polyurethane
FM-2	Surfaces in chemical storage room.	Commercial blast cleaning SSPC-SP6	(100) amine-cured epoxy
FM-3	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in potable water, utility water, and wastewater including all surfaces lower than 2 feet above high water level in hydraulic structures, 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-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	(102) polyamide-cured epoxy
FM-8	Where indicated, ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4 inches or larger.	White metal blast cleaning SSPC-SP5	(100) amine-cured epoxy
FM-9	**Ferrous surfaces of sleeve-couplings and interior surfaces of above-grade steel pipe wellhead facilities.**	Solvent cleaning SSPC-SP1, followed by white metal blast cleaning SSPC-SP10	(106) fusion-bonded epoxy
FM-10	All ferrous surfaces of sluice gates, flap gates, and shear gates, including wall thimbles.	White metal blast cleaning SSPC-SP5	(102) polyamide-cured epoxy
FM-11	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC-SP10	(100) amine-cured epoxy
FM-16	**Surfaces of indoor equipment not submerged and exterior surfaces of above-grade steel pipe wellhead facilities.**	Commercial blast cleaning SSPC-SP6	(8) epoxy, equipment
FM-18	Buried pipe couplings, valves, fittings, and flanged joints (where piping is plastic).	Removal of dirt, grease, oil	(201) rich portland cement mortar
FM-19	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement

FM-20	Buried pipe couplings, valves, and flanged joints (where piping is mortar-coated steel or reinforced concrete), including factory-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 shall be coated except for the following items which shall be coated only if 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	(4) aliphatic polyurethane
FMG-2	Surfaces in chemical storage room.	Solvent cleaning SSPC-SP1	(100) amine-cured epoxy
FMG-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FMG-4	Surfaces buried or submerged in water or wastewater, including all surfaces lower than two feet above high water level and all surfaces inside enclosed hydraulic structures and vents.	Solvent cleaning SSPC-SP1 followed by brush-off grade blast cleaning SSPC-SP7	(100) amine-cured epoxy

3.18 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	(4) aliphatic polyurethane
NFM-2	Chlorination room, chlorine storage room.	Solvent cleaned SSPC-SP1	(100) amine-cured epoxy

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 3.10	(12) aliphatic polyurethane fiber glass

3.19 COATING SYSTEM SCHEDULE - CONCRETE

	Item	**Surface Prep.**	**System No.**
C-3	Floor slab and walls, exposure to chemicals, where indicated	Per paragraph 3.9	(108) epoxy, concrete

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SECTION 09900 - ARCHITECTURAL PAINT FINISHES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall paint surfaces not specifically included under the requirements of Section 09800 - Protective Coating, in accordance with the requirements of this Section and the Contract Documents.

B. Surfaces listed in the coating schedule of Section 09800 shall be deemed to be surfaces requiring coating under that Section, not this Section. In case of conflict between the provisions of the Protective Coating Section and the Architectural Paint Finishes Section, the provisions of Section 09800 shall take precedence.

C. Materials not to be painted hereunder shall include the following:

1. Work having complete factory finish other than prime coat.

2. Surfaces whose coatings are for the specific purpose of protection from abrasion, wear and tear, or from corrosion, oxidation, decomposition, or other effects of exposure.

3. Stainless steel, aluminum brass, bronze, and plated finished metals (not zinc or cadmium).

4. Finish hardware except prime-coated items, and fusible links, UL labels, nameplates, numbers, and identifying data.

5. Walking surfaces.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. In case of conflict between codes, reference standards, and the Contract Documents, the most stringent requirements shall govern. Conflicts shall be brought to the attention of the ENGINEER for clarification and directions prior to ordering or providing any materials or labor.

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **List of Paint Materials:** Prior to submittal of color and gloss samples, the CONTRACTOR shall submit for acceptance, a complete list of all paint materials proposed for use, identifying each material by manufacturer's name, product name, and number. The list shall include all primers, thinners, and coloring agents, together with manufacturer's catalog data fully describing each material as to contents, recommended usage, and preparation and application methods. The CONTRACTOR shall identify surfaces to receive various paint materials and shall make no deviations from accepted list. The list shall be submitted within 60 days after execution of the Agreement.

C. Color samples and stain samples shall be submitted as required by the ENGINEER. Stain samples shall be provided on the same substrate as the stain will be applied in the final installation.

D. **Extra Stock:** Upon completion of the project, the CONTRACTOR shall furnish one gallon or quart of each type and color of paint, depending on quantity used on the project.

1.4 QUALITY ASSURANCE

A. The CONTRACTOR shall verify with the authorities having jurisdiction over air pollution control, the use of any materials containing organic chemical compounds of which use at the date of installation may be prohibited or restricted by any regulations then in effect.

B. Materials shall be subject to such tests as the ENGINEER may require. Costs of such testing shall be paid according to the General Conditions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The paint materials shall be delivered to the Site in the manufacturer's unopened containers. A list of all batch numbers shall be furnished to the ENGINEER prior to the start of work.

B. Stored paints and liquids shall be kept covered, and precautions shall be taken for the prevention of fire. Empty containers and paint-soiled or oily rags shall be removed from the Site at the end of each day's work. Paint thinner shall not be stored in a room scheduled to receive resilient flooring.

1.6 ATMOSPHERIC CONDITIONS

A. No coating shall be applied:

1. when the surrounding air temperature or the temperature of the surface to be coated is below 40 degrees F

2. to wet or damp surfaces or in rain, fog or mist

3. when the temperature is less than 5 degrees F above the dewpoint

4. when it is expected the air temperature will drop below 40 degrees F, or less than 5 degrees F above the dewpoint within 8 hours after application of coating. Dewpoint shall be measured by use of a sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau psychrometric tables.

1.7 SAFETY AND HEALTH REGULATIONS

A. **General:** In accordance with requirements of OSHA Safety and Health Standards for Construction (29CFR1926) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions and appropriate technical bulletins and manuals, the CONTRACTOR shall provide and require use of personnel protective equipment for persons working in or about the Site.

B. **Head and Face Protection and Respiratory Devices:** Equipment shall include protective helmets which shall be worn by all persons while in the vicinity of the WORK.

In addition, workers engaged in or near the work during sandblasting shall wear OSHA approved eye and face protection devices and air purifying, halfmask or mouthpiece respirators. Barrier creams may be used on any exposed areas of skin.

C. **Ventilation:** Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Forced air ventilation shall be provided to reduce the concentration of air contaminant to a safe limit. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. **Sound Levels:** Whenever the occupational noise exposure exceeds maximum allowable sound levels, the CONTRACTOR shall implement a Hearing Conservation Program including furnishing and requiring the use of approved ear protective devices.

E. **Illumination:** Adequate illumination shall be provided while work is in progress, which may include explosion-proof lights and electrical equipment. Whenever required by the ENGINEER, the CONTRACTOR shall provide additional illumination to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the ENGINEER.

F. **Temporary Ladders and Scaffolding:** All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the ENGINEER to facilitate inspection and shall be moved by the CONTRACTOR to locations as requested by the ENGINEER.

1.8 CLEANUP

A. Upon completion of the work, staging, scaffolding, and containers shall be removed from the Site. Coating spots and oil or stain upon adjacent surfaces shall be removed. Damage to adjacent surfaces or facilities resulting from the WORK performed under this Section shall be cleaned, repaired, or refinished to the satisfaction of the ENGINEER.

1.9 WARRANTY INSPECTION

A. A warranty inspection shall be conducted during the eleventh month following completion of painting work. The CONTRACTOR or its authorized representative shall attend this inspection. Defective work shall be repaired in accordance with the requirements of the Contract Documents and to the satisfaction of the OWNER. The OWNER may, by written notice to the CONTRACTOR, reschedule the warranty inspection within the correction of defects period, or may cancel the warranty inspection altogether.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Where alternative painting systems are indicated, selection from the alternatives is the CONTRACTOR's option.

B. The CONTRACTOR may propose to use substitute paint materials under the requirements of the Contract Documents.

C. Unless otherwise approved by the ENGINEER in writing, coatings applied under a single paint system shall be the products of a single manufacturer.

2.2 FACTORY MIXING

A. To the maximum extent practicable and, unless otherwise approved by the ENGINEER, each paint shall be factory-mixed to the specified color, gloss, and consistency required for application.

2.3 MATERIALS LIST

A. All paint materials shall be of the following grades or brands, or equals, in each case:

PRIMERS

Symbol	Generic Group	Trade Name
P1	Masonry Prime Coat Waterproofing (VOC Compliant for use in California)	**Tamms Industries Co., "Barracade M.E."** **Rainguard products co., "Rainguard Microseal"**
P2	Pigmented Wall Primer and Sealer	**Pittsburgh Speedhide Primer Sealer** **SW Wall Primer and Sealer B49W1** **Sinclair Pigmented Sealer**
P3	Pigmented Vinyl Primer	**Pittsburgh Speedhide Vinyl Primer, Pigmented** **SW Promar Latex Pigmented Wall Primer B28W1 Sinclair Pigmented PVA Sealer**
P4	Exterior Wood Primer	**Pittsburgh Exterior Wood Primer B46W31** **Sinclair Exterior Wood Primer**
P-5	Enamel Undercoater	**Pittsburgh Speedhide Enamel Undercoater SW Enamel Undercoater B49W2** **Sinclair Sinco Prime Undercoater**
P-6	Clear Primer-Sealer	**Pittsburgh REZ Clear Primer-Sealer** **Sinclair Clear Primer-Sealer**
P-7	Wood Waterproofing	**Chemstop Wood Waterproofing** **Houston Chemical Co., No. 3 Waterproofing**
P-8	Semi-Transparent Stain	**Pittsburgh REZ Semi-Transparent Stain** **SW Exterior Semi-Transparent Stain A14** **Sinclair Stainteke Semi-Transparent Stain**

Symbol	Generic Group	Trade Name
F1	Latex Flat Wall Paint	**Pittsburgh Speedhide Latex Flat Wall** **SW Promar Latex Flat Wall B30 Series** **Sinclair Sinwall Vinyl Latex**
F2	Semi-Gloss Alkyd Enamel	**Pittsburgh Speedhide Semi-Gloss Enamel** **SW Promar Alkyd Semi-Gross Enamel B34 Series** **Sinclair Sinco Satin Enamel**
F3	Exterior Latex Finish	**Pittsburgh Speedhide Semi-Gloss Enamel** **SW Promar Exterior Latex B36 Series** **Sinclair Plast-O-Life**
F4	Gloss Alkyd Enamel	**Pittsburgh Speedhide Exterior Wood Finish** **SW Promar Gloss Alkyd Enamel** **Sinclair Avalon Gloss**

2.4 PAINTING SCHEDULE

A. Painting shall conform to the following schedule of finishes, number of coats, and pretreatment requirements. Paint materials are keyed to the identifying numbers listed above.

Item	1st Coat	2nd Coat	3rd Coat	4th Coat
EXTERIOR WORK:				
Exterior Concrete Block Masonry, Waterproofing	P1	P1	--	--
Exterior Wood, Flat	P4	F3	F3	--
Exterior Wood, Sealer	P7	--	--	--
INTERIOR WORK:				
Interior Drywall, Semi-Gloss	P3	F2	F2	--
Interior Wood, Semi-Gloss	P5	F2	F2	--

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. **Workmanship:** Unless otherwise indicated, paint materials shall be applied by brush or roller in strict accordance with the manufacturer's printed instructions. Spray painting is not allowed without specific approval in each case. Each coat shall be applied at proper

consistency, and shall be free of brush or roller marks, sags, runs, or any other evidence of poor workmanship. The splattering of paint on glass, hardware, tile, trim, and other surfaces not to be painted will not be accepted. Masking tape shall be applied as required. The CONTRACTOR shall sand between all enamel coats.

B. **Coverage Rates:** In no case shall paint application exceed the paint manufacturer's published coverage rate based upon unthinned material. In the event that paint has been extended beyond the recommended coverage, or the "hide" produced is inadequate, as determined by the ENGINEER, the CONTRACTOR shall apply one or more additional coats as determined by the ENGINEER. The manufacturer's recommended amount of thinner shall not be exceeded. Unless otherwise approved, finish coat material shall be applied as taken from manufacturer's container.

C. **Protection:** Floors, fixtures, equipment, and similar surfaces shall be protected with impervious protective covers and/or drop cloths.

D. **Barricades:** The CONTRACTOR shall maintain barricades and wet paint signs for duration of time needed.

E. **Scaffolds:** The CONTRACTOR shall furnish and move scaffolds, staging, and planking as necessary for proper performance of work.

3.2 PREPARATION

A. **General:** The CONTRACTOR shall properly prepare surfaces to receive finishes as indicated.

B. **Woodwork:** The preparation of the surfaces of woodwork to receive paint shall conform to the following requirements:

1. Painted surfaces shall be sanded smooth and dusted clean. Nail holes, cracks, or other defects shall be carefully puttied after prime coat using putty which matches the color of the paint. Knots and sappy areas shall be covered with shellac or accepted knot sealer.

2. Putty work shall be knifed as indicated, thumb puttying is not allowed. On painted and enameled work, exposed end grain shall be putty-glazed smooth and flush, and shall be allowed to dry before the next coat.

C. **Ferrous and Galvanized Metal:** Ferrous metal surfaces shall be cleaned of rust, scale, grease, oil, and other deleterious matter by wire brushing, scraping, washing with solvent, sandblasting, or other means necessary to properly prepare surfaces for painting. Shop painted ferrous metal surfaces that show rusting when initially installed shall be touched up with a rust inhibitor similar to **Porter Metalprep No. 40** or an equal. Rust inhibitor shall meet the requirements of MIL-M-10578B for Phosphoric Acid rust inhibitor, and shall be applied only after wire brushing to a sound surface, and then coated with a compatible universal primer. Galvanized metals shall be cleaned with suitable organic solvent.

3.3 APPLICATION

A. **General:** Paint shall not be applied in extreme heat, nor in dust or smoke laden air, nor in damp or humid weather.

B. Drying times shall be not less than called for in manufacturer's printed instructions.

C. Drop cloths shall be placed where required to protect floors and equipment from splatter and droppings.

D. Spray painting, where allowed, shall be conducted under controlled conditions, and the CONTRACTOR shall be fully responsible for any damage to adjacent WORK or adjoining property occurring from spray painting.

E. Each coat will be inspected by the ENGINEER prior to application of the next coat. Areas found to contain runs, overspray, roughness, or other signs of improper application shall be required to be recoated in accordance with the ENGINEER's instructions.

F. The CONTRACTOR shall apply complete paint system required for exposed surfaces behind permanent cabinets, cases, counters, and similar work before such items are installed.

G. **Coats and Colors:** The number of coats indicated are minimums only. Paint finishes shall be even, of uniform color, and free from cloudy or mottled appearance in surfaces and evident thinness of coatings. Each coat shall be tinted a sufficiently different shade of finish color to permit identification, in accordance with accepted samples.

3.4 OUTLINE OF PAINTING AND FINISHING WORK

A. **Exterior:** In general, all exposed exterior surfaces of the building shall be painted and finished in accordance with the requirements herein for paint materials and surfaces. Exposed surfaces of miscellaneous metal, sheet metal items, mechanical equipment, and all other items, as required, shall be painted with the required primers and coats of paint.

B. **Interior:** In general, exposed surfaces of the building shall be painted and finished in accordance with the requirements herein for paint and finish materials and surface:

1. Exposed surfaces of gypsum wallboard, doors and frames, shall be primed and painted.

2. Metal items in partitions and ceilings such as registers, grilles, and similar items shall be painted to match finish of room or area in which they occur, unless directed otherwise by the ENGINEER.

3. Painted doors opening into rooms or spaces having different finishes or colors shall have the edges finished as directed by the ENGINEER.

C. **Mechanical and Electrical Work:** Mechanical and electrical products requiring painting shall conform to the requirements of Section 09800 except for the following:

1. Areas behind grilles, baffles, ventilators, and louvers: exposed surfaces, not factory finished, visible from inside and outside of the building shall be painted with appropriate primers and one coat of black semi-gloss (low sheen) enamel paint far enough to conceal such areas and spaces when looking towards them from the floor and ground levels.

2. Pipe identification shall be in accordance with Section 15005.

3.5 ADJUSTMENT AND CLEANING

A. **General:** The CONTRACTOR shall make a detailed inspection of paint finishes after painting work has been completed, and shall carefully remove splatterings of paint material from adjoining work, particularly plumbing fixtures, trim, tile, and finish metal surfaces and shall make good any damage thereto that may be caused by such cleaning operations. The CONTRACTOR shall carefully touch-up all abraded, stained, or otherwise disfigured painting work and shall leave the entire painting work in first-class condition.

B. **Clean-up and Disposal:** During and upon completion of WORK, the CONTRACTOR shall remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work of this section in clean approved condition in accordance with the requirements of Section 01700 - Project Closeout.

- END OF SECTION -

SECTION 10400 - IDENTIFYING DEVICES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide signs and other identifying devices and appurtenant work, complete and in place, in accordance with the Contract Documents.

B. This Section applies to all equipment, unless indicated otherwise in the equipment sections.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Full-size or scaled layouts of signs showing sign size, color, fasteners and mounting, and location. A typical of repetitive sign layouts may be submitted. Most restrictive conditions shall be depicted.

C. **Samples:** Samples of all the materials and colors proposed for the WORK, clearly marked to show the manufacturer's name and product identification along with the manufacturer's technical data and application instructions.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Identification devices shall be installed where directed by the ENGINEER. Wording shall be as indicated and shall be verified before fabrication.

2.2 ARCHITECTURAL NAMEPLATES

A. Nameplates shall be **Builders Brass Works, Vomar Products, Inc.,** or equal, with colored 1/8-inch acrylic plastic (matte finish). Lettering shall be white, 1/2-inch high, or 36 points, and be fused by heat and pressure to a depth of approximately 0.005-inch. Plates shall be installed in an extruded aluminum frame, medium bronze or dark anodized finish, and be provided with 2-way adhesive mounting tape. Plastic color and letter style shall be as selected by the ENGINEER.

B. Nameplate Schedule

Room	Name on Plate
101	Pump Room
102	Sodium Hypochlorite
103	Motor Control Center

2.3 EQUIPMENT NAMETAGS

A. **Small Equipment, as defined in Section 11000 – Equipment General:** 1/16 inch thick acrylic plastic with matte finish, color selected by the ENGINEER. Letters shall be white, 1/2- inch tall, embossed and fused by heat and pressure into the material. Lettering shall be the equipment number in the Contract Documents.

B. Large Equipment per Section 11000

1. Stainless steel plate, 1/16-inch thick, at least 4-inches by 6 inches, lettering embossed into the plate, at least 1-inch tall.

2. Lettering stenciled directly onto the equipment, in letter size and color determined by the ENGINEER. Furnish the proposed wording to the ENGINEER for approval.

C. The ENGINEER will determine the location for all equipment nametags and the methods of attachment.

2.4 SIGNS

A. **General:** Signs or warnings shall be enamel painted on semi-rigid butyrate. Signs shall conform to OSHA Standards and directions. Lettering sizes shall be 3-inch in height unless indicated otherwise.

B. The following sign shall be provided on interior side of doors 01, 02,03, 04

EXIT

C. The following sign shall be provided on all hose bibbs where water is non-potable:

CAUTION
NON-POTABLE WATER
DO NOT DRINK

D. Automatic startup: all pumps and equipment which can be started either automatically or remotely shall have the following sign attached:

WARNING
THIS PIECE OF EQUIPMENT
MAY START AUTOMATICALLY

2.5 ADDRESS NUMBERS

A. **Metal:** Numbers shall be as manufactured by **"Metal Arts"**, or approved equal. Numbers shall be 8-inch cast metal oxidized bronze finish #60, in the **"Futura"** design. Letters shall be provided complete with fasteners for concrete block wall installation at the locations indicated.

2.6 NFPA PLACARD

A. Placard shall be located at the exterior wall of the Chemical Storage Room, as required by OSHA Hazard Communication Standard and the National Fire Protection Association (NFPA) hazardous material classification system. The placard shall be a 15 inch by 15 inch aluminum diamond panel system, with four 6 inch by 6 inch sub-diamonds zones.

Anchorage devices shall be as required for the signage to be removable, for application to the concrete masonry wall.

B. Placard shall be as manufactured by; **“Emedco”, “California Safety & Cleanroom”, “Saf-T-Gard International, Inc.”, (800) 548-4273,** or approved equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installations of identifying devices shall be vandal-resistant. Fasteners shall be concealed, non-corrosive fasteners appropriate for materials being fastened and as required.

3.2 LETTERS

A. Installation of metal letters shall be 3/4-inch projection mounted from concrete block wall surface with threaded studs and space collars. Letters shall be installed per manufacturer's published instructions.

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SECTION 10520 - FIRE PROTECTION SPECIALTIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide fire protection equipment and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

B. All fire protection equipment shall be products of a single manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

1. National Fire Protection Association publications (NFPA), as referenced herein.

2. Uniform Fire Code (UFC) as published by the Western Fire Chiefs Association, Inc. and the International Conference of Building Officials.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Literature:** Manufacturer's literature, installation instructions, and details shall be submitted.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Fire prevention equipment and installation shall comply with the Code, NFPA Pamphlet No 10, and the manufacturer's published recommendations and specifications.

2.2 MATERIALS

A. **Fire Extinguisher Designated FE-2:** FE-2 fire extinguishers shall be 20-pound minimum capacity, A.B.C. dry-chemical type with minimum UL rating of 20A:120BC.

B. **Fire Extinguisher Designated FE-3:** FE-3 fire extinguishers shall be 10-pound minimum capacity, Carbon Dioxide type with minimum UL rating of 10B:C.

C. **Bracket:** Mounting brackets shall be specially designed for extinguisher.

D. **Other Materials:** All other materials, not specifically described but required for a complete and proper installation of fire fighting devices shall be as selected by the CONTRACTOR, subject to the review of the ENGINEER.

2.3 MANUFACTURERS

A. Fire protection items shall be from the following manufacturers, or equal:

1. **Larsen's Manufacturing Co.**

2. **Potter-Roemer**

3. **General Fire Extinguisher Co.**

PART 3 -- EXECUTION

3.1 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 with manufacturer's name, product description, and rating.

B. **Storage:** All materials shall be carefully stored in an area which is protected from deleterious elements as recommended by the material manufacturer. Storage shall be in a manner that will prevent damage to the material and its finish.

3.2 LOCATIONS AND INSTALLATION

A. **Locations:** Fire prevention equipment locations and mounting heights shall be verified with the Fire Marshall before installation and shall be installed where directed. If locations are not directed by the Fire Marshall, the ENGINEER will direct locations.

B. **Installation:** Installation shall be per NFPA Pamphlet No. 10 unless directed otherwise by the local Fire Marshall.

C. **Brackets:** All fire extinguishers shall be provided with and installed on brackets or brackets within cabinets. The CONTRACTOR shall block and reinforce walls to support the fire extinguishers.

- END OF SECTION -

SECTION 11000 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all equipment and appurtenant work, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all equipment except where otherwise indicated.

C. **Equipment Arrangement:** Unless specifically indicated otherwise, the arrangement of equipment shown on the Drawings is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer in all cases. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:

1. American Society for Testing and Materials (ASTM).

2. American National Standards Institute (ANSI).

3. American Society of Mechanical Engineers (ASME).

4. American Water Works Association (AWWA).

5. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

6. American Welding Society (AWS).

7. National Fire Protection Association (NFPA).

8. Federal Specifications (FS).

9. National Electrical Manufacturers Association (NEMA).

10. Manufacturer's published recommendations and specifications.

11. General Industry Safety Orders (OSHA).

B. The following standards are referenced in 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
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.

C. **Spare Parts List:** The CONTRACTOR shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

D. Torsion and Vibration Analyses

1. The CONTRACTOR shall arrange for and submit torsional and lateral vibration analyses for the following equipment types:

   a. Engine drives except engine generators.

   b. Pumps, blowers, and compressors with constant speed drives of 500 horsepower and greater.

   c. Pumps, blowers and compressors with variable speed drives of 100 horsepower and greater.

d. Vertical pumps with universal joints and extended shafts.

e. Other equipment as indicated.

2. An experienced specialist from the equipment manufacturer shall perform a complete torsional and lateral vibration analysis of each distinct equipment, motor, and variable speed drive. These analyses shall identify the dry and wet lateral critical speeds plus the torsional critical speeds of the system. Appropriate lateral and critical speed maps shall be produced and submitted.

3. No active critical speed shall be allowed within 25 percent of the operating speed range. No fabrication of the equipment shall be started until the analyses have been approved by the ENGINEER.

1.4 QUALITY ASSURANCE

A. **Costs:** Responsibility shall be the CONTRACTOR's for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The OWNER will pay for costs of power and water. If available, the OWNER'S operating personnel will provide assistance in the field testing.

B. **Inspection:** The CONTRACTOR shall inform the local authorities, such as building and plumbing inspectors, fire marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, and related items to obtain all required permits and certificates, and shall pay all inspection fees.

C. **Quality and Tolerances:** Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

1. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER’S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR’S responsibility.

3. All materials shall meet the physical and mechanical properties in accordance with the reference standards.

D. **Machine Finish:** The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

E. **Manufacturer's Experience:** Equipment manufacturer shall have a record of at least 5 years of successful, troublefree operation in similar applications and size equal or larger than the equipment in this contract.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **Noise Level:** When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 105 dBA for one hour exposure per day.

B. **High Noise Level Location:** The CONTRACTOR shall provide one personal hearing protection station at each high noise level location. Locations are defined as follows:

1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2 hour exposure. Where such equipment is separated by a distance of more than 20-feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.

2. Indoor Location

a. Any single equipment item or any group of equipment items located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2 hour exposure.

b. Any single equipment item or any group of equipment items located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8 hour exposure.

C. **Personal Hearing Protection:** The CONTRACTOR shall furnish 3 pairs of high attenuation hearing protectors in the original unopened packaging. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, provided at an approved location near the noise producing equipment.

D. **Drive Trains and Service Factors:** Service factors shall be applied in the selection or design of mechanical power transmission components. All components of drive train assemblies between the prime mover and the driven equipment shall be designed and

rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Centrifugal Fans	1.0	Uniform

E. Mechanical Service Factors

	Mechanical Service Factors	
	Electric Motor	**Internal Combustion Engine**
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

F. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear manufacturer sizing information.

G. For service factors of electric motors, see Section 16460 - Electric Motors.

H. Where load classifications are not indicated, service factors based on AGMA 514.02 shall be used for standard load classifications and for flexible couplings.

I. **Welding:** Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.

2. Latest revision of AWWA C206.

3. Composite fabricated steel assemblies that 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 to prevent entrance of air or moisture.

4. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld

reinforcement shall be as specified by 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 that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

J. **Protective Coating:** Equipment shall be painted or coated in accordance with Section 09800 - Protective Coating, unless otherwise indicated. 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.

K. **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 having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized and shafts shall be rotated. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, and recoated to restore it to original condition.

L. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

a. Pumps, compressors, and blowers smaller than 100 horsepower shall receive acrylic plastic nametags in accordance with Section 10400 – Identifying Devices.

b. Pumps, compressors, and blowers larger than 150 horsepower shall receive stainless steel plate nametags in accordance with Section 10400.

M. **Vibration Isolators:** Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

N. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

O. **Controls:** Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. **Equipment Supports:** Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity.

Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise indicated.

B. **Anchors:** Anchor bolts shall be in accordance with Section 05500 - Miscellaneous Metalwork.

C. **Equipment Foundations:** Mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 3.5-inch high concrete bases, unless otherwise indicated. Equipment foundations are indicated on Drawings. The CONTRACTOR through the equipment manufacturer shall verify the size and weight of equipment foundation to insure compatibility with equipment.

2.3 COUPLINGS

A. Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise indicated or recommended by the equipment manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	Coupling Type
Vertical turbine pumps	3 piece spacer for solid shaft or double nut for hollow shaft

B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, 2 sets of universal type couplings shall be provided.

D. **Taper-Lock** or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.4 SHAFTING

A. **General:** Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. **Design Criteria**: All shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of 2 in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway.

Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.

C. **Materials:** Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.

2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Other grades of carbon steel alloys shall be suitable for service and load.

4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

D. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

2.5 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the ENGINEER.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the CONTRACTOR shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.6 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ANSI Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.7 SPROCKETS

A. **General:** Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. **Materials:** Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with **Taper-Lock** bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.8 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be provided complete with **Taper-Lock** or **QD** bushings as required.

E. Finish bored sheaves shall be complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.9 DRIVE GUARDS

A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the Division of Industrial Safety General Industrial Safety Orders latest edition. The guards shall be constructed of minimum 10 gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.10 BEARINGS

A. **General:** Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. **Anti-Friction Type Bearing Life:** Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. **Sleeve Type Bearings**: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment

thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer.

H. **Plate Thrust Bearings**: Thrust bearings shall be the **Kingsbury** Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide necessary piping, filters, and valves.

2.11 PIPING CONNECTIONS

A. **Pipe Hangers, Supports, and Guides:** Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 15006 - Pipe Supports.

B. **Flanges and Pipe Threads:** Flanges on equipment and appurtenances shall conform to ANSI B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ANSI/ASME B1.20.1 and Section 15000 - Piping, General.

C. **Flexible Connectors:** Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 15000. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

D. **Insulating Connections:** Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 15000.

2.12 GASKETS AND PACKINGS

A. Gaskets shall be in accordance with 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 and approved by the ENGINEER, in accordance with Section 11100 - Pumps, General.

2.13 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head 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.

2.14 TOOLS AND SPARE PARTS

A. **Tools:** The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish.

Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by **Snap On, Crescent, Stanley,** or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. All spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.15 EQUIPMENT LUBRICANTS

A. The CONTRACTOR shall install lubricants for all equipment during storage and prior to initial testing of the equipment. After successful initial testing, final testing, and satisfactory completion startup testing as specified in Section 01660 - Equipment Testing and Plant Startup, the CONTRACTOR shall conduct one complete lubricant change on all equipment. In addition, the CONTRACTOR shall be responsible for the proper disposal of all used lubricants. The OWNER will then be responsible for subsequent lubricant changes

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment**: Where required by individual sections, an authorized, experienced, and competent service representative of the manufacturer shall visit the Site for the number of days indicated in those sections to witness or perform the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of equipment

2. Inspection, checking, and adjusting the equipment and approving its installation

3. Startup and field testing for proper operation, efficiency, and capacity

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements

B. Instruction of the Owner’s Personnel

1. Where required by the individual equipment sections, an authorized training representative of the manufacturer shall visit the Site for the number of days indicated in those sections to instruct the OWNER’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least 2 years experience in training. A resume of the representative shall be submitted.

3. Training shall be scheduled 3 weeks in advance of the scheduled session.

4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the ENGINEER shall be incorporated into the material.

5. The training materials shall remain with the trainees after the session.

6. The OWNER may videotape the training for later use by the OWNER's personnel.

C. **Vibration Monitoring**: For the equipment types listed in paragraph 1.3D, the CONTRACTOR shall arrange for at least two Site visits by the manufacturer's specialist during testing of the equipment covered by torsional and vibration analysis submittals to measure the amount of vibration and prepare written recommendations for keeping the vibration within acceptance limits. If vibration readings exceed the specified or the applicable referenced standard vibration limits for the type of equipment, the CONTRACTOR shall make necessary corrections for the equipment to meet the acceptance criteria.

3.2 INSTALLATION

A. **General:** Equipment shall be installed in accordance with the manufacturers written recommendations.

B. **Alignment**: Equipment shall be field tested to verify proper alignment.

3.3 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with subcontractors to avoid later change orders.

B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide all material and labor necessary for a complete installation as required by the manufacturer.

3.4 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with "**Never Seize"** compound or equal.

3.5 WELDING

A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

3.6 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or no overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable Standards.

2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration and bearing temperatures.

3. Operate equipment indicated in Section 01660.

C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER of the test schedule three days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and resettled until it satisfies the requirement.

- END OF SECTION -

SECTION 11100 - PUMPS, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. The requirements of Section 11000 – Equipment General Provisions apply to this Section.

D. **Unit Responsibility:** The pump manufacturer shall be made responsible for furnishing the WORK and for coordination of design, assembly, testing, and installation of the WORK of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section.

E. **Single Manufacturer:** Where 2 or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Pump name, identification number, and specification Section number.

2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. Performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be furnished for each centrifugal pump equipped with a variable speed drive.

3. The CONTRACTOR shall require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.

4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Data, in accordance with Section 16460 - Electric Motors, for the electric motor proposed for each pump.

6. Elevation of proposed local control panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the local control panel.

7. Wiring diagram of field connections with identification of terminations between local control panels, junction terminal boxes, and equipment items.

8. Complete electrical schematic diagram.

C. **Technical Manual:** The Technical Manual shall contain the required information for each pump Section.

D. **Spare Parts List:** A spare parts list shall contain the required information for each pump Section.

E. **Factory Test Data:** Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

F. Certifications

1. Manufacturer's certification of proper installation.

2. CONTRACTOR'S certification of satisfactory field testing.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. **Performance Curves:** All centrifugal pumps shall have a continuously rising curve or the system operating range shall not cross the pump curve at two different capacities or “dip region.” Unless indicated otherwise, the required pump shaft horsepower at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

C. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not indicated shall be high-grade, standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.

2. Bronze pump impellers shall conform to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications, where dezincification does not occur.

3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be Type 316.

4. Anchor bolts, washers, and nuts in Standard Service (Non-Corrosive Application) shall be galvanized steel in accordance with the requirements of Section 05500 - Miscellaneous Metalwork. Anchor bolts, washers, and nuts in Corrosive Service as defined in Section 05500 shall be stainless steel in accordance with that Section.

B. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.

2.3 PUMP COMPONENTS - GENERAL

A. **Flanges and Bolts:** Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Bolts shall be in accordance with Section 05500.

B. **Lubrication:** Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise indicated. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed line shafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.

C. **Handholes:** Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. **Drains:** All gland seals, air valves, cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

E. **Grease Lubrication:** For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

F. **Stuffing Boxes:** Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by **John Crane Co., Lakos (Claude Laval Corp.),** or equal.

1. Conventional Packing Gland Type Seal: Unless otherwise indicated, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, **Chesterton 1400R**, or equal for non-potable water service and braided PTFE material, **Chesterton 1725** or equal that is listed under NSF Standard 61 for potable water service.

Shaft speeds	up to 2500 fpm
Temperature	up to 500 degrees F
pH range	0-14

2. Mechanical Seals (Conventional Non-Split Type): Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Sewage, Sludge, or Wastewater Pumps	Double seals	**John Crane Type 88, Flowserve Type ISCPP, Chesterton Type GDS** or **255**
Abrasives, Grit, or Lime Slurry Pumps	Double seals	**John Crane Type 88** (hard faces)**, Flowserve Type ISCPP** or **SLC** (check with pump manufacturer)**, Chesterton Type GDS** or **255**
Chemicals or Corrosive Liquid Pumps	Single seals	**John Crane Type 8-1** or **9, Flowserve Type ISCPX,** or **Chesterton Type UV, GSS,** or **155**
Water Pumps (hot and cold)	Single seals	**John Crane Type 88SRS, Flowserve Type ISCPX, Chesterton Type UV, GSS,** or **155**

3. Mechanical Seals (Split Type): Split type mechanical seals shall be fresh water flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following or equal

Sewage, Sludge, or Wastewater Pumps	Double seals	**John Crane Type 3710, Flowserve Type PSS2, Chesterton Type 442**
Abrasives, Grit, or Lime Slurry Pumps	Double seals	Split seals are not recommended.
Chemicals or Corrosive Liquid Pumps	Single seals	Split seals are not recommended because of leakage.
Water Pumps (Hot and cold)	Single seals	**John Crane Type 3710, Flowserve Type PSS II, Chesterton Type 442**

G. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

H. Mechanical seals for all services shall be equipped with nonclogging, flexible–mounted seats with elastomer secondary seals. Wetted metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid. Dual cartridge seals shall be double balanced to allow for seal integrity in case of flush water pressure reversal. All single and double seals shall have springs in the non-wetted end of the seal.

I. Fresh water shall be delivered to the seals through appropriate size piping with plug valves, strainers, pressure regulators, electrically operated solenoid valves, and rotameters. Wiring shall comply with Division 16 and solenoid control shall comply with Division 17.

2.4 PUMP APPURTENANCES

A. **Nameplates:** Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. **Solenoid Valves:** The pump manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges

1. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

2. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

3. Pressure and compound gauges shall be provided in accordance with Section 17108 - Pressure Measuring Systems.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Motors: Electric motors shall be tested in accordance with Section 16460. Test results shall be furnished to the pump manufacturer prior to the pump test.

2. Pump Systems: All centrifugal pump systems with drives 10 hp up to and including 125 hp shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) acceptance Level "A" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. For sump pumps, acceptance shall be in accordance with Level "B" of ANSI/HI 1.6 unless indicated

otherwise. Tests shall be performed using the complete pump system to be furnished, including the project motor and variable speed drive if equipped with variable speed drive. For pumps with motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test results shall be submitted:

a. Hydrostatic test results

b. At maximum speed, a minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute. For variable speed driven pumps, each pump shall be tested between maximum and minimum speed at 100 rpm increments.

c. Pump curves showing head, flow, bhp, and efficiency requirements.

d. NPSH required test curve if required by the pump specification. Otherwise, a calculated NPSH required curve may be submitted.

e. Certification that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

3. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. All costs for OWNER and ENGINEER shall be borne by the CONTRACTOR and shall be included in the bid price. Such costs shall include travel and subsistence for two people excluding salaries. Test results shall be submitted to the ENGINEER. No equipment shall be shipped until the test data have been approved by the ENGINEER.

4. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested until found satisfactory.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** Where required by the individual pump Sections, an authorized service representative of the manufacturer shall visit the Site for the number of days indicated in those sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment

2. Inspection, checking, and adjusting the equipment

3. Startup and field testing for proper operation

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements

B. Instruction of the Owner's Personnel

1. Where required by the individual pump Sections, an authorized training representative of the manufacturer shall visit the Site for the number of days indicated in those Sections to instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least 2 years experience in training. A resume for the representative shall be submitted.

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 submitted for review. Comments shall be incorporated into the material.

5. The training materials shall remain with the trainees.

6. The OWNER may videotape the training for later use with the OWNER'S personnel.

3.2 INSTALLATION

A. **General:** Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. **Alignment:** All equipment shall be field tested to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. **Lubricants:** The CONTRACTOR shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 09800 - Protective Coating.

3.4 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate:

1. Satisfactory operation without excessive noise and vibration.

2. No material loss caused by cavitation.

3. No overheating of bearings.

4. Indicated head, flow, and efficiency at design point.

B. The following field testing shall be conducted:

1. Startup, check, and operate the pump system over its entire speed range. If the pump is driven by a variable speed drive, the pump and motor shall be tested at 100 RPM increments. If the pump is driven at constant speed, the pump and motor shall be tested at max RPM. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed if variable speed at 100 RPM increment or at max RPM if constant speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time until bearing temperatures have stabilized shall precede this test, unless insufficient liquid volume is available.

4. Electrical and instrumentation tests shall conform to the requirements of the sections under which that equipment is specified.

C. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish 3 days advance notice of field testing.

D. In the event any pumping system fails to meet the indicated requirements, the pump shall be modified or replaced and re-tested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The CONTRACTOR shall be responsible for all costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear. If available, the OWNER'S operating personnel will provide assistance in field testing.

- END OF SECTION -

SECTION 11103 - VERTICAL TURBINE PUMPS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide vertical turbine pumps and drives with associated piping, controls, wiring, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11100 - Pumps, General apply to this Section.

C. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification

Pump Name	Woodcreek North Well Pump No. 1
Equipment Number	WD34-PUMP26101
Quantity	1

B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed, electric motor
Ambient environment	Indoors
Ambient temperature, degrees F	33 to 100
Ambient relative humidity, percent	0 to 100
Fluid service	Raw Groundwater
Fluid temperature, degrees F	40 to 70
Fluid pH range	6 to 8
Fluid specific gravity	1
Fluid viscosity, absolute centipoises at 60 deg. F	1.139
Project site elevation, ft (msl)	110
Minimum available NPSH, ft	87

C. Performance Requirements

Maximum shutoff head, ft	600
Design Point 1 flow capacity, gpm	2000
Design Point 1 bowl head TDH, ft plus or minus 0 feet	402.6
Design Point 1 minimum bowl efficiency, percent	80%
Design Point 2 flow capacity, gpm	2340
Design Point 2 bowl head TDH, ft, plus or minus 15 feet	365
Design Point 2 minimum bowl efficiency, percent	82%
Maximum flow capacity at maximum speed, gpm	2800
Maximum flow bowl head TDH, ft, plus or minus 20 feet	280
Maximum flow minimum bowl efficiency, percent	79%
Maximum flow NPSH required, ft	29
Pump speed, rpm	1770
Motor speed, rpm	1800
Minimum motor size, hp	300

D. Pump Dimensions

Length from base plate to suction bell, ft	315
Minimum column diameter, in	12
Minimum discharge diameter, in	12
Discharge flange rating ANSI, psi	150
Maximum bowl diameter, in	15
Maximum diameter of column-bowl-strainer assembly, in	15.25
Acceptance of Vibration Criteria	per the latest revised edition of the Hydraulic Institute Standards at the time of Bidding.

2.2 PUMP REQUIREMENTS

A. **Pump Construction:** Construction of vertical turbine pumps shall conform to the following requirements:

Bowls	Cast-iron, vitreous-enameled for sizes 18 inches in diameter and smaller; larger sizes lined with 3 coats of epoxy having a total thickness of 25 mils. The exterior surfaces of the bowl units shall be coated with 8 mils of epoxy in accordance with Section 09800 - Protective Coating
Impeller	ASTM B584 – Alloy 903
Impeller shaft method of connection	Type 416 Stainless Steel shaft key
Wear rings	Bronze replaceable
Bowl shaft	Stainless Steel, Type 410 or 416
Suction bell and strainer (see drawings)	Cast iron bell, with bottom bearing and streamlined ribs, lining and coating , see bowls (Stainless Steel strainer, Type 316).
Strainer	Threaded suction case with 5 feet of suction pipe and cone strainer.
Column	Steel pipe, Schedule 40, in maximum 10-ft lengths, threaded
Line shaft and couplings	ASTM A582 Type 416 Stainless Steel shaft in maximum 10-ft lengths, sized for a critical speed of min 20 percent above max operating speed. Shaft coupling shall be ASTM A582 Type 416 Stainless Steel, threaded or keyed to the shaft.
Shaft lubrication	Product water lubricated
Shaft seal	Mechanical seal fresh water lubricated, with solenoid valve
Line shaft bearings	Rubber with bronze or ductile iron drop-in bearing retainers at each joint for open lineshaft

Discharge head	Fabricated steel, reinforced to withstand pipe thrust, epoxy-lined with flange, base plate, and minimum 1-1/4-inch, 3000 lb forged steel half-couplings for air valve, pressure switch, and drain connections. Provide pump column shaft flushing pre-lube connection per pump manufacturer recommendations with solenoid valve.
Motor shaft coupling	shaft adjusting nut for hollow shaft motors 2-piece head shaft with threaded coupling to couple the line shaft to the hollow shaft motor.
Bowl and suction bearings	Product-lubricated bronze sleeves case bearings. Suction bearing to be permanently grease packed with a non-soluble grease.
Sole plate	Extra-heavy, epoxy coated-carbon steel sole plate, drilled and tapped to match discharge head (required only for pumps not mounted on a pump barrel)

B. Discharge Head

1. Pump discharge head construction shall be designed to support the pumping unit including motor.

2. Discharge head and motor shall be coupled via a registered fit connection. Discharge head shall provide space for a two-piece headshaft coupling.

3. Tapped drain and bearing prelube openings shall be provided in the discharge head.

4. Discharge head shall be fabricated with ANSI B16.5 Class 150 discharge, access and base flanges. The access nozzle may be used to inject water into the well annulus, if required to supplement injection through the column assembly. Discharge and recharge nozzle orientations shall be as shown on the drawings.

5. The discharge head shall be attached to the steel well sole plate via ¾" studs plug welded to sole plate and matching the bolt pattern required for the discharge head as indicated on the drawings. The sole plate shall be fabricated of 1 ½" thick steel plate, and machined to a flat surface to match the discharge flange. The sole plate shall incorporate an o-ring seal groove and anchor bolt locations as indicated on the Contract Drawings.

6. All tapped openings, flanges, and sole plate connection shall be sealed in order to accommodate a variation in pressure conditions from 30psi to –29in Hg (full vacuum) within the discharge head and well casing.

7. The discharge head shall be configured with openings for maintenance.

8. Pump discharge head shall be equipped with lifting lugs.

C. Pump Column

1. The 12-inch OD pump column shall be threaded with schedule 40S wall steel pipe. All coupling threads to be sealed.

2. Column sections shall be no greater than 10 feet in length. Top and bottom sections shall be supplied in 5 feet maximum lengths for ease of installation.

3. Column section lugs shall be capable of supporting the entire column section and bowls.

4. The column pipe shall be lined with fusion bonded epoxy (excluding threads). Fusion bonded epoxy shall be in accordance with Section 09800-Protective Coatings, System 106. Provide touch-up kit for field coating. Column pipe exterior shall be uncoated.

5. Column shall be placed in well casing in such a manner as to avoid damage to the casing lining. Rubber coated centralizers or rubber bumpers shall be used at 20 ft spacing during installation of pump column. Centralizer data shall be submitted for approval in accordance with Section 1330 – Submittals. Contractor shall coordinate selected product so that no conflict exists between control feed lines (nitrogen or hydraulic) for wells equipped with downhole injection control valves specified in Section 02085.

D. Pump Shaft and Line Shaft

1. Shafts shall be coupled with threaded type 416 stainless steel couplings.

2. Shaft diameter shall be sized to meet that required for the nameplate horsepower rating and prevent distortion and vibration. Shaft shall also be sized to continuously sustain torque produced by a reverse flow through the pump of 1350 gpm with the shaft locked by the motor nonreverse ratchet.

3. A two-piece headshaft with threaded coupling shall be provided to couple the line shaft to the hollow shaft motor. Impeller clearance shall be set by an adjusting nut with locking screw at the top of the headshaft.

E. Line Shaft Bearings

1. Marine type bronze backed rubber bearings or neoprene snap-in type, internally spiral grooved, shall be provided.

2. Line shaft bearing retainers shall be provided integral with the column.

F. Pump Shaft Bearings

1. Bronze or dual bronze and rubber bearings shaft bearings shall be provided.

2. Suction case bearing shall be permanently packed, grease lubricated bronze.

G. Pump Bowl Assembly

1. The pump bowl assembly shall be designed for use with a water lubricated column.

2. The bowl castings shall be free from blow holes, sand holes, and all other material defects.

3. Bowl wear rings shall be pinned or interference press-fit to the bowl so that they remain fixed and do not move or loosen during operation of the pump.

4. The bowls shall be hydrostatically tested at 1.5 times the pressure produced at shut-off head.

H. Stuffing Boxes

1. Stuffing boxes shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. The seals shall be product flushed, per API Plan 13. A pre-lube port shall be furnished in the seal gland.

2. Mechanical Seals (Split Type): Split type mechanical seals shall be product flushed. Seals shall be rated for vacuum in the stuffing box (-25in Hg). Mechanical seals shall be as manufactured by the following or equal.

Well Pumps	Single seals	**Chesterton Type 442**

I. Impeller

1. The impeller shall be enclosed type.

J. Wear Rings

1. Bronze impeller wear rings shall be provided.

2. Bronze bowl wear rings shall be provided.

K. Discharge Nozzle

1. An ANSI 16.1B 250 lb. flanged discharge nozzle shall be provided.

L. Suction Pipe

1. A suction pipe 10 feet in length shall be provided with Type 316 stainless steel cone type strainer. A check valve/foot valve shall be provided between the suction pipe and strainer for pumps that are fitted with downhole injection control valves.

M. Drawdown Gage

1. A .25 inch OD Dekoron Type 1005 Plastic coated single line Type 316 stainless steel tube shall be provided for the purpose of measuring drawdown.

2. Drawdown shall extend from the pump discharge head to a point one foot above the pump bowls.

3. The tubing shall be fastened to the pump column at intervals of not more than 10 feet.

4. The drawdown gauge shall be direct reading and shall be mounted on each the pump discharge head.

5. The gauge shall be graduated in feet of water.

6. The gauge assembly shall include a mounting bracket, a valve stem for air connection, and a hand held air pump for each unit.

7. The gauge shall be Marshalltown Figure 44K.

N. Cocks, plugs, and Accessories

1. One Trerice series no. 450, 4 1/2" size liquid filled pressure gauge with a range of 300 psi shall be provided for each pump.

O. Balance

1. All rotating parts shall operate smoothly without excessive vibration.

2. The vibration displacement (peak-to-peak) as measured at the top bearing of the motor shall not exceed that allowed by the Hydraulic Institute.

P. Drive

1. Each pump shall be provided with a vertical, hollow shaft, high efficiency, high thrust open, drip proof, 460 volt, 3-phase, 60 Hertz heavy duty, electric motor in accordance with Section 16460 - Electric Motors. Each electric motor shall be designed to accept the total, unbalanced thrust imposed by the pump. A non-reverse-type rachet mechanism shall be provided to lock the shaft against reverse rotation.

2. Acceptable motor manufacturers are Westinghouse World Series, Siemens, GE, and U.S. Motors.

2.3 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 17100 - Process Control and Instrumentation and Control Systems.

2.4 SPARE PARTS

A. Furnish the following spare parts for each pump:

1. One set of all bowl, suction, and discharge case bearings

2. One set of impellers

3. One set of all wear rings

4. One set of all pump line shaft bearings

5. One mechanical seal kit

6. Two sets of all gaskets and o-rings

2.5 MANUFACTURERS, OR EQUAL

A. **Floway**

B. **Byron Jackson (BW/IP International, Inc.)**

C. **Goulds Pumps, Inc.**

D. **Peerless Pumps**

E. **Worthington (Ingersoll-Dresser Pump Company)**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation of the pump and motor shall be in accordance with American National Standard for Vertical Pumps for Nomenclature, Definitions, Application, and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994 and manufacturer's printed instructions. An authorized technical representative of the manufacturer shall visit each site to witness the following and to certify in writing that the equipment has been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment.

2. Inspection, checking and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

B. The pump discharge heads shall be supplied with a mating sole plate. This assembly must be set in proper alignment and sealed as specified. After assembling the pump, column and shafting in the well, attach the discharge head and the sole plate. The Contractor and Manufacturer’s Representative shall set the discharge head in the location that eliminates or minimizes springing of the pump column caused by any out-of-plumbness of the well casing.

C. After identifying the location of the discharge head that minimizes column springing, the pump sole plate and discharge head base shall be aligned in that location. The eccentricity of the pump headshaft to the top ring of the discharge head shall be measured by rotating a dial indicator around the headshaft. The sole plate shall be shimmed using steel wedges until the eccentricity of the headshaft to the discharge head is within 0.002 inch.

D. Steel wedge taper shall be less than ¼-inch per foot. Double-wedges shall be used to provide a parallel bearing surface. The Contractor and Manufacturer’s Representative shall accomplish wedging so that the sole plate is not sprung out of place.

E. The sole plate final location and alignment shall be carefully maintained, and the discharge head lifted, to provide access to the joint between the well casing and the sole plate. This joint shall be sealed by a 3/8-inch thick angle ring around the casing, which is continuously seal welded to the casing and the sole plate. Welding shall meet applicable standards of the AWS and form an air tight seal at the joint between the well casing and sole plate.

F. The sole plate shall be secured to the concrete pedestal with adhesive anchor bolts. Anchor bolt size shall be as recommended by the Manufacturer, but not less than ¾-inch in diameter.

G. The space between the sole plate and the concrete pedestal shall be grouted with a non-shrink grout of the proper category. Remove wedges after grout has set and fill voids with grout.

H. Install the discharge head on the sole plate with an O-ring seal and perform pressure and vacuum tests on the annular space between the well casing and the pump column. Demonstrate performance of the seal under vacuum conditions by creating a vacuum during annulus recharge, followed by shutting off the recharge. The vacuum must be greater than 29 inches Hg before taking the initial reading. The vacuum must be maintained for a minimum of 30 minutes with no measured loss of vacuum. If the vacuum reading decreases during the test, the source of the leak shall be repaired and the test repeated. The Contractor shall bear all expenses related to the leak identification, repair, and re-testing.

I. Demonstrate performance of the seal under pressure by pressurizing the annulus with compressed air to 50 psi and checking for leaks at the seal using a foaming, detergent-based solution. Performance of the seal is acceptable if no bubbling of the solution is observed at the seal after 30 minutes at a pressure of 50 psi. If leakage is observed during the test, the source of the leak shall be repaired and the test repeated. The Contractor shall bear all expenses related to the leak identification, repair, and re-testing.

J. Field Acceptance Tests

1. After the official startup the Contractor will be given a period of time in which to make adjustments to the pump equipment under the supervision of the pump manufacturer's technical representative.

2. Once the adjustments are made the pumps will be operated for 30 calendar days or 30 hours minimum with successive starts and stops.

3. Initial testing of equipment will be paid for by the Owner. Subsequent tests will be paid for by the Contractor.

4. After the 30 calendar day period the pumps will be accepted after successful performance of Field Testing as indicated in Section 3.2.

3.2 FACTORY TESTING

A. Provide non-witnessed Factory Bowl Performance Testing.

B. Provide non-witnessed Factory Hydrostatic Testing, including bowl assembly and the discharge head.

3.3 FIELD TESTS

A. Each pump system shall be field tested after the 30 day acceptance period to demonstrate:

1. Satisfactory operation without excessive noise and vibration at any operating head, including shutoff.

2. No material loss caused by cavitation.

3. No overheating of bearings.

4. Indicated head, flow, and efficiency at design point.

5. No undue attention is required for operation.

B. The following field testing shall be conducted:

1. Startup, check, and operate the pump system at max RPM. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed if variable speed at 100 RPM increment or at max RPM if constant speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time until bearing temperatures have stabilized shall precede this test, unless insufficient liquid volume is available.

4. Electrical and instrumentation tests shall conform to the requirements of the sections under which that equipment is specified.

C. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish 3 days advance notice of field testing.

D. In the event any pumping system fails to meet the indicated requirements, the pump shall be modified or replaced and re-tested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

3.4 FIELD PAINTING

A. Factory painted items requiring touch up work shall cleaned completely, and shall be primed and topcoated in accordance with Section 09800 – Protective Coating.

3.5 MANUFACTURER'S SERVICES

A. A Manufacturer's qualified representative with experience in the installation, adjustment, and operation of the specified equipment shall supervise the installation, adjustment, and testing of the equipment.

B. Thirty (30) working days of supervisory service shall be provided by the Manufacturer at no expense to the Owner.

3.6 DEMONSTRATION

A. The Contractor shall provide instructional training for a period of not less than 8 hours on the operation and maintenance of the equipment as specified in this section. A manufacturer’s qualified representative shall also provide a separate training session for a period of not less than 4 hours to address general operation and maintenance questions.

1. The training shall be provided by one or more competent Engineers.

2. The training shall be received by a representative of the Owner.

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SECTION 11258 - CHEMICAL FEEDING EQUIPMENT, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide chemical feeding equipment, complete and operable, in accordance with the Contract Documents.

B. Equipment shall be from manufacturers with several years of experience in the manufacture and assembly of similar products, with a record of successful installations. Such manufacturers shall maintain a well established, authorized, local service agency with sufficient spare parts and personnel to respond within 48 hours to any service calls.

C. The requirements of Section 11000 - Equipment General Provisions apply to the WORK of this Section.

D. Unless indicated otherwise, the requirements of this Section apply to all chemical feeding equipment in the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, pumps, tanks, mixers, supports, panels, and other accessories forming a part of the equipment, plus schematics, diagrams, and panel layouts.

C. **Certification:** The CONTRACTOR shall obtain written certification from the manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and the Drawings, that the materials are best suited for the chemicals handled, and that the manufacturer accepts joint responsibility with the CONTRACTOR for coordination of equipment, including motors, variable speed drives, controls, and services required for proper installation and operation of the completely assembled and installed unit.

D. **Technical Manuals:** Furnish complete operations and maintenance manuals prior to start-up.

E. **Spare Parts List:** The CONTRACTOR shall obtain from the manufacturer a list of suggested spare parts for each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc.

F. **Maintenance:** Printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units.

G. **Field Procedures:** Instructions for field procedures for erection, adjustments, inspection, and testing shall be furnished prior to installation of the equipment.

H. **Calibration Graphs:** The manufacturer's representative shall prepare a calibration graph from field tests for each chemical feed unit which does not have a rate set device. Graphs shall read in pounds per hour for dry feeders or in gallons per hour for liquid feeders. The graph shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and be sealed in clear plastic.

1.3 MANUFACTURER'S SERVICE REPRESENTATIVE

A. **Erection and Startup Assistance:** Service and instruction assistance by the manufacturer's engineering representative for each equipment unit shall be furnished by the CONTRACTOR during the following period:

1. One day during erection, unless indicated otherwise in the feed equipment section.

2. One day during startup, unless indicated otherwise in the feed equipment section.

B. **Instruction of OWNER's Personnel:** The CONTRACTOR shall furnish the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment. This service shall consist of a minimum one day's visit to the plant for each type of similar equipment.

1.4 GUARANTEES, WARRANTIES

A. After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, and flow ranges and meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Wherever it is required that a single manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment unit, it shall be understood to mean that the CONTRACTOR shall provide only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any indicated requirements.

B. Manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. Where 2 or more units of the same type or size of equipment are required, such units shall be produced by the same manufacturer.

2.2 MATERIALS

A. **General:** Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

B. **Corrosion Resistance:** Materials used in the construction of chemical feeding equipment, shall be resistant to corrosive attacks from the chemicals. The following table lists the most commonly used chemicals for water and wastewater treatment and some of the suitable materials for the construction of chemical feeding equipment. Unless the manufacturer proposes more suitable materials, the table shall be adhered to:

Chemical	Suitable Handling Material
Activated Carbon	Activated Carbon Monel Type 316 stainless steel Monel Hastelloy C Titanium Bronze FRP (verify with FRP manufacturer) PVC Saran Hypalon Rubber
Activated Silica (SiO_2)	Iron Steel Stainless steel Hypalon Viton Tyril Rubber
Aluminum Chloride ($AlCl_3$ $6H_2O$)	Carpenter 20 (10percent solution) Hastelloy B FRP PVC Vinyl Saran Hypalon Teflon Tyril Rubber Ceramic

Dry Aluminum Sulfate (Al_2 (SO_4)3.14H_2O)	Type 316 stainless steel Carpenter 20 Ni-Resist Lead Titanium FRP PVC Vinyl Hypalon Polyethylene Tyril Rubber Glass Ceramic
Alum solution (Al_2 (SO_4)3.XH_2O)	Hastelloy C Type 316 stainless steel Carpenter 20 Lead Titanium FRP PVC, CPVC Teflon EPDM Buna N Neoprene Viton Saran Hypalon Tyril Rubber
Ammonia Anhydrous (NH_3)	Steel Type 316 stainless steel Monel Ni-Resist Neoprene
Ammonia Aqueous (NH_4OH)	Iron (fair) Steel (fair) Type 316 stainless steel Neoprene Tyril Teflon EPDM

Ammonium Sulfate $(NH_4)_2\ SO_4$	Type 316 stainless steel Hastelloy C D Titanium Monel FRP PVC Vinyl Hypalon Tyril Rubber
Calcium Carbonate ($CaCO_3$)	Iron Steel Rubber
Calcium Hydroxide ($Ca(OH)_2$) (slaked lime)	Iron Steel Type 316 stainless steel PVC Hypalon Rubber
Calcium Oxide (CaO) (Quicklime)	Iron Steel PVC Hypalon Rubber
Carbon Dioxide (CO_2)	Dry gas — Iron Steel Type 316 stainless steel Monel FRP PVC Hypalon Saran Viton Vinyl
Chlorine (Cl_2)	Anhydrous — Black Iron Steel Copper Wet gas — Hastelloy C Silver Tantalum Titanium PVC Teflon Viton

Chlorine Solution	Carpenter 20 (fair) Hastelloy C (fair) Titanium PVC FRP (verify with FRP manufacturer) Viton Saran Teflon Polyethylene
Chlorine Dioxide (ClO_2) (3% solution)	Titanium (fair) PVC FRP (verify with FRP manufacturer) Hypalon Teflon Saran Vinyl Ceramic Glass
Dolomitic Hydrated Lime $Ca(OH)_2.Mg(OH)_2$)	Iron Steel PVC Hypalon Penton Rubber Carbide Valves
Dolomitic Lime (CaO.MgO)	Iron Steel PVC Hypalon Penton Rubber Carbide valves
Ferric Chloride ($FeCl_3$)	Hastelloy C (fair) Titanium PVC FRP Hypalon Saran Vinyl Kynar Tyril Rubber Glass Ceramics Teflon

Ferric Sulfate ($Fe_2(SO_4)_3.3H_2O$)	Type 316 stainless steel Carpenter 20 Titanium PVC FRP Hypalon Saran Teflon Vinyl Polyethylene Rubber Tyril Glass Ceramic
Ferrous Sulfate ($FeSO_4.7H_2O$)	Carpenter 20 PVC FRP (verify with FRP manufacturer) Hypalon Teflon Vinyl Rubber Tyril Ceramic
Fluosilicic Acid: (H_2SiF_6.) (Hydrofluosilicic Acid)	Hastelloy C Lead PVDF Viton Hypalon Teflon Saran Vinyl Polypropylene
Hydrochloric Acid (HCl)	Titanium PVC Viton Teflon Hypalon Vinyl Polyethylene Tyril
Hydrogen Peroxide (H_2O_2)	Hastelloy C Type 316 Stainless Steel Aluminum (special alloy) Teflon PVDF (kynar) Polyethylene Ceramic

Magnesium Hydroxide ($Mg(OH)_2$)	Steel Iron Hypalon PVC FRP Teflon Rubber
Ozone (O_3)	Type 316 stainless steel Aluminum anodized (fair) Teflon Silicone Rubber Glass Ceramics PVC (fair)
Polymers (Ionic) (Cationic) (Nonionic)	Type 316 stainless steel PVC FRP (verify with FRP manufacturer) Teflon Polypropylene
Phosphoric Acid (H_3PO_4)	Type 316 stainless steel Carpenter 20 Hastelloy C PVC FRP (verify with FRP manufacturer Viton Hypalon Vinyl Teflon Rubber Polypropylene
Potassium Permanganate ($KMnO_4$)	Steel Iron Type 316 Stainless steel PVC FRP (verify with FRP manufacturer) Hypalon Kynar Teflon Polypropylene Rubber Lucite

Sodium Aluminate ($Na_2Al_20_4$)	Iron Steel Type 316 stainless steel Hypalon Viton Teflon Rubber
Sodium Bicarbonate ($NaHCO_3$)	Iron (fair) Steel (fair) Type 316 stainless steel Hypalon Saran Teflon PVC FRP (verify with FRP manufacturer) Tyril Rubber
Sodium Bisulfite (anhydrous) ($Na_2S_2O_5(NaHSO_3)$)	Type 316 stainless steel Carpenter 20 PVC FRP (verify with FRP manufacturer) Hypalon Teflon Tyril Glass
Sodium Carbonate (Na_2CO_3) (Soda Ash)	Iron Steel Carpenter 20 Titanium Hypalon Teflon PVC FRP (verify with FRP manufacturer) Rubber Tyril
Sodium Chloride (NaCl)	Carpenter 20 Hastelloy C Titanium PVC FRP (verify with FRP manufacturer) Kynar Teflon Hypalon Saran Vinyl Tyril Glass

Sodium Chlorite ($NaClO_2$)	Hastelloy C Titanium CPVC FRP (verify with FRP manufacturer) Hypalon Penton Polypropylene Saran Vinyl Tygon Tyril Glass
Sodium Fluoride (NaF)	Type 316 stainless steel (fair) Viton Penton Teflon Hypalon Saran PVC FRP (verify with FRP manufacturer) Rubber Tyril Polypropylene
Sodium Hexa-Meta Phosphate ($(NaPO_3)_6$)	Type 316 stainless steel PVC FRP (verify with FRP manufacturer) Hypalon Teflon Saran Vinyl Tyril Rubber Ceramics
Sodium Hydroxide (NaOH) (Caustic Soda)	Cast Iron (fair) Steel (fair) Type 304 and 316 stainless steel (fair) PVC, CPVC Teflon EPDM Hypalon Polypropylene

Sodium Hypochlorite (NaOCl)	Hastelloy C Titanium PVC Viton Penton Hypalon Vinyl Saran Polyethylene Tyril Glass
Sodium Phosphate (Anhydrous) (NaH_2PO_4)	Type 316 stainless steel Carpenter 20 PVC FRP Hypalon Teflon Vinyl Rubber Tyril
Sodium Phosphate (Hydrated) ($NaH_2PO_4H_20$)	Type 316 stainless steel Carpenter 20 PVC FRP Hypalon Teflon Vinyl Rubber Tyril
Sodium Sulfite (Na_2SO_3)	Cast Iron Steel Type 304 stainless steel PVC FRP Hypalon Teflon Saran Vinyl Tyril
Sulfur Dioxide: (Dry) (SO_2)	Cast Iron Type 316 stainless steel Steel Brass Copper Aluminum Bronze

Sulfur Dioxide: (Wet)	Hastelloy C Carpenter 20 Type 316 stainless steel Titanium PVC FRP (verify with FRP manufacturer) Penton Teflon Viton Hypalon Glass Ceramics Polypropylene
Sulfuric Acid (H_2SO_4) Diluted	Cast Iron (concentrated acid only) Steel (concentrated acid only) Hastelloy C Carpenter 20 (fair) FRP (verify with FRP manufacturer) CPVC Aluminum Bronze Teflon Viton Polypropylene Glass Duriron

2.3 APPURTENANCES

A. **Nameplate:** Each piece of equipment shall be provided with a stainless steel nameplate, indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.

B. **Solenoid Valves:** The equipment manufacturer shall provide solenoid valves which are part of the chemical feeding unit. The solenoid valve electrical rating shall be compatible with the equipment voltage and valves shall be complete with the necessary conduit and wiring from the control panel to the solenoids. The valve material shall be suitable for the intended service in accordance with the Section 15230 -Miscellaneous Valves.

C. **Pressure Gauges:** Where indicated, chemical transfer and metering pumps and other equipment shall be equipped with pressure gauges with diaphragm seals in accordance with Section 17108 - Pressure Measuring Systems, except that the size of gauges on small metering pumps may be smaller than indicated in that section.

D. **Equipment Supports:** Chemical feeding equipment and piping shall be firmly supported on concrete equipment pads and anchored down. Fabricated metal supports exposed to chemical spills shall be of type 316 stainless steel or enameled steel. Anchor bolts, nuts, and washers of such supports shall be of Type 316 stainless steel, with an antiseize compound on the threads.

E. **Variable Speed Drives:** Variable speed drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with Section 16455 - Variable Frequency Drive Units.

F. **Controls:** Controls shall be housed in enclosures with NEMA ratings which comply with the area designations of Section 16050 - Electrical Work, General.

G. **Safety Equipment:** Where required by Code, chemical unloading, storage, and feeding equipment shall be provided with the necessary safety devices and warning signs, clearly visible.

H. Heating Cable

1. Where electric heat trace cable is required for proper operation of the system, it shall be **Chromalox type SRL-3-1;** or equal. Cable shall be self-regulating with 150 degrees F maintenance temperature, 120 volt, 3 watts per ft. output and twin 16 AWG copper buss wires within insulated jacket.

2. After pipe and tanks are heat traced, they shall be insulated with exterior jacketing applied in accordance with Section 15145 - Pipe and Equipment Insulation.

2.4 TOOLS AND SPARE PARTS

A. **Tools:** Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the WORK; such tools shall be suitably stored in metal 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:** Furnish spare seals, packing, gaskets, wear rings, and bearings as required by the feed equipment sections.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** Chemical feeding equipment shall be installed in accordance with governing safety standards, the Shop Drawings, and as indicated.

B. **Alignment:** Equipment shall be field tested to verify proper alignment, operation as indicated, and freedom from binding, scraping, vibration, shaft runout, leaks, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. **Lubricants:** The WORK shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

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SECTION 11259 - METERING PUMPS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide chemical metering pumps and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 - Equipment General Provisions apply to the WORK of this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The pumps shall be of corrosion-resistant construction, and diaphragm pumps and seals shall be a suitable material for the chemicals indicated at maximum temperature of 125 degrees F. Each pump shall be complete with pump base, drive, diaphragm, check valves, back-pressure valve, internal relief valve, pulsation dampener, coupling guard and electric motor. Size and characteristics of the pumps shall be as indicated.

2.2 CONSTRUCTION

A. **Type and Range:** The pumps shall be of solenoid driven diaphragm type, suitable for metering service, with an adjustable stroke (dosage) control range of 10:1 with accuracy of 1.0 percent of the full-scale range. Pumps requiring variable speed drives shall have a set speed range of 10:1 which, in conjunction with the stroke control, shall provide a total feeding range of 100:1, minimum.

B. **Materials:** Wetted parts of metering pumps shall be selected by the manufacturer to ensure optimum, corrosion-free, and erosion-free operation for the chemicals involved. Pumps for polymer service shall be suitable for feeding cationic, nonionic, or anionic polymer solutions having a maximum viscosity of 3,000 centipoise. Pump bases shall be steel, coated in accordance with Section 09800 – Protective Coating. Plastic bases are not acceptable.

2.3 CONTROL

A. The dosage of each metering pump shall be set at each metering pump control station. The drive speed of each metering pump shall vary automatically in response to a 4-20 mA flow signal input from the well pump (PMP101) flow meter; length of stroke shall be adjusted manually in order to maintain pre-set dosage.

2.4 SCHEDULE OF METERING PUMPS

I D No.	Chemical	Feed Range (gph)	Min Head (psi)	Min Motor (hp)	Type of Drive
PMP201	$Ca(OCl)_2$	5.75	100	1/3	Variable frequency drive

2.5 PUMP ACCESSORIES

A. **Mounting and Connections:** Unless otherwise indicated, metering pumps shall be mounted on concrete pedestals of approximately 2 feet in height and shall be provided with corrosion-resistant pulsation dampeners, sample valves, pressure gages with diaphragm seals, shut-off valves, check valves, relief valves, valved and graduated calibration tanks in pump suction, flush connections, and backpressure valves. Pipe connections to pumps shall be firmly supported from a floor-mounted, galvanized, structural steel frame, to avoid any stress on the pump or on the piping system.

B. **Pressure Relief Valves:** Each chemical metering pump shall be furnished with an external corrosion-resistant pressure relief valve on the discharge of the chemical metering pump. The size, type, and materials of construction shall be determined by the chemical metering pump manufacturer.

C. **Backpressure Valves:** Each chemical feed system shall be furnished with a corrosion-resistant backpressure valve on the common discharge of the chemical metering pump. The size, type, and materials of construction shall be determined by the chemical metering pump manufacturer.

D. **Calibration Columns:** Each chemical feed system shall be furnished with corrosion-resistant valved and graduated calibration columns on the common suction of the chemical metering pumps. The calibration columns shall be acrylic tubes with PVC heads. The columns shall be calibrated in hundredths of gallons and shall have a minimum capacity of 3 gallons and a maximum height of 3 feet. The columns shall be securely supported at both the top and bottom.

2.6 SPARE PARTS

A. A complete set of extra diaphragms and seals shall be furnished with each pump. Where applicable, one set of spare bearings shall be furnished with each piece of equipment.

2.7 MANUFACTURER

A. **Manufacturer's Experience:** The pumps shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least 5 years of successful operation of this type of process. The CONTRACTOR may be required to submit evidence to this effect together with a representative list of installations. The pump manufacturer shall maintain a permanent, local service department and a spare parts department.

B. Manufacturers, or Equal

1. **ProMinent**

2. **Milton Roy Company (Sunstrand)**

3. **Pulsafeeder (Chemwest)**

4. **U.S. Filter/Wallace and Tiernan**

C. **Unit Responsibility:** The CONTRACTOR shall assign to a single manufacturer full responsibility for the furnishing and functional operation of the chemical feeder system

along with all related tanks, mixers, pumps, piping, valves and controls. The designated single manufacturer, however, need not manufacture more than one part of the system but shall coordinate the design, assembly, testing, and erection of the system as indicated. The manufacturer of the metering pump shall also manufacture the dry chemical feeders.

2.8 PUMP DRIVES

A. Each pump shall be furnished with an electric motor that meets the requirements specified in Section 16460 - Electric Motors. Electric motors shall be TEFC and shall be rated for 240 volts, 3 phase, 60 hertz. The electric motor shall have a maximum speed of 1800 rpm. Motors shall be chemical severe duty, inverter duty, and designed for variable speed operation.

B. Each pump shall be provided with a variable frequency drive that meets the requirements specified in Section 16465 - Variable Frequency Drives (10 HP and smaller).

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 11100 - Pumps, General.

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SECTION 13675 - POLYETHYLENE TANKS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide cross-linked, high density polyethylene tanks and accessories, complete and in place, in accordance with the Contract Documents.

B. **Unit Responsibility:** The CONTRACTOR shall assign responsibility for furnishing the tank system as indicated except for the level indication to the tank manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM C 177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C 273	Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM D 638	Standard Test Method for Tensile Properties of Plastics
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Standard Test Method for Vicat Softening Temperature Plastics
ASTM D 1998	Polyethylene Upright Storage Tanks
ASTM D 1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D 1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D 1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D 1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

ASTM D 2126	Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D 2842	Standard Test Method for Water Absorption of Rigid Cellular Plastics
ASTM D 2856	Standard Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
NEMA ICS 6	Enclosures for Industrial Control and Systems

1.3 CONTRACTOR SUBMITTALS

A. Submit the following in compliance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Tank manufacturer's data and dimensions showing locations of openings, level indicators, tank accessories, and seismic support structure and anchoring system details.

2. Details on inlet and outlet fittings, manways, flexible connections, vents and level indicators.

3. Tank pad requirements such as pads and blockouts.

C. Manufacturer’s Qualifications

1. List of installations documenting manufacturer's qualifications.

D. **Technical Manual:** Include the following in Part 2 - Operational Procedures.:

1. Manufacturer's recommendations for installation.

2. Fitting installation and adjustment procedures.

3. Repair procedures for typical situations including small holes, pinholes, and minor cracks in the tank.

E. Documentation

1. Certification signed by the manufacturer that the tanks have been factory tested and meet the requirements indicated.

2. Seismic restraint plans and instructions as specified in paragraph 2.5.

3. Calculations used to determine wall thickness. Hoop stress shall be indicated.

4. A representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted.

F. Seismic Restraint Calculations

1. Submit calculations for the seismic restraint system.

1.4 MANUFACTURER'S QUALIFICATIONS

A. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes indicated. The manufacturer shall furnish names and telephone numbers of locations which can be visibly inspected.

1.5 SPECIAL WARRANTY REQUIREMENT

A. The tank shall be warranted for 5 years to be free of defects in material and workmanship. Warranty may be prorated over the last 3 years.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Tanks shall be circular in cross-section, vertical, complete with piping inlets and outlets, drains, overflows, and anchoring system. Covered tanks shall be vented, and where indicated, tanks shall be provided with entrance manways, level indicators, and exterior coating. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, and capacity. Tanks shall meet the requirements of ASTM D 1998 unless otherwise indicated.

2.2 TANKS

A. **Materials**: Polyethylene shall be the cross-linked, high density type meeting or exceeding the following:

Parameter	ASTM Test Method	Value
Density, gm/cc	D 1505	0.937 to 0.945
Tensile strength at yield, psi minimum	D 638	2600
Elongation at break, min percent	D 638	400
Stress-crack resistance, min hours for F_{50}	D 1693	1000
Vicat softening temperature, deg. F	D 1525	230
Brittleness temperature, deg. F, maximum	D 746	-180
Flexural modulus, psi	D 790	100,000

B. Resin used in the tank shall be **Phillips Chemical Marlex CL-200 or CL-250, PAXON grade 7004 or 7204**, or equal, and shall contain a minimum of 0.3 percent ultraviolet stabilizer as recommended by the manufacturer. Where black tanks are indicated, the black resin shall contain 2 percent carbon black blended into the resin. Provide anti-oxidant resin on tank interior to prevent against sodium hypochlorite oxidation of the cross-linked, high density polyethylene.

C. **Operating Conditions:** Chemical storage tanks shall be suitable for the following operating conditions:

Equipment number	-	WD39-TANK26203
Chemical stored	-	Calcium Hypochlorite
Concentration, percent	-	10
Unit weight, lb/gal	-	9.5
Design specific gravity	-	1.14
Maximum fluid temperature, deg. F	-	85
Minimum fluid temperature, deg. F	-	60
Minimum ambient air temperature, deg. F	-	60

D. **Construction**: Tanks shall be constructed using a rotationally molded fabrication process. Wall thickness of the tank shall be designed by the manufacturer with a hoop stress no greater than 600 psi using 1.5 times the specific gravity indicated. Stress shall be calculated using the Barlow formula.

E. Tanks shall have the following characteristics:

1.	Equipment No.	-	WD39-TANK26203
2.	Type (see Note 1)	-	FLH
3.	Nominal diameter, ft	-	4’-0”
4.	Nominal height, ft (see Note 2)	-	4’-3”
5.	Nominal capacity, gallons	-	360
6.	Liquid depth, maximum, ft	-	3’-10”
7.	Manway (see Note 3)		
	Mounting	-	TM
	Diameter, inches	-	18”
8.	Exposure	-	Indoor
9.	Color	-	White

Note 1: CD = closed, domed top; CF = closed, flat top; OIF = open, internal flange; OEF = open, external flange; FLR = flat lid removable; FLH = flat lid hinged.

Note 2: Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded end.

Note 3: TM = top mount; TSM = top and side mount
Unless otherwise indicated, manways shall be integrally molded with the tank.

2.3 TANK FITTINGS

A. Tank fittings shall be according to the fitting schedule below. Gasket material shall be Viton. PVC fittings shall be compression type Schedule 80 long shank high-torque design with minimum of 85 percent threaded contact. Any screwed fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation. Tank fittings shall meet the requirements for connection to future "OSEC BP" on-site electrolytic chlorine generation system manufactured by US Filter Wallace & Tiernan.

Item		Fitting Type (Note 4)
1. Equipment No.	-	WD39-TANK26203
2. Fill	-	N/A
3. Overflow	-	N/A
4. Tank drain	-	see Note 4
5. Vent	-	PVC
6. Outlet to pump	-	PVC
7. Level indication	-	Mfg. Std.
8. Level transmitter mount	-	PVC with 4-inch flanged opening connection. Coordinate with level transmitter supplier.

Note 4: Refer to drawings for fitting size and location. Abbreviations for fittings are:

BF-H: Bolted flanged fitting with Hastelloy-C studs and polyethylene encapsulated heads.
BF-SS: Bolted flanged fitting with 316 SS studs and polyethylene encapsulated heads.
IMFO: Integrally molded flanged outlet.
PVC: Double-nut PVC fitting.

2.4 LEVEL INDICATION

A. Level indication shall be provided where indicated. Graduations shall be provided at every 25-gallon interval with 100-gallon intervals clearly labeled for bulk storage tanks. Unless otherwise indicated, graduations shall be marked on the tank exterior.

B. Level indication shall be by ultrasonic level transmitter as indicated in Section 17106 - Level Measuring Systems.

2.5 TANK STANDS AND SEISMIC RESTRAINT SYSTEM

A. The tank shall be supported on a 4" high concrete pad and shall be bolted to the floor. See structural drawings for concrete pad detail.

B. The tanks shall be provided with seismic restraint systems manufactured in conformance with plans and instructions prepared by an engineer registered in the State of California. The lateral restraint assembly shall be designed for seismic Zone 3 and importance factor 1.5, and shall conform to the Uniform Building Code.

2.6 SAFETY SIGNS

A. Each tank inlet and tank outlet shall be clearly marked with hazardous material warning signs, 10 inches by 14 inches in size. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign ("DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE"). Signs shall comply with Section 10400 and the requirements herein.

2.7 FACTORY TESTING

A. **Material Testing**: Material taken from each tank shall be tested for the following:

Parameter	Test Standard	Value
Impact	ASTM D 1998	120 ft-lb, min
Gel, minimum percent	ASTM D 1998	1/32-inch of inner wall: 65 outer wall: 90 total wall: 70

B. Following fabrication, the tanks, including inlet and outlet fittings, shall be hydraulically tested with water. The factory test shall compensate for the difference in specific gravity between the test water and chemical stored to simulate actual maximum operating pressures. Test methods may include adding a 2.5 psi air pad to a filled tank or filling the tank with standpipes, raising the maximum water surface approximately 5 feet higher than the normal maximum tank level. The test duration shall be 24 hours. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated conditions have been met.

2.8 MANUFACTURERS, OR EQUAL

A. **Poly Processing Company**

B. **Central California Container Mfg**.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and all fittings, the tank shall be water tested by filling the entire tank with water and monitoring the tank as well as all fitting connections for at least 24 hours. Leaks shall be corrected prior to acceptance. Following successful field testing, the tank shall be completely emptied and dried.

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SECTION 15000 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all piping sections in Divisions 2 and 15.

C. The mechanical drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are **not** pipe construction or fabrication drawings. Where pipe supports and spacings are indicated on the Drawings and referenced to a Standard Detail, the CONTRACTOR shall use that Detail. Where pipe supports are not indicated on the Drawings, it is the CONTRACTOR's responsibility to develop the details necessary to design and construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide all spacers, adapters, and connectors for a complete and functional system.

D. CONTRACTOR shall conform to the City of Roseville Construction Standards.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate all spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

3. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

C. **Samples:** Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR'S responsibility.

D. Certifications

1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that all pipes will be manufactured subject to the fabricator’s or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Extent of Work:** Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.

B. **Pipe Supports:** Pipes shall be adequately supported, restrained, and anchored in accordance with Section 15006 - Pipe Supports, and as indicated. Supports shall resist stresses created by a seismic load in an amount of 34 percent of maximum weight.

C. **Lining:** Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 2 unless otherwise indicated.

D. **Coating:** Application, thickness, and curing of pipe coating shall be in accordance with the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-coated in accordance with Section 09800 - Protective Coating.

E. **Pressure Rating:** Piping systems shall be designed for the maximum expected pressure as defined in Section 01656 - Pressure Pipe Testing and Disinfection, or as indicated on the Piping Schedule.

F. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with requirements.

G. **Tests:** Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. The CONTRACTOR shall be responsible for performing material tests.

H. **Welding Requirements:** Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of ANSI/AWS D1.1 - Structural Welding Code. Welding procedures shall be submitted for the ENGINEER'S review.

I. **Welder Qualifications:** Welding shall be done by skilled welders and welding operators who have adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. Qualification testing of welders and materials used during testing are part of the WORK.

2.2 PIPE FLANGES

A. **General:** Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flange faces shall be perpendicular to the axis of the adjoining pipe. Flanges for miscellaneous small pipes shall be in accordance with the standards indicated for these pipes.

B. Pressure Ratings

1. 150 psi or less: Flanges shall conform to either ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 150 lb class.

2. 150 psi to 275 psi: Flanges shall conform to either ANSI/AWWA C207 Class E or Class F, or ANSI/ASME B16.5 150 lb class.

3. 275 psi to 700 psi: Flanges shall conform to ANSI/ASME B16.5, 300 lb class.

4. Selection based on test pressure: AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. **Blind Flanges:** Blind flanges shall be in accordance with ANSI/AWWA C207, or as indicated for miscellaneous small pipes. Blind flanges for pipe sizes 12-inches and greater shall be provided with lifting eyes in the form of welded or screwed eye bolts.

D. **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.

E. **Flange Bolts:** Bolts and nuts shall conform to Section 05500 - Miscellaneous Metalwork. Studs and bolts shall extend through the nuts a minimum of 1/4-inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

F. **Insulating Flanges:** Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter, and shall be in conformance with City of Roseville Construction Standard detail W-21 and shall be in conformance with City of Roseville Construction Standard detail W-21.

G. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a stainless steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inch, insulating sleeves and washers shall be 2 piece and shall be made of polyethylene or phenolic material. Stainless steel washers shall be in accordance with ASTM A 325 - Structural Bolts, Stainless Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturers, or equal

1. **Calpico**

2. **Maloney Pipeline Products Co., Houston**

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full-faced type, with material and thickness in accordance with ANSI/AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to eleven, and pressures to 1000 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, unless otherwise indicated. Flange gaskets shall be as manufactured by **John Crane, Style 2160, Garlock, Style 3000,** or equal**.**

2. Gaskets for flanged joints used in water with chloramines shall be **Gylon, Style 3500** as manufactured by **Garlock** or by **Crane**, or equal.

3. Gaskets for flanged joints used in chemicals, air, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature.

2.3 THREADED INSULATING CONNECTIONS

A. **General:** Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. **Materials:** Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Manufacturers of Couplings for Steel Pipe, or equal

1. **Gustin-Bacon (Aeroquip Corp.) (banded or grooved)**

2. **Victaulic Style 41 or 44 (banded, flexible)**

3. **Victaulic Style 77 (grooved, flexible)**

4. **Victaulic Style 07 or HP-70 (grooved, rigid)**

B. Manufacturers of Ductile Iron Pipe Couplings, or equal

1. **Tyler**

2. **US Pipe**

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

C. Manufacturers of Couplings for PVC Pipe, or equal

1. **Tyler**

2. **US Pipe**

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

2.5 SLEEVE-TYPE COUPLINGS

A. **Construction:** Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End

Pipe. Couplings shall be steel with steel bolts, without pipe stop. Couplings shall be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The coupling shall be either 5 or 7-inches long for sizes up to and including 30-inches and 10-inches long for sizes greater than 30-inches, for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and 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 the requirements of Section 05500. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

B. **Pipe Preparation:** Where indicated, the ends of the pipe 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**

1. 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 meet the following specifications:

    a. Color - Jet Black

    b. Surface - Non-blooming

    c. Durometer Hardness - 74 plus and minus 5

    d. Tensile Strength - 1000 psi Minimum

    e. Elongation - 175 percent Minimum

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where sleeve couplings are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

D. **Insulating Sleeve Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of all coupling metal parts from the pipe.

E. **Restrained Joints:** Sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system. Mechanical joint restraints shall be used per the City of Roseville Construction Standards for all buried pipe.

F. Manufacturers, or equal

1. **Mega Lug**

2. **TR Flex**

3. **Dresser, Style 38**

4. **Ford Meter Box Co., Inc., Style FC1 or FC3**

5. **Smith-Blair, Style 411**

2.6 FLEXIBLE CONNECTORS

A. **Low Temperatures:** Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9-inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the manufacturer. The CONTRACTOR shall submit manufacturer's shop drawings and calculations.

B. **High Temperature:** Flexible connectors shall be installed in engine exhaust piping and where indicated. Connectors shall be sufficient to compensate for thermal expansion and contraction and also to isolate vibration between the engine and the exhaust piping system. Connectors shall be stainless steel bellows type, flanged, and rated for minimum 150 psi, 2000 degrees F.

2.7 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be flanged end, stainless steel, Monel, rubber, or other materials best suited for each individual service. The CONTRACTOR shall submit detailed calculations and manufacturer's Shop Drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature and pressure ratings.

2.8 PIPE THREADS

A. Pipe threads shall be in accordance with ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

2.9 PIPE INSULATION

A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as indicated, in accordance with the requirements of Section 15145 - Pipe and Equipment Insulation. No unprotected hot piping shall be within reach of operating personnel or other persons.

B. Preinsulated pipe for underground service shall be in accordance with Section 02550 - Preinsulated Pipe.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall slope to low points and be provided with drip legs, shut-off valves, strainers, and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150 lb iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or equal

1. **Armstrong International, Inc.**

2. **Spirax Sarco, Inc.**

PART 3 -- EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. Defective or damaged materials shall be replaced with new materials.

3.2 GENERAL

A. Piping, fittings, and appurtenances shall be installed in accordance with the requirements of applicable Sections of Division 2 and Division 15. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Each gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

3. Bolts shall be initially hand-tightened with the piping connections properly aligned. Bolts shall be tightened with a torque wrench in a staggered sequence to the AISC recommended torque for the bolt material.

4. After installation, joints shall meet the indicated leakage rate. Flanges shall not be deformed nor cracked.

B. **Lined Piping Systems:** The lining manufacturer shall take full responsibility for the complete, final product and its application. Pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.

C. **Core Drilling:** Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and reinforcing bars.

D. **Cleanup:** After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be handed over in a clean and functional condition.

- END OF SECTION -

SECTION 15005 - PIPING IDENTIFICATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide identification for exposed piping and valves, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI A13.1 Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings: A list of suggested wording for each valve tag, prior to fabrication.

C. Samples

1. One sample of each type of identification device.

PART 2 -- PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Except as indicated below for very short pipe lengths, identify exposed piping larger than 2-inches nominal size for the pipe contents and direction of flow.

1. Marker Type

a. Snap Around: Vinyl or polyester sheet with UV- resistant ink, preshaped and sized to tightly curl around the pipe and remain in position.

b. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

c. Stencil: Lettering painted directly on surface of pipe inside color coded marker area.

2. Marker Area: Sized per pipe size according to ANSI A13.1; color from the table below.

3. Lettering: Sized per pipe size according to ANSI A13.1; color from the table below.

4. Arrows: at least 2 arrows at each marker area, showing direction of flow.

B. Pipe 2-inches and smaller shall be identified by plastic plates made from laminated 3-layer plastic with engraved black letters on white background.

C. Pipe identification shall be as manufactured by **Brady, Seton,** or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the indicated system.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

C. Wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.

PART 3 -- EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.3 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. At least once in every room.

3. Within 2-feet of turns, elbows, and valves.

4. On the upstream side of tees, branches, and other distribution points.

5. On both sides of walls and floors through which the piping passes.

3.4 IDENTIFICATION COLORS

A. Conform to the following color codes.

Color Schedule				
Pipe Contents		**Pipe Color**	**Marker Color**	**Letter Color**
Abbreviation	**Identification**			
A	Air		blue	white
BD	Bottom drain		green	white
BP	Plant bypass		green	white
C	Condensate		yellow	black
CD	Chemical drain and vent		yellow	black
CL	Chlorine (gas or liquid state)		yellow	black
CLS	Chlorine solution		yellow	black
CV	Chlorine vent & detection line		yellow	black
FE	Final effluent		green	white
FI	Filter influent		green	white
FSP	Fire protection sprinkler system		red	white
IA	Instrument air		blue	white
LO	Lube oil		yellow	black
LSP	Landscape sprinkler system		green	white
NG	Natural gas		yellow	black
OF	Overflow		green	white
PA	Plant air		blue	white
PD	Plant drain		green	white
PI	Plant influent		yellow	black
PW	Potable water		green	white
RW	Raw water		green	white
SA	Sample lines		yellow	black
SC	Spare chemical		yellow	black

SD	Sanitary drains and vents		yellow	black
SDR	Storm drain		green	white
SS	Sanitary sewer		yellow	black

- END OF SECTION -

SECTION 15006 - PIPE SUPPORTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pipe supports, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the CONTRACTOR shall design and provide the supports in accordance with this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall include the following information:

1. Drawings of pipe supports, hangers, anchors, and guides

2. Calculations for special supports and anchors.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **Code Compliance:** All piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 - Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. **Structural Members:** Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the ENGINEER.

C. **Pipe Hangers:** Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.

D. **Hangers Subject to Horizontal Movements:** At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod

deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. **Spring-Type Hangers:** Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. **Thermal Expansion:** Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or expansion joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed.

G. **Heat Transmission:** Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. **Riser Supports:** Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. **Freestanding Piping:** Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction

1. General: All pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged Supports: All submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24-inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.

3. Corrosive: All piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. **Point Loads:** Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. **Concrete Anchors:** Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table. Consult the ENGINEER for any anchor applications not on the table. Anchor embedment shall comply with Section 05500.

Pipe Support Application	Type of Concrete Anchor
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use **Grinnell (Anvil International), Tolco**, or equal.
Existing Concrete	Use non-shrink grouted anchors, metallic type expansion anchors, or epoxy anchors. Exceptions: Metallic type expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer. Epoxy anchors are not accepted where anchors are subject to vibration or fire.
Vibratory Loads and High Temperature Conditions	Use non-shrink grouted anchors

M. **Noise Reduction:** To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

B. Where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing below.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and greater	30

2. Support Spacing for Welded Fabricated Steel Pipe:

Maximum Spans for Pipe Supported in Minimum
120 degree Contact Saddles (feet)

Nominal Pipe Diameter (inches)	Wall Thickness (inches)									
	3/16	1/4	5/16	3/8	7/16	1/2	5/8	¾	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	43	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	35	40	44	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	40	44	48	51	53	58	62		
54	--	40	44	48	51	54	58	62		
57	--	41	45	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71
66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72
78	--	41	46	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = (7500tD/(32t+D))^{1/2}$$

where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

3. Support Spacing for Ductile-Iron Pipe:

Nominal Pipe Diameter (inches)	**Maximum Span (feet)**
All Diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

4. Support Spacing for Copper Tubing:

Nominal Pipe Diameter (inches)	**Maximum Span (feet)**
1/2 to 1-1/2	6
2 to 4	10
6 and greater	12

5. Support Spacing for Schedule 80 PVC Pipe:

Nominal Pipe Diameter (inches)	**Maximum Span (at 100 degrees F) (feet)**
1/2	4
3/4	4.5
1	5
1-1/4	5.5
1-1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

6. Support Spacing for Schedule 80 Polypropylene Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (at 100 degrees F) (feet)
1/2	3
3/4	3.5
1	3.75
1-1/4	4
1-1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75
12	9.5

7. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (at 100 degrees F) (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
18 and greater	18

2.3 MANUFACTURED SUPPORTS

A. **Stock Parts:** Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. Manufacturers, or Equal:

1. **Basic Engineers Inc**., Pittsburgh, PA;

2. **Bergen-Paterson Pipesupport Corp**., Woburn, MA;

3. **Grinnell Corp. (Anvil International)**, Cranston, RI;

4. **NPS Products, Inc**., Westborough, MA;

5. **Power Piping Company**, Pittsburgh, PA.

6. **Tolco Incorporated**, Corona, CA

2.4 COATING

A. **Galvanizing:** Unless otherwise indicated, all fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. **Other Coatings:** Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09800 - Protective Coating.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 - Power Piping. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. **Appearance:** Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. **Quality Control:** Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

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SECTION 15025 - STEEL PIPE
(ASTM A 53 / A 106, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 15000 - Piping, General apply to the WORK of this Section.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. **Water, Air, Fuel Gas, Oil, Steam, and Waste Service:** Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40 or 80, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

B. **Chlorine and Sulfur Dioxide Pressure Service:** Black steel pipe shall conform to Chlorine Institute Pamphlet 6, ASTM A 106, Grade A or B, and shall be Schedule 80.

2.2 PIPE JOINTS

A. Black steel pipe for general service shall have screwed ends with NPT threads, welded joints, or flanged joints. Screwed joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, socket-weld fittings, or flanges. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

B. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.

C. Galvanized steel pipe shall have screwed ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

D. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.3 FITTINGS

A. **Common Use:** The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Threaded malleable iron fittings conforming to ANSI/ASME B 16.3 - Malleable-Iron Threaded Fittings, Classes 150 and 300.

2. Threaded cast iron fittings conforming to ANSI/ASME B 16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

3. Forged steel socket welded fittings conforming to ANSI/ASME B 16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ANSI/ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.

5. Threaded cast iron drainage fittings conforming to ANSI/ASME 16.12 - Cast Iron Threaded Drainage Fittings.

6. Flanged cast iron fittings conforming to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

7. Flanged steel fittings conforming to ANSI/ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

8. Grooved ductile iron fittings with grooving dimensions conforming to ANSI/AWWA C 606 - Joints, Grooved and Shouldered Type.

9. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

B. Special Applications

1. Fittings for chlorine and sulfur dioxide under pressure shall be 3,000 lb. forged steel socket welded fittings conforming to ASTM A 105, Grade 2 - Forgings, Carbon Steel, for Piping Components, and 300 lb. forged steel fittings conforming to ANSI/ASME B 16.11, as indicated in the Piping Schedule.

2. Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A 105, ANSI/ASME B 16.5, Class 300, with 1/16-inch raised face, with 1/16-inch high temperature, compressed, self-centering ring type gaskets to ANSI/ASME B 16.21 - Nonmetallic Flat Gaskets for Pipe Flanges. Unions shall be four bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets.

3. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 500-lb. CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Company; Vogt Valve Co.;** or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** All steel pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site, to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all

piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the ENGINEER.

B. **Supports and Anchors:** All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Water, steam, condensate, gas, vacuum, and air supply piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. **Branch Connections:** Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipefittings shall be equally cleaned before assemblage.

3.3 PIPE JOINTS

A. **Threaded Joints:** Pipe threads shall conform to ANSI/ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 - Piping, General.

C. **Grooved Joints:** Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conform to ANSI/AWWA C 606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

D. **Push On Joints:** Push on joints and gasket installation shall be in accordance with the Manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

3.4 INSPECTION AND FIELD TESTING

A. **Inspection:** All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired to the satisfaction of the ENGINEER.

B. **Field Testing:** Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are

indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices at no extra cost to the OWNER. For additional testing requirements, refer to Section 01656 - Pressure Pipe Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. After completion of the pressure tests, all chlorine gas piping shall be tested for leakage using chlorine gas under operating pressures. Piping shall be thoroughly clean and dry before admitting chlorine gas into the system. Chlorine shall be slowly admitted to the piping system. Leakage shall be checked with a swab soaked in aqua ammonia solution and waved in the vicinity of each fitting. Ammonia solution shall not be applied to the fittings. Formation of white fumes will be evidence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.

3. Leaks shall be repaired to the satisfaction of the ENGINEER, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

SECTION 15075 - METERS, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide meters and flow measurement devices, complete and operable, in accordance with the Contract Documents.

B. Unless indicated otherwise, the requirements of this Section apply to all meters in Division 15 of the Specifications.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ISA - S 5.1	Instrumentation Symbols and Identification
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
ASME REPORT	Fluid Meters, Sixth Edition, 1971

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Each meter shall be identified with its equipment number, as indicated.

C. **Manufacturer's Data:** With the Shop Drawings, furnish certified curves indicating flow versus differential pressure and any other information called for in the individual meter specifications.

D. **OWNER'S Manual:** Furnish 5 identical copies of complete operation and maintenance instructions of all the metering systems including instrumentation and controls, in accordance with the paragraph “Operational Procedures” in Section 01300.

E. **Spare Parts List:** The CONTRACTOR shall furnish a list of manufacturer's recommended spare parts.

F. **Special Tools:** A list of special tools shall be submitted to the ENGINEER.

G. **Documentation:** After completion the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the metering systems will operate within the published accuracies and flow ranges and meet these Specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

1.4 QUALITY ASSURANCE

A. **Accuracy Requirements:** Unless otherwise indicated, flow meters shall be guaranteed to register flow to an accuracy of plus and minus 2 percent of actual flow throughout the range indicated. Density measuring equipment shall have a degree of accuracy within plus and minus 2 percent of actual solids content over the range indicated.

PART 2 -- PRODUCTS

2.1 SPARE PARTS AND SPECIAL TOOLS

A. Furnish the spare parts listed in the individual meter sections. Spare parts shall be suitably packaged and labeled by part name and associated equipment number.

B. The CONTRACTOR shall furnish special tools suitably wrapped and identified for application.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. After installation, the CONTRACTOR shall obtain the services of an experienced factory service representative to inspect the installation and test all meters for proper performance.

B. **Instruction of OWNER's Personnel:** After completion of the installation and during startup of the plant, the CONTRACTOR shall instruct the OWNER's personnel in the proper operation, maintenance and repair of all metering equipment. For this purpose, the CONTRACTOR shall obtain the services of an experienced factory service representative, who shall spend sufficient time on the Site to fully instruct the OWNER's operating personnel on all phases of the metering equipment.

3.2 INSTALLATION

A. The CONTRACTOR shall assemble and install equipment in strict accordance with the manufacturer's published instructions, under the supervision of the manufacturer's representative. Installation shall be accomplished by competent craftsmen in a workmanlike manner.

B. Meters shall be installed in easily accessible locations for ease of reading and maintenance, and, where shown, for balancing of flow in several lines, in conjunction with throttling and shut-off valves. Wherever possible, all meters shall be installed in such a way to provide the manufacturer's recommended straight approach and straight piping downstream. Meters and shut-off and balancing valves shall be firmly supported from the structure or from the floor with approved supports. In-line meters shall be installed to provide full-line flow and not less than the manufacturer's recommended head at all times.

3.3 TESTING

A. Equipment shall be prepared for operational use in accordance with manufacturer's instructions, including bench test and calibration, where required.

B. Each item shall be subjected to an operating test over the total range of capability of the equipment. Where applicable, tests shall be conducted in accordance with the Test Code of the Standards of the Hydraulic Institute. The CONTRACTOR shall obtain copies of factory test certifications and shall notify the ENGINEER one week in advance of all tests to be conducted on Site.

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SECTION 15181 - DUPLEX STRAINERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide duplex type pipe strainers with manual switch-over valves in accordance with the Contract Documents.

B. All strainers shall be of ample size, with the perforations suitable for each individual service, and designed for easy cleaning and removal of the strainer baskets.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall include construction details, sizes, dimensions, materials, and pressure ratings, in accordance with Section 11000 - Equipment General Provisions.

PART 2 -- PRODUCTS

2.1 DUPLEX STRAINERS (PLASTIC BODY)

A. **Equipment Requirements:** The pipeline strainers for screening corrosive liquids shall be duplex, basket type strainers with manual switch-over valves.

B. **Construction:** The strainers shall have PVC or CPVC bodies with removable covers, flanged ends, switch-over valves with position indicators, drain plugs, plastic baskets with 1/16-inch perforations and minimum ratio of 6:1 of open area to pipe cross-section. All duplex strainers shall have a non-shock pressure rating of 150 psi at 70 degrees F.

C. Manufacturers, or Equal:

1. **Hayward Industrial Products, Inc.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Duplex pipe strainers shall be installed in accordance with the manufacturer's printed instructions and Shop Drawings. There shall be sufficient clearance and working space around the strainers for cleaning purposes and a floor drain or floor sink shall be installed at the strainer for cleaning and draining of the equipment.

B. The pipe connections to each duplex strainer shall be well supported and anchored to allow for safe operation of the switch-over valves.

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SECTION 15200 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 - Equipment General Provisions, apply to the WORK of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

D. Where a valve is to be supported by means other than the piping to which it is attached, the CONTRACTOR shall obtain from the valve manufacturer a design for support and foundation that satisfies the criteria in Section 11000. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.

E. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

F. **Single Manufacturer:** Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for all control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Data in accordance with Section 16460 - Electric Motors for all electric motor-actuated valves.

6. Complete wiring diagrams and control system schematics.

7. Valve Labeling: A schedule of valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. **Technical Manual:** The Technical Manual shall contain the required information for each valve.

D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. **General:** Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. **Valve Actuators:** Unless otherwise indicated, valve actuators shall be in accordance with Section 15201 - Valve and Gate Actuators.

C. **Protective Coating:** The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09800 - Protective Coating. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on all shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 15005 - Piping Identification Systems, and shall by permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

E. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall

any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.

2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

3. **Performance Testing:** Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

F. **Certification:** Prior to shipment, the CONTRACTOR shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

G. **Valve Marking:** Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. **General:** Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:

1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. **Ductile Iron:** ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

3. **Steel:** ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. **Bronze:** ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

5. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

6. **PVC:** Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

7. **CPVC:** Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.

8. **NSF Standard 14:** Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. **Valve End Connections:** Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal.

E. **Stem Guides:** Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.

F. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be in accordance with Section 05500 - Miscellaneous Metalwork.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. The CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated and shall be approved in the City of Roseville Construction Standards for the appropriate service.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

A. **General:** Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. **Access:** Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

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SECTION 15201 - VALVE AND GATE ACTUATORS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. **Unit Responsibility:** The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.

D. **Single Manufacturer:** Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 16485 - Local Control Stations and Miscellaneous Electrical Devices apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals and Section 15200 - Valves, General.

B. **Shop Drawings:** Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. **Calculations:** Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The CONTRACTOR shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. **Manufacturers:** Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.

C. **Materials:** Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. **Actuator Mounting and Position Indicators:** Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. **Standard:** Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Fasteners shall be in accordance with Section 05500 - Miscellaneous Metalwork.

G. Protective coatings shall be in accordance with Section 09800 - Protective Coatings.

2.2 MANUAL ACTUATORS

A. **General:** Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. **Buried Valves:** Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. 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 actuators. Covers of valve boxes shall be permanently labeled as required by the local Utility Company or the ENGINEER. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

C. **Floor Boxes:** Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

D. **Tee Wrenches:** Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.

E. **Manual Worm Gear Actuator:** The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." 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. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 15200 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

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SECTION 15202 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 – Equipment General Provisions apply to this Section.

C. The requirements of Section 15200 - Valves, General apply to this Section.

D. The requirements of Section 15201 - Valve Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 15200.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

4. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for fresh water service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B. Valves 30 inches through 72-inches shall be of the class indicated. Valves larger than 72-inches shall be of the class indicated, designed in accordance with the intent of AWWA C504. If the operating

conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.

B. Valves shall be of the body type, pressure class, end joint, and actuator indicated.

C. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A 126, Class B
End flanges	Gray iron, ASTM A 126, Class B
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 316
Valve discs	Gray iron, ASTM A 126, Class B
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09800 – Protective Coating

D. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.

E. **Worm Gear Actuators**: Valves 30-inches and larger, as well as submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

F. **Electric Actuators:** Electric actuators shall meet the requirements of AWWA C540. Electric actuators in open and close service shall be rated to produce output torque of at least 1.5 times the required valve maximum seating or maximum dynamic torque, whichever is greater. For valves in modulating service with dynamic torque exceeding the seating torque, the rated output torque of the actuator shall be twice the dynamic torque required by the valve. Actuator rated torque is defined as pullout torque rated at 10 percent below the rated voltage of the motor. The torque switch shall be field set at no greater than 60 percent and 50 percent of the maximum actuator rated torque for

open/close service and modulating service, respectively. After plant startup, the manufacturer shall prepare a certification including a torque curve to demonstrate that the torque requirements have been met.

G. Manufacturers, or Equal

1. **DeZURIK Water Controls, Corporation**

2. **Kennedy Valve**

3. **M & H Valve Company**

4. **Mueller Company**

5. **Henry Pratt Company**

6. **Rodney Hunt Company** (24-inches and larger)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 15200.

3.2 SERVICES OF MANUFACTURERS

A. Inspection, Startup, and Filed Adjustment: The service representative of the valve Manufacturer shall be present at the site for 0.5 work days, to assist the CONTRACTOR in the installation and adjustment of the valve(s).

B. Instruction of OWNER's Personnel: The training representative of the valve Manufacturer shall be present at the site for 0.5 work days to instruct the personnel in the operation, adjustment, and maintenance of the valves(s).

C. For the purpose of this paragraph, a work day is defined as an eight hour period, excluding travel time.

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SECTION 15203 - CHECK VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 SWING CHECK VALVES (3-INCH AND LARGER)

A. **General:** Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with ANSI/AWWA C 508 - Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. They shall have a flanged cover piece to provide access to the disc.

B. **Body:** The valve body and cover shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or mechanical joint ends, as indicated.

C. **Disc:** The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

D. **Seat and Rings:** The valve seat and rings shall be of bronze to conforming ASTM B 584 or B 148 - Aluminum-Bronze Castings, or of Buna-N.

E. **Hinge Pin:** The hinge pin shall be of bronze or stainless steel.

F. Manufacturers, or Equal

1. **American Flow Control (Darling)**

2. **APCO (Valve and Primer Corp.)**

3. **Kennedy Valve**

4. **Mueller Company**

5. **Stockham Valves and Fittings**

2.2 SWING CHECK VALVES (2-1/2-INCH AND SMALLER)

A. **General:** Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inch and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. They shall have screwed ends, unless otherwise indicated, and screwed caps.

B. **Body:** The valve body and cap shall be of bronze conforming to ASTM B 763 - Copper Alloy Sand Castings for Valve Application, or ASTM B 584 with threaded ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. **Disc:** Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. **Hinge Pin:** The hinge pins shall be of bronze or stainless steel.

E. Manufacturers, or Equal

1. **Crane Company**

2. **Milwaukee Valve Company**

3. **Stockham Valves and Fittings**

4. **Wm. Powell Company**

2.3 SLANTING DISC CHECK VALVES

A. **General:** Slanting disc check valves for water service shall have a seating angle of approximately 55 degrees. Valves shall have replaceable seat rings and disc rings. The water passage cross-sectional area shall be equal to the full pipe area. Valves shall have sufficient clearance around the pivot pins to permit free seating of the disc without binding and shall be guaranteed not to stick in the closed position. All slanting disc check valves shall have position indicators and two flanged connections for attachment of dashpots or hydraulic snubbers. The valves shall be designed for a water working pressure of 150 psi, unless otherwise indicated.

B. **Body:** The valve body shall be of cast iron conforming to ASTM A 48 - Gray Iron Castings, or A 126, Class B, with flanged ends conforming to ANSI/ASME B 16.1, Class 125, unless otherwise indicated.

C. **Disc:** The valve disc shall be designed with an "aerofoil" configuration of cast iron or ductile iron, with bronze seating face, except for valves 10-inches or smaller, which may have solid bronze or aluminum bronze discs. The disc shall be partially balanced with a short travel, to resist slamming.

D. **Seat Ring:** The seat ring shall be of centrifugally cast bronze, aluminum bronze, or stainless steel, with beveled edges, firmly clamped or screwed into the valve body.

E. **Pins:** The pivot pins and bushings shall be of stainless steel, bronze, or aluminum bronze, to allow free movement of the disc without binding.

F. **Dashpot:** A top mounted hydraulic dashpot shall be provided to control the opening and closing cycle of the valve to prevent surge and water hammer. The dashpot shall have

two control flow rates: (1) 90 percent rapid rate and (2) 10 percent slow rate during shut down and start up. Each rate shall be infinitely and independently adjustable. The dashpot shall be a self contained oil system separate and independent from the water line media. The oil reservoir for the closing cycle shall be stainless steel and open to the atmosphere with an air breather cap to prevent oil spillage. The oil reservoir for the opening cycle shall be stainless steel and hermetically sealed to contain pressure (air over oil) and be equipped with a 3-inch diameter pressure gage and pneumatic fill valve. There shall be a provision for disconnecting the dashpot from the valve for servicing, without removal of the valve.

G. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation)**

2. **Crane Company** (Without Dashpot, Only)

3. **VAL-MATIC (Valve and Manufacturing Corporation)**

2.4 RUBBER FLAPPER SWING CHECK VALVES

A. **General:** Rubber flapper swing check valves for water, sewage, sludge, and abrasives shall have full pipe size flow areas, one moving part only, and body seats at 45 degrees, to permit horizontal and vertical up-flow. Valves shall be designed for a minimum water-working pressure of 150 psi, with a flanged cover plate holding down the rubber flapper. The valves shall be of the non-clog design.

B. **Body:** The valve body and cover shall be of cast iron conforming to ASTM A 126 with flanged ends conforming to ANSI/ASME B 16.1. There shall be a threaded tapping in the bottom of the body for insertion of a back-flow device, and provision for mounting of a signal switch.

C. **Disc:** The valve disc or flapper shall be of Buna-N or other best-suited elastomer one-piece construction, precision molded, with integral O-ring type sealing surface, steel and nylon or fabric reinforced, with non-slam closing action through a 35-degree disc stroke, for bubble-tight shut off at high and low pressures.

D. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation)**

2. **VAL-MATIC (Valve and Manufacturing Corporation)**

2.5 PLASTIC BALL CHECK VALVES

A. **General:** Plastic ball check valves for corrosive fluids, in sizes up to 4-inch, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. **Construction:** The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections, or flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve

design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal

1. **ASAHI-AMERICA**

2. **George Fischer, Inc.**

3. **NIBCO Inc. (Chemtrol Division)**

4. **Spears Mfg. Co.** (PVC, CPVC, AND PP only)

2.6 METAL BALL AND LIFT CHECK VALVES

A. **General:** Metal ball check valves for saturated steam, oil, water and gas in sizes 1/2 up to 1-inch shall be used for horizontal installation only. Lift check valves for LP gas in sizes 1/4 up to 2-inches shall be used for horizontal installation only.

B. **Construction:** The ball check valve body and cap shall be bronze ASTM B 584. Ball disc shall be stainless steel construction, as best suited for each individual service condition. The union cap shall provide a tight joint and be easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 150 psi saturated steam or non-shock cold water, oil, and gas rating of 300 psi.

C. The lift check valve body, and cap shall be leaded bronze ASTM B 763. Disc shall be special composition, as best suited for petroleum service condition. The disc shall be secured to the disc by means of a disc retaining nut. To protect against leakage on light oils and gases, the disc shall be sealed into the holder. The union cap shall provide a tight joint, easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 400 psi cold water, oil, gas, LP gases, and volatile fluids.

D. Manufacturers, or Equal

1. **Crane**

2.7 PLASTIC DIAPHRAGM CHECK VALVES

A. **General:** Plastic diaphragm check valves shall be the type which require no system pressure for sealing and operate silently with minimal pressure drop in either horizontal or vertical flow conditions. They shall utilize either an elastomer diaphragm or teflon encapsulated spring to effect closure.

B. **Construction:** The valve bodies shall be PVC, CPVC, polypropylene (PP), or polyvinylidene fluoride (PVPF) as indicated on the piping schedule. Union connections shall be either NPT or socket ends conforming to ANSI/ASME B 16.5 Class 150. They shall give bubble tight shutoff without dependence on gravity direction, mounting positon, or reverse flow. Seats and seals shall be EPDM, Buna-N, or Viton, as best suited for the service. Inlet pressure ratings shall be 150 psi at 73 degrees F for PVC and PVDF and 100 psi at 73 degrees F for PP.

C. Manufacturers, or Equal

1. **Plastic-O-Matic Valves, Inc.**

2.8 PLASTIC SWING OR WYE-CHECK VALVES

A. **General:** Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8 inches or as available, may be used for horizontal or vertical up-flow conditions.

B. **Construction:** The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction, as best suited for each individual service condition. They shall have flanged ends conforming to ANSI/ASME B16.5 Class 150, and flanged top access covers, and they shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inch and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal

1. **ASAHI-AMERICA**

2. **George Fischer, Inc.**

3. **Spears Mfg. Co.** (Plastic Swing Check only)

2.9 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)

A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.

B. Body: The bodies of all valves in sizes 3-inch and larger shall be of cast iron conforming to ASTM A 126 with 125-lb flanged ends conforming to ANSI/ASME B 16.1 unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body or screwed into the body.

C. Valves smaller than 3-inches shall have bronze bodies with screwed ends conforming to ANSI/ASME B 1.201, suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise indicated. The type of bronze shall be suitable for the intended service.

D. Disc and Stem: The disc and stem of all valves in sizes 3-inch and larger shall be of bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications, or stainless steel. The stem shall have two-point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.

E. Valves smaller than 3-inches shall have discs and retaining rings of Teflon, nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.

F. Stem Guide: The stem guide shall be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall furnish each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the Shop Drawing submittal.

G. Seat: Valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. Resilient seats shall be firmly attached to the seating ring by compression-molding or other acceptable method.

H. Spring: Valves in sizes 3-inch and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inch shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

I. Manufacturers, or Equal

1. **APCO (Valve and Primer Corp.)**

2. **CPV (Combination Pump Valve Company)**

3. **Miller Valve Co., Inc.**

4. **VAL-MATIC (Valve and Manufacturing Corporation)"**

2.10 DEEP WELL CHECK VALVE

A. General: Deep well check valves shall be of the internal spring-loaded type, with female threaded ends. Valve discs shall be of the poppet type or the twin, hinged type.

B. Poppet Valves: Valve bodies shall be ductile iron conforming to ASTM A536. Discs shall be ductile iron or stainless steel, mounted on stainless steel stems, which shall be guided by bronze bushings. Valves shall have stainless steel springs and resilient Buna-N seats for bubble-tight shut-off. Valves shall be rated for a water working pressure of not less than 300 psi.

C. Twin Disc Valves: Valve bodies shall be bronze conforming to ASTM B62. Internals shall be bronze. Valves shall have stainless steel springs and resilient Buna-N seats for bubble-tight shut-off. Valves shall be rated for a water working pressure of not less than 300 psi.

D. Manufacturers

1. Poppet valves shall be as manufactured by **FLOWMATIC Corporation,** or equal.

2. Twin disc valves shall be as manufactured by **TECHNO Corporation,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 15200 - Valves, General.

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SECTION 15205 - DIAPHRAGM VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide diaphragm valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

C. The requirements of Section 15201 - Valve Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **Construction:** Diaphragm valves shall be of the weir type, unless otherwise indicated, and be of the material combination best suited for each individual application. They shall be suited for bi-directional throttling service and installation in any position, with bubble-tight shut-off. Valves on outlets and drain nozzles of storage tanks shall have lined metal bodies.

B. **Actuators:** Unless otherwise indicated, diaphragm valves shall have manual hand-wheel actuators with position indicators and transparent plastic stem covers of clear acrylic, polycarbonate, or similar material. Valve actuators shall be in accordance with Section 15201 - Valve Actuators. The handwheels shall be of cast-iron, aluminum, or polypropylene.

2.2 METAL BODY DIAPHRAGM VALVES

A. **Construction:** The valve body shall be of cast-iron to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B, or of ductile iron to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, with PVDF lining. The valve ends shall be flanged to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 125 lb. rating, or screwed, as indicated. The valve bonnet shall be steel, with brass or bronze sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts and nuts shall be of stainless steel and the stem and bonnet seals of Viton O-rings.

B. **Diaphragm:** The diaphragms shall be of the best suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal

1. **ITT Dia-Flo**

2. **Mc Canna, Inc.**

2.3 PLASTIC BODY DIAPHRAGM VALVES

A. **Construction:** Unless otherwise indicated, valve bodies shall be of PVC, CPVC, PP, or PVDF construction, as best-suited for each individual service, with union ends, screwed ends, socket-welded ends, spigot ends, or flanged ends to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, drilled to 150 lb. dimensions, as indicated. The valve bonnets shall be flanged and of PVC, PP, or PVDF construction. The valve compressor stem shall be the same material as the valve body or of a material compatible with the fluid service. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 73 degrees F, diminishing to not less than 50 psi for larger sizes.

B. **Diaphragm:** The diaphragms shall be of the best-suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon, Viton, or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be laminated Teflon/EPDM: diaphragms shall be constructed with suitable lamination to prevent gas migration. Diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal

1. **ASAHI/America**

2. **George Fischer, Inc. (+GF+)**

3. **ITT Dia-Flo**

4. **Mc Canna, Inc.**

5. **Spears Mfg. Co.**

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 15200. Care shall be taken that all valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

SECTION 15206 - GATE VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

C. The requirements of Section 15201 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Buried valves shall be of the inside screw, non-rising stem type. The valve actuators shall be as indicated, with counter-clockwise opening stems, in accordance with Section 15201.

2.2 METAL-SEATED GATE VALVES (3-INCHES AND LARGER)

A. **Construction:** Metal-seated gate valves for water and sewage service shall conform to AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service. The valve bodies shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, or ductile iron conforming either to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, or to ASTM A 536 - Ductile Iron Castings, with flanged, bell and spigot, or mechanical joint-ends as indicated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of AWWA C500. The design working water pressure shall be 200 psig for valves 12-inches and smaller and 150 psig for larger valves. The valves may be of the double-disc type for tighter shut-off, or of the solid-wedge type, with rising or non-rising stem. For sewage or fluids containing solids, an outside thread shall be used. Valves 14-inches and larger installed in vertical pipes shall be fitted with bronze slides, tracks, rollers, and scrapers to assist the travel of the gate assembly. Gate valves 14-inches and larger shall be furnished with bypass assemblies.

B. **Actuators:** Unless otherwise indicated, gate valves shall have manual actuators in accordance with Section 15201.

C. Manufacturers, or Equal

1. **Clow Valve Co.**

2. **Kennedy Valve**

3. **M & H Valve Company**

4. **Milwaukee Valve Company, Inc.**

2.3 KNIFE-GATE VALVES (2- to 96-inch)

A. **Construction:** Knife-gate valves shall be of the flanged or wafer design, with raised face and resilient seats for positive seating. Wetted parts shall be constructed of Type 316 stainless steel, and the gates shall be finish-ground on both sides to prevent packing or seat damage. Valves 2- to 12-inches in size shall be furnished with cast stainless steel bodies; valves 14-inches and larger shall have semi-steel bodies with stainless steel linings. The valve stem shall be of stainless steel with a long life packing. The valves shall be rated for tight shut-off at the following pressures:

1. Valve sizes 4- to 12-inches 150 psi (bi-directional)

2. Valve sizes larger than 12-inches 50 psi

B. **Actuators:** Knife-gates shall have outside-screw and yoke-rising stems with manual handwheel actuators, unless otherwise indicated, in accordance with Section 15201.

C. Manufacturers, or Equal

1. **DeZURIK Water Controls Corporation**

2. **Fabri-Valves**

3. **Rovang, Inc.**

2.4 RESILIENT-SEATED GATE VALVES

A. **General:** Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the ENGINEER.

B. **Construction:** Resilient-seated gate valves shall conform AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service. The valves shall be suitable for a design working water pressure of 200 psig, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 AWWA C515. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C515.

C. **Protective Coating**: Valves shall be factory coated in accordance with Section 09800 - Protective Coating. The CONTRACTOR shall submit a test report from a coating inspector that the coating is holiday-free. The CONTRACTOR shall be aware that it may retain the services of a third party coating applicator to achieve the holiday-free requirement.

D. **Actuators:** Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 15201.

E. Manufacturers, or Equal

1. **Mueller Company**

2. **M & H**

3. **Clow**

2.5 HIGH-PRESSURE GATE VALVES (2- TO 12-INCHES)

A. **Construction:** High-pressure gate valves, except for buried valves, shall have cast iron bodies and flanged bonnets with outside screw & yoke rising stems conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 250 psi flanged ends. The valves shall be rated for 250 psig steam and 500 psig cold water working pressure. The solid wedges shall be of bronze or cast iron, bronze-fitted, and the stem shall be of bronze with non-asbestos fiber packing.

B. **Actuators:** Unless otherwise indicated, high-pressure gate valves shall have cast iron or ductile iron handwheels with 2-inch square operating nuts, in accordance with Section 15201.

C. Manufacturers, or Equal

1. **Crane Company**

2. **Milwaukee Valve Company**

3. **Wm. Powell Company**

4. **Stockham Valves and Fittings**

5. **Walworth Company**

2.6 PLASTIC GATE VALVES (1-1/2 TO 14-INCHES)

A. **Construction:** Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined wedges for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2 through 8-inches, 110 psig for size 10-inches, and 70 psig for sizes 12- and 14-inches.

B. **Actuators:** Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 15201.

C. Manufacturers, or Equal

1. **ASAHI/America**

2. **Spears Mfg. Co.**

PART 3 -- EXECUTION

3.1 GENERAL

A. Gate valves shall be installed in accordance with the provisions of Section 15200. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

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SECTION 15214 - CONTROL VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide control valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 VALVE CHARACTERISTICS

A. **Function:** The waste valve shall be controlled with a CLOSE-OPEN-AUTO (COA) selector switch. In CLOSE, the waste valve shall close by energizing the solenoid. In OPEN, the waste valve shall open. In AUTO, the waste valve shall be controlled by the PLC. A pilot line to the waste valve will use the distribution system pressure downstream of the check valve to keep the waste valve in the open position. When the pump starts, with the waste valve in AUTO, the waste valve shall be open. After a period of time (to be determined during start up), the solenoid shall be energized to close the waste valve and allow discharge from the pump to flow into the distribution system.

B. **Operation:** The valve shall be a hydraulically operated, adjustable pilot controlled, diaphragm type globe valve.

2.2 VALVE CONSTRUCTION

A. **Valve Body:** The valve body shall be of ductile iron to ASTM A 536 - Ductile Iron Castings, with 150 lb flanged ends to ANSI/ASME B 16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and of the same material as the body. All necessary repairs shall be possible without removing the valve from the pipeline.

B. **Valve Trim:** The valve stems with position indication, springs, body seat rings, and all bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. The valve pistons and piston liners shall be bronze to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings. All rubber parts shall be of Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover.

C. **Valve Controls:** The valve shall be furnished with a complete, externally mounted control system, including an adjustable speed control, needle valves, strainers, check valve, isolation valves, solenoid control, limit switch assembly, 3-way diaphragm-type valve, and all necessary copper or stainless steel connecting tubing and fittings. The controls shall be capable of achieving all the flow and speed adjustment indicated and of preventing any backflow through the valve.

2.3 FACTORY TESTS AND WARRANTY

A. All valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the ENGINEER prior to delivery of the valve. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship

2.4 OPERATING CONDITIONS

A. The valve shall be designed to operate under the following conditions:

1.	System pressure (psi)	-	65
2.	Pump shut-off head (psi)	-	260
3.	Maximum flow (gpm)	-	2,800
4.	Maximum head loss at maximum flow (psi)	-	10
5.	Valve size (inches)	-	10
6.	Size of pipeline (inches diameter)	-	10

2.5 SPARE PARTS

A. The following spare parts shall be furnished in accordance with Section 15200:

1. 1 set of all resilient seals and discs

2. 1 diaphragm (for diaphragm valves, only)

2.6 MANUFACTURERS OR EQUAL

A. Control valve shall be as manufactured by **Cla-Val Company, Model 661-02, 10-inch reduced port valve,** or equal.

B. **G A Industries**

C. **OCV Control Valves**

D. **Ross Valve Mfg. Co., Inc.**

E. **Singer Valve, Inc.**

F. **Watts, ACV**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in accordance with provisions of Section 15200.

3.2 SERVICES OF MANUFACTURERS

A. **Inspection, Startup, and Field Adjustment:** The service representative of the valve Manufacturer shall be present at the site for 0.5 work days, to assist the CONTRACTOR in the installation and adjustment of the valve(s).

B. **Instruction of OWNER's Personnel:** The training representative of the valve Manufacturer shall be present at the site for 0.5 work days to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a work day is defined as an eight hour period, excluding travel time.

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SECTION 15218 - PRESSURE RELIEF VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide pressure relief valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 TEMPERATURE AND PRESSURE RELIEF VALVES

A. **Valve Construction:** Temperature and pressure relief valves for cold and hot water, steam, and air service, unless otherwise indicated, shall have a minimum pressure rating of 250 psi, bronze, steel, or stainless steel bodies, adjustable spring action, screwed or flanged connections, and trim to suit individual applications. Settings shall be adjusted for each specific condition.

B. Manufacturers, or Equal

1. **A.W. Cash Valve Mfg. Corp.**

2. **Consolidated (Dresser Industries Valve Division)**

3. **Fisher Controls Company**

4. **Kunkle Valve Division**

5. **Masoneilan (Dresser Industries Valve and Controls Division)**

6. **Watts Regulator Company**

7. **Wilkins Regulator (A Division of Zurn Industries)**

2.2 PLASTIC PRESSURE RELIEF VALVES, SIZES 1/2 THROUGH 1-1/2 INCHES

A. Plastic pressure relief valves shall be suitable for the fluid service and shall be designed for a maximum of 150 psi water working pressure. For chemicals and all corrosive fluids, solenoid valves shall be of PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon, as recommended by the manufacturer for the specific application.

B. **Characteristics:** Pressure relief valves shall open when the inlet pressure exceeds a set maximum level. It shall maintain that pressure and gradually close as the inlet pressure drops below the maximum pressure. Valves shall be spring or hydraulically

operated, direct acting, adjustable, diaphragm or piston type globe or angle valve, as indicated.

C. Manufacturers, or Equal

1. Corrosive fluids

a. Plast-O-Matic Valves, Inc.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 15200.

3.2 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** The service representative of the valve manufacturer shall be present at the Site for 1/2 work days, to assist the CONTRACTOR in the installation and adjustment of the valve(s).

B. **Instruction of OWNERS Personnel:** The training representative of the valve manufacturer shall be present at the Site for 1/2 work days to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a work day is defined as an eight hour period, excluding travel time.

- END OF SECTION -

SECTION 15219 - DOWNHOLE INJECTION CONTROL VALVE SYSTEMS

PART 1 -- GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall furnish all tools, equipment, materials and supplies and shall perform all labor required to furnish and install the aquifer storage and recovery control valve and appurtenances shown on the plans and specifications herein.

1.2 SCOPE OF WORK

A. The work of this section shall include the furnishing, installation, and testing of the aquifer storage and recovery control valve and appurtenances as specified herein, shown on the plans, and as required to make the valve operable and complete.

B. Major Items Included

1. Valve

2. Automated Control Panel

3. Appurtenances, including hoses and tubing, receivers, tanks, valves, regulators, and fittings

4. All other items necessary for the valving system to function as required by this Section.

1.3 RELATED WORK

A. Related work not included in this section can be found in the following sections:

1. Section 15200, Valves

2. Section 11103, Vertical Turbine Pumps

1.4 SUBMITTALS

A. In accordance with Section 15200, for each valve and power unit:

1. Shop Drawings, showing dimensions and materials of construction

2. Assembly instructions and spare parts list

3. Preventive/corrective maintenance instructions

4. Procedures for installing, adjusting, and testing the valves

5. Factory test reports

6. Valve manufacturer’s certificate of proper installation for each valve

7. Cavitation chart for the full range of recharge operating conditions

B. The CONTRACTOR shall coordinate Baski Flow Control Valve submittal with Section 11103 Vertical Turbine Pump submittal.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The ASR valves will be placed above the pump bowl assembly in vertical turbine pump columns. The open pump line shaft shall pass through the ASR valve interior without obstruction.

B. The ASR valves shall control recharge flow rates into the well. A foot valve will be installed at the pump suctions to prevent recharge water from passing through the pump bowls.

C. Recharge flow shall be stable within ± 3 percent when injection pressure and valve control pressures are constant and injection water level is stabilized. The ASR valves shall not cause cavitation in the valve or in the annular space between the valve and well casing during recharge at the conditions specified.

D. ASR valves shall be capable of supporting 3,000 lbs of pump, foot valve, ASR valve and column weight during installation in the well and operation.

E. ASR valves shall be coupled to the pump column by means of carbon steel threaded adaptors.

F. The ASR valve manufacturer shall supply stainless steel protectors for each column pipe coupling to protect control tubing or hoses.

G. Materials

1. Bolts shall conform to the requirements of ASTM A193, Gr B8M.

2. Control tubing and fittings shall be Type 316 stainless steel.

3. ASR valve bodies shall be stainless steel, Type 316, in standard or low carbon (L) grades.

H. Control Panel

1. Provide the following functions:

a. Automated control panel.

b. Ability to make changes in valve opening.

c. Selection between recovery and recharge mode.

I. Operating Conditions

1. Fluid service	-	Well water
2. Fluid temperature, (degrees F)	-	50-85

3. Fluid pH - 6-8

4. Well casing ID, (inches) - 20

5. Pump column OD, (inches) - 12.75

6. Static water level, (ft , BGS) - 105

7. ASR valve setting depth (ft , BGS) - 295 top of valve

J. Performance Requirements

1. Design well recharge flow (gpm) - 1,000

2. Design well production flow (gpm) - 2,340

3. Design well pump-to-waste flow (gpm) - 2,800

4. Maximum internal pressure, valve (psi) - 400

5. Valve 100 percent C_v (gpm/(psi)$^{0.5}$) - 300-450

6. Allowable recharge flow fluctuation – 3 with constant recharge pressure and control pressure (percent plus and minus)

K. Install neoprene between pump column and control tubing by sleeving control tubing with neoprene and securing with 1-inch stainless steel banding at 10-foot spacing. Provide tubing protectors for the stainless steel control tubing at each coupling with stainless steel attaching bands. The protectors should prevent metal tubing-to-coating contact with either the column pipe or the well casing.

2.2 MANUFACTURER – SPECIFIC REQUIREMENTS

A. The downhole injection valve and appurtenances shall be provided by Baski Inc., to match existing City equipment.

B. “Baski Flow Control Valve” ASR valve and appurtenances shall be as follows:

1. A pressurized nitrogen gas control system shall be provided to pressurize the ASR valve rubber control element. The system shall be designed and provided by the ASR valve manufacturer and consist of solenoid control valves, nitrogen pressure transmitter, nitrogen supply system, make-up nitrogen supply system, interconnecting tubing and valves, and an automated control panel.

2. The nitrogen supply system shall consist of two filled “k” size cylinders with regulators, gauges, valve manifold, and cylinder rack. Nitrogen cylinders shall be obtained by the Contractor from a local gas supply business, selected by the City of Roseville.

3. Provide nitrogen pressure transmitter with digital display to be mounted on automated control panel, with pressure range of 0 to 400 psi.

4. Interconnecting tubing shall be provided between all nitrogen gas control system components. Tubing shall be ¼-inch OD, fully annealed Type 316 stainless steel

tubing with a minimum working pressure rating of 5,000-psi. Tube fittings shall be Type 316 stainless steel compression fittings rated to the working pressure of the tubing.

5. The nominal valve end size shall be 12-inch. The valve shall be coupled to the 12-inch pump column by the use of adaptors as specified and shown on the drawings.

2.3 FACTORY TESTING

A. ASR valves shall be inspected and performance tested at the factory before shipping.

B. Head loss data shall be collected, and Cv shall be calculated at 4 different flows within the specified range in each flow direction.

C. Test records and report shall be submitted in accordance with Section 01300.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation of each ASR valve shall be in strict accordance with manufacturer’s recommendations.

B. The CONTRACTOR shall furnish a trained and authorized manufacturer's field service representative from each manufacturer for 2 days to act in an advisory capacity during installation of its equipment. The valve manufacturer shall certify in writing that each valve is correctly installed, and will function as intended by the Contract Documents, prior to final acceptance by the OWNER.

C. The CONTRACTOR shall hydrostatically test the complete pump, ASR valve and deep well check valve assemblies prior to equipment startup. The test pressure shall be selected by the ENGINEER to produce a differential of 250 psi across the closed deep well check valve.

3.2 STARTUP

A. Each authorized field service representative shall perform at least 8 hours of start-up, testing, and training services. Concurrent with these 8 hours, the representatives shall remain on call for on-site assistance until its ASR valve has operated satisfactorily for 4 hours.

- END OF SECTION -

SECTION 15230 - MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 15200.

PART 2 -- PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. **Air and Vacuum Valves:** Air and vacuum valves shall be in accordance with the City of Roseville Construction Standards.

2.2 AIR AND VACUUM VALVES FOR VERTICAL TURBINE PUMPS

A. An air and vacuum valve for the vertical turbine pump shall be installed on the pump discharge pipe indicated. The valve shall vent large quantities of air out through the orifice when pump starts, close tight when liquid enters, and permit and large quantities of air to re-enter through orifice when pump stops, to prevent vacuum forming in the pump column. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. The discharge orifice shall be fitted with a double-acting throttling device to regulate and restrict air venting, which shall establish a pressure loading on the rising column of water and eliminate damaging shock to the pump, controls, and valves during pump start. On pump stop, a double-acting throttling device shall automatically open, allowing full line unrestricted air re-entry to prevent any vacuum to form in the pump column. The valve shall be designed for minimum 250 psi water-working pressure.

B. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation**)

2. **Val-Matic (Valve and Manufacturing Corporation)**

2.3 BACKFLOW PREVENTER VALVES

A. **General:** Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. Manufacturers, or Equal

1. **Watts, ACV**

2. **Wilkins Regulator Division (Zurn Industries)**

3. **Ames**

2.4 CORPORATION STOPS

A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required.

B. Manufacturers, or Equal

1. **Ford Meter Box Company, Inc.**

2. **James Jones Company (Watts, ACV)**

3. **Mueller Company**

2.5 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Unless otherwise indicated, for chemicals and all corrosive fluids, solenoid valves with PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or Teflon materials of construction, suitable for the specific application shall be provided. Enclosures shall be NEMA rated in accordance with the area designations of Section 16050 - Electrical Work, General. All coil ratings shall be for continuous duty. For electrical characteristics see electrical drawings or specifications.

B. Manufacturers, or Equal

1. For general duty

a. **Automatic Switch Co. (ASCO), Model "RED HAT"**

b. **Skinner Valve (Parker Hannifin Corporation)**

c. **Magnatrol Valve Corporation**

d. **J. D. Gould Co.**

2. Metallic valves for corrosive fluids

a. **Valcor Engineering Corporation**

3. Plastic valves for corrosive fluids

a. **+GF+ Plastic Systems, Inc.**

b. **Spears Mfg. Co.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, and wherever there is any danger of contamination, and where indicated.

B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with provisions of Section 15200.

C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

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SECTION 15430 - PLUMBING PIPING AND SPECIALTIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plumbing piping and specialties, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15000 - Piping, General apply to the WORK of this Section.

1.2 WORKMANSHIP AND MATERIALS

A. All work shall in strict accordance with the Uniform State Plumbing Code, and codes of the State of California, City of Roseville, and any other authorities having jurisdiction. The CONTRACTOR shall have required certifications and be thoroughly familiar with the local codes. The CONTRACTOR shall obtain and pay for all necessary permits.

B. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and erection of piping and placing of equipment. The CONTRACTOR shall remove all stains and repair all damage before final acceptance of the WORK.

C. If the ENGINEER finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the CONTRACTOR has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof will be determined by the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

B. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.

2.2 PIPING AND FITTINGS

A. Cast iron sanitary, storm, and vent pipe and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A 74 - Cast Iron Soil Pipe and Fittings. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A 74.

B. Hub-Less cast iron soil pipe and fittings with **Clamp-All** type pipe couplings, or equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities. Hub-Less cast iron soil pipe and fittings shall meet CISPI Standard 301. Pipe couplings shall have high torque capacity and meet FM standard 1680.

C. Copper tubing and fittings for potable and service water 3-inches and smaller shall be Type K copper tube with soldered fittings.

D. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12-inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet.

E. Drainage and vent piping from equipment in the laboratories shall be acid resistant polypropylene. The piping shall extend from the outlets of the sinks through deep seal polypropylene traps to the main sanitary sewer. The piping shall follow local code requirements for combination waste and vent systems and for floor drains and sinks. The piping shall be flame retardant polypropylene with mechanical joints as manufactured by **Lab-Line/Enfield**, or equal.

2.3 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. **General:** The CONTRACTOR shall provide all necessary hangers and supports. No perforated strap hangers and no wire supports will be permitted. Pipe supports shall be as indicated in Section 15006 - Pipe Supports.

B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation. Insulation at support points shall be provided with metal shields to prevent damage to the insulation.

C. Spacing

1. Pipe support spacing for steel and cast iron pipe is given in Section 15006.

2. Copper tube support spacing shall be not more than 6-feet between supports.

D. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.

E. Pipe hangers used to support uninsulated copper tube shall be copper or copper plated.

F. Vertical piping shall be supported at the base with fittings made for this purpose or supported from the nearest horizontal member or floor with a riser extension pipe clamp.

G. Anchors that are installed into existing concrete shall be **Grinnel Figure 117, Modern Figure 740**, or equal expansion case inserts. Drill clean holes for insertion of case and patch concrete around hole as required.

H. Continuous slotted concrete inserts, if used, shall be **Crawford Figure 148, Fee & Mason Figure 9000**, or equal. The CONTRACTOR shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.

I. Concrete inserts shall be as indicated in Section 15006. Inserts shall be galvanized.

2.4 PIPE SLEEVES

A. Where pipes pass through floors, sleeves shall extend 3-inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.

B. Sleeves shall be Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.

C. At exposed wall or ceiling surfaces, the CONTRACTOR shall install a suitable chromium plated brass wall plate approved by the ENGINEER.

2.5 VALVES

A. **General:** Water shut off valves shall be the gate type, except on fixture supply piping where globe valves shall be used.

B. Interior hose valves shall be provided as indicated. The globe valve indicated shall be as given hereinbefore for valves. The hose nipple shown on the detail shall be a female iron pipe thread inlet with hose thread outlet. Hose bibbs shall be 3/4-inch in size.

C. Gate, globe, check, plug, and angle valves shall be in accordance with the following:

1. Section 15206 - Gate Valves

2. Section 15203 - Check Valves

D. The CONTRACTOR shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system. Shut off valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.

E. Valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.

F. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The CONTRACTOR shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or elsewhere if approved by the ENGINEER.

2.6 ACCESS DOORS AND COVERS

A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be **Karp Assoc., Style DSC-210, Inryco-Milcor, Style AT**, or equal. Doors shall be of sufficient size to allow access but shall be not less than 12-inches by 12-inches. Ceilings with lay-in acoustical tile will not require access panels. Valves and equipment located above ceiling tile shall have a 3/4-inch diameter blue plastic button with a letter "V" set in tile.

B. Floor access covers in unfinished concrete floors not exposed to chemicals shall be galvanized cast iron with a clear opening of not less than 8-inches by 8-inches, and shall be as manufactured by **Alhambra Foundry Company, Model A-2015; Neenah Foundry Co., No.R-6687**, or equal. In traffic or chemical areas, access covers shall be as manufactured by **Alhambra Foundry Company, Model A-1240; Neenah Foundry Co., Model R-1977**, or equal, with clear opening of not less than 10-inches in diameter.

2.7 ROOF DRAINS

A. Roof drains shall have galvanized cast iron drain bodies, threaded outlet, removable locking mushroom aluminum or brass stone strainers, clamping collars with integral gravel guards, receiver, deck clamp, and extension sleeves where required.

B. Manufacturers, or Equal

1. **Josam Mfg. Co., Series 21500**

2. **Jay R. Smith Mfg. Co., Fig. 1010**

3. **Zurn Industries, Inc., Series Z-100**

2.8 FLOOR DRAINS IN CONCRETE FLOORS

A. **General:** Floor drains in concrete floors shall be of cast iron, in the sizes indicated, with sediment buckets. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing, 12 inches minimum all around.

B. Manufacturers, or Equal

1. **Josam Mfg. Co., Series 31120**

2. **Jay R. Smith Mfg. Co., Fig. 2350**

3. **Zurn Industries, Inc., Series Z-520-Y**

2.9 FLOOR DRAINS IN CHEMICAL AREAS

A. General: Floor drains in chemical handling areas subject to corrosive liquids shall be made of high silicon content corrosion-resistant cast iron with NO-HUB mechanical joints, in the sizes indicated.

B. Manufacturers, or Equal

1. **Flowserve Corp., Model 5502-CB,** for slab-on-grade drains.

2. **Flowserve Corp., Model 5501-CBF,** for drains on upper floors.

2.10 FLOOR SINKS

A. **General:** Floor sinks shall be 12-inch by 12-inch by 8-inch, of acid-resistant white enameled cast iron, with epoxy-coated, interior aluminum dome strainer, nickel-bronze or acid-resistant full-size, half, or quarter grating as required by the number of indirect wastes, and have a flashing clamp for upper floor locations, only.

B. Manufacturers, or Equal

1. **Josam Mfg. Co., Series 49040**

2. **Jay R. Smith Mfg. Co., 3150 Series**

3. **Zurn Industries, Inc., Series ZN-1806**

2.11 TRAP SEALS AND PRIMERS

A. Where required by code, floor drains and floor sinks connected to the sanitary sewer shall be protected by trap primers connected to the water supply to the nearest plumbing fixture. One half-inch copper tubes shall run from the primers to the traps. Trap primers shall be mounted in accessible locations.

B. Manufacturers, or Equal

1. **Josam Mfg. Co., Model 88250**

2. **Jay R. Smith Mfg. Co., Model 2699**

3. **Zurn Industries, Inc., Model Z-1022**

2.12 CLEANOUTS

A. **General:** Cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.

B. Manufacturers, or Equal

	Josam Series	J.R. Smith No.	Zurn No.
Exposed Locations	**58500-20**	**4405**	**Z-1440-A**
Underground (finished floors)	**56010/30**	**4143**	**ZN-1400-2**
Walls, Concealed	**58790-20**	**4535**	**ZN-1445-1-A**
Traffic Areas	**56070**	**4240**	**Z-1420-27**

C. Clean outs shall have a minimum diameter of 3-inches.

D. Stack cleanouts shall be installed at the base of each stack. Cleanouts shall be galvanized cast iron with ABS plastic cleanout plugs.

2.13 HOSE BIBBS AND HYDRANTS

A. **General:** Hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs reading "DO NOT DRINK" in clearly legible letters, permanently attached at the hose bibb. Where indicated, hose bibbs shall be provided with vacuum breakers as furnished by **Crane Co., American Standard**, or equal.

B. Manufacturers, or Equal

Drawing Callout	Fixture Type	Description
HB-2	Non-freeze wall-type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. 1. **Josam Mfg. Co., Series 71000** 2. **Jay 5. Smith Mfg. Co., Fig. 5510/5511** 3. **Zurn Industries, Inc., Fig. Z-1300.**
HB-3	Hose valves	Heavy duty bronze hydrant, with composition disc, handwheel, cap and chain. Size 3/4-inch, without cap and chain: 1. **Apollo (Conbraco Industries, Inc.) Model 70-804, or 78-104** 2. **Chicago Faucet No.7T** 3. **Ford Meter Box Co., Model B8H-233HB2** 4. **Woodford Manufacturing Co., Model Y24 or 24P**

2.14 SHOCK ABSORBERS

A. Cold and hot water piping in buildings connecting to self-closing faucets, quick-action valves, water closets, emergency showers, washers, and dishwashers shall be protected by shock absorbers located at each fixture or battery of fixtures. Shock absorbers shall be corrosion-resistant, permanently sealed, and shall be sized and installed to the manufacturer's printed recommendations.

B. Manufacturers, or Equal

1. **Josam "SHOKTROLS"**

2. **Jay R. Smith "HYDROTROL"**

3. **Zurn, Model Z-1022**

2.15 WALL-MOUNTED HOSE RACKS

A. The CONTRACTOR shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gauge sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100-feet of the hose indicated below. Racks located in the open shall be supported from two 2 by 2 by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.16 HOSES AND NOZZLES

A. The CONTRACTOR shall furnish the following lengths of hose:

2 – 75 ft lengths of 3/4-inch hose

B. Each length of hose shall be provided with male and female connectors and nozzle. Hoses shall be seamless extruded rubber with dacron cotton exterior designed for a working pressure of at least 200 psi.

C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.

D. Nozzle Manufacturers, or Equal

1. **W.D. Allen Mfg. Co.**

2. **Fire-End and Croker Corp.**

3. **Halprin Supply Co.**

4. **Western Fire Equipment Co.**

2.17 BACKFLOW PREVENTER

A. Provide reduced pressure backflow prevention units where indicated. The units shall be bronze body construction, with celcon check seats and stainless steel relief valve seats, shafts, and bolts. The units shall have tight seating check valve and relief assemblies, and bronze bodies with non rising stem ball valve test cocks. The units shall be **No. 909 series** as manufactured by **Watts Regulator Co.; Febco;** or equal. Installation shall meet all local code requirements. Backflow preventers for automatic sprinkler systems shall be in accordance with Section 15230 - Miscellaneous Valves.

2.18 PAINTING

A. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09900 - Architectural Finishes. Prime colors shall be compatible with finish coats to be applied in the field.

B. Self contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.

C. Field painting shall comply with Section 09900 - Architectural Finishes.

PART 3 -- EXECUTION

3.1 PREPARATION

A. The CONTRACTOR shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

3.2 OPENINGS

A. **New Construction:** The CONTRACTOR shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. Openings shall be as indicated or as required to provide passage for the plumbing WORK.

B. Existing Construction

1. The CONTRACTOR shall provide openings required in existing walls, floors, and roofs for the passage of piping and plumbing equipment. Openings shall be as indicated or required for passage.

2. Openings shall be cut in a neat and orderly manner, minimizing damage to existing structures. Patching of openings shall match existing construction.

3. The CONTRACTOR shall be responsible for hangers and supporting members installed in existing masonry or structural steel as required for the proper completion of the WORK.

3.3 INSTALLATION AND APPLICATION

A. The CONTRACTOR shall provide plumbing specialties in accordance with manufacturer's printed instructions.

B. Pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. Pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. Piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

E. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve, or piece of equipment may be easily disconnected.

F. Drainage and sanitary lines shall be properly run, trapped, and vented to conform with Code requirements. Changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3-feet.

G. Horizontal soil, drain, and waste pipes shall be given a slope of at least 1/4-inch per foot unless indicated otherwise.

H. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

I. Plug each natural gas outlet, including valves, with a threaded plug or cap immediately after installation and retain the plugs until continuing piping or equipment connections are completed.

J. Joints in PE pipe shall be installed so that the longitudinal pull out resistance of each joint is at least equal to the tensile strength of the pipe

3.4 EQUIPMENT - DAMAGE AND REMOVAL

A. The CONTRACTOR'S operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment which are to remain in the finished WORK. Any damage caused by the CONTRACTOR or subcontractor through their operations shall be repaired to the satisfaction of the ENGINEER.

3.5 TESTING

A. CONTRACTOR shall make such tests as are required by local ordinances and codes in the presence of a local governing authority inspector to show that piping is tight, leak free, and satisfactory, and shall also perform such tests as the ENGINEER may direct to insure that all fixtures and equipment operate properly. The CONTRACTOR shall pay all costs in making such tests and the costs of making all changes or repairs until the WORK is acceptable to the governing authorities.

3.6 DISINFECTION

A. After potable water supply lines are tested, they shall be disinfected by introducing HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 psi pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the OWNER. This procedure shall be repeated as often as necessary until the line is pronounced safe for use by the OWNER. No cross connection between the water mains and any pipe not yet disinfected will be permitted.

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SECTION 15440 - PLUMBING FIXTURES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plumbing fixtures, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Show material type, material thickness, sinks, counters, splashes, drawers shelves, legs, frame, supports, and anchors or fasteners for the counter sink unit.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be of the latest design, new, first-quality products, manufactured for the intended usage, and shall be compatible with elements of related or connected WORK.

B. Plumbing fixtures shall be without flaws and with white finish unless otherwise indicated. Exposed brass, faucets, valves, wastes, traps, piping, and escutcheons shall be chrome-plated. Each fixture shall be provided with individual stops and shall be anchored firmly to the building wall or floor. Softeners, water heaters, and lab equipment shall have drains and isolating valves on each side.

C. Insulation at lavatories requiring handicapped persons protection shall conform to the wheelchair accessibility requirements of ADA and other governing authorities. The insulation shall be easily removable, bacteria resistant, molded to piping and fixture configurations, closed cell vinyl assembles. Fasteners shall be corrosion resistant and reusable. Handicapped persons protection shall be **Lav Guard as manufactured by Truebro, Inc., Pro-Warp as manufactured by McGuire, Inc.**, or equal.

2.2 FIXTURE SCHEDULE

Dwg. Callout	Fixture Type	Description
S-4	Laboratory Sink (light duty)	18-gauge stainless steel sink, size 16-7/8 x 14 x 10 inches deep, with rounded corners; clamps; basket strainer; "P" trap; and gooseneck wrist-handle faucets with vacuum breakers, hot and cold.
DS-1	Drench Shower (with eye-face wash and independent operated valves)	The emergency drench showers, not subject to freezing, with shower head, self-closing manual valve, handle, eye wash with stainless steel bowl and galvanized drain, and 1-1/4-inch supply shall be **HAWS Model No. 8300; Bradley Corp., Model S19-310 AC** or equal.

2.3 MANUFACTURERS OR EQUAL

A. Unless indicated otherwise, fixtures shall be:

1. **Crane Co.**

2. **Kohler**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Each fixture shall be installed with trap, easily removable for servicing and cleaning, and be vented in accordance with the applicable plumbing code.

B. The CONTRACTOR shall provide chrome-plated rigid or flexible supplies to fixtures with angle stops, reducers, and escutcheons.

C. All components shall be installed level and plumb. Supplies and wastes shall be centered on or between the wall tiles.

D. All fixtures shall be installed and secured in place with wall supports, wall carriers, or floor carriers, and bolts, as appropriate.

E. Fixtures shall be sealed to wall and floor surfaces with sealant as indicated in Section 07920-Sealants and Caulking. Color shall match fixture.

F. All fixtures shall be mounted to the following heights above finished floor:

Lavatory:

Standard	31 in.	(785 mm) to top of basin rim
Handicapped	34 in. (max)	(864 mm) to top of basin rim
	29 in. (min)(736 mm)	clearance under or pullman option

Emergency Eye and Face Wash:

Standard	38 in.	(965 mm) to receptor rim
Handicapped	34 in. (max)	(864 mm) to receptor rim
Handicapped	27 in.	(686 mm) to spray head

Emergency Shower:

Standard	84 in.	(2130 mm) to bottom of head
Handicapped	48 in. (max)	(1220 mm) to pull handle

3.2 ADJUSTING AND CLEANING

A. Stops or valves shall be adjusted for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, the CONTRACTOR shall clean all plumbing fixtures and equipment.

- END OF SECTION -

SECTION 15500 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide heating, ventilating, and air conditioning systems, complete and operable, in accordance with the Contract Documents.

1. Provide and install one packaged HVAC unit ducted to serve the Pump Room, the Chemical Feed Room and the Electrical Room.

2. Provide and install one wall-mounted exhaust fan to serve the Chemical Storage Area

B. The requirements of Section 11000 - Equipment General Provisions apply to the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All WORK shall be in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning Systems), the local Plumbing Code, the local Building Code, Fire Code, and all other local codes. Nothing in the Contract Documents shall be construed to permit WORK in violation of the above codes, rules, and regulations. In the absence of applicable codes, installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration, and Air Conditioning Engineers.

1.3 CONTRACTOR SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 - Contractor Submittals.

B. **Equipment Numbers:** Equipment is identified by number code for reference and location purposes in the Contract Documents. The appropriate equipment numbers shall be included on the Shop Drawings and on other submittals.

1.4 WARRANTY

A. Fans shall carry the manufacturer's standard warranty, and all such warranties shall be furnished to the ENGINEER before final acceptance.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Quality:** All mechanisms and parts shall be amply proportioned for the stresses which may occur during operation and during fabrication and installation. Individual parts which are alike in all units shall be alike in materials workmanship, design and materials and shall be of the manufacturer's top of the line, industrial-commercial grade.

B. **Supports:** Equipment and appurtenances shall be firmly anchored or connected to supporting members. Supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided by the heating and

ventilating subcontractor, unless otherwise indicated. Equipment shall be supported on restrained spring-type vibration isolators.

C. **Noise/Vibration Control:** The system shall be free of any objectionable vibrations and noise. Flexible connections shall be provided in all ducts and piping connections to fans, and any other vibrating equipment.

D. **Electric Motors:** Electric motors shall be provided in accordance with Section 16460 - Electric Motors.

2.2 DUCTWORK AND MISCELLANEOUS ACCESSORIES

A. **Construction:** Sheet metal ducts and plenums shall be constructed with airtight joints and seams in accordance with ASHRAE standards and SMACNA Duct Construction Manual. Joints on concealed ducts shall be taped with pressureless tape and adhesive, except welded or soldered joints. Ductwork materials shall be aluminum, unless otherwise indicated. Minimum duct gauges are as follows:

Maximum Dimension of Duct (inches)	Galvanized Steel U.S. Standard Gauge	Aluminum B and S Gauge
12 and less	26	24
13 through 30	24	22
31 through 54	20	20
55 through 84	20	18

B. Supports

1. Supports for horizontal ducts and plenums shall be galvanized steel angles with hanger rods. Band iron straps shall be allowed for duct sizes recommended by SMACNA. Supports for vertical ducts shall be band iron strap or angle bracket type. Inlet ducts shall be amply braced to withstand maximum negative pressure.

2. Seismic Restraints: Duct supports and restraints shall be designed for static, dynamic, and seismic loads in zone 4 per the Uniform Building Code. Seismic restraints shall not induce stresses in the ductwork caused by thermal expansion and contraction.

C. **Balancing Dampers:** Butterfly or multi-blade dampers shall be provided as indicated and required for balancing air quantities to values indicated. A locking quadrant shall be provided on each manual damper with easy access for operation.

D. **Fire Dampers:** Fire dampers shall be 1-1/2 hour rated, **Pacific Air Products Company, Air Balance,** or equal. Blades shall be stored out of the airstream. Dampers shall be approved for horizontal or vertical installation as indicated. Fire dampers for connection to ceiling grilles, registers, and diffusers shall be UL-labeled and shall have minimum 1-hour rating and be approved for horizontal installation.

E. **Bird Screens:** Removable bird screens shall be provided on all outside air intakes and exhaust air discharges to outside air. Screens shall be secured in frames made from the same metal as the screens. Bird screens shall be 1/2-inch mesh by 14-gauge and shall

be of same material and finish as duct, hood, louver, or equipment to which the screens are attached.

F. **Flexible Connectors:** Flexible duct connections shall be made with banded or flanged 8-oz canvas, reinforced plastic, or equal at each point where a blower unit is connected to a duct. A minimum clearance of 3 inches between the duct and source of vibration shall be maintained.

G. **Diffusers, Grilles, and Registers:** Supply air registers and diffusers, return air, and exhaust grilles shall be of aluminum construction with smooth corners, flanges, and sponge rubber gaskets. Ceiling-mounted outlets shall be off-white. Wall-mounted outlets shall be factory prime-coated. Terminals shall be **Titus**, **Agitair**, **Krueger**, or equal.

H. **Weather Louvers:** Unless otherwise indicated for architectural work, weather louvers in outside walls shall be of sturdy construction, with flanged wall frames and "J" shaped blades, at 45 degrees or 30 degrees to the horizontal plane, backed with bird screen and securely caulked and built into the wall. Unless otherwise indicated, these louvers shall be of extruded minimum 12-gauge aluminum construction as manufactured by **Krueger**, **Airolite**, or equal. Coat louvers in accordance with Section 09800.

I. **Turning Vanes:** Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside rails. Construction shall be of the same material as the ductwork and be rigid enough to prevent vibration at high air flow.

J. **Air Extractors:** An air extractor shall be provided on each take-off from main supply duct adjacent to any diffuser, register, or grille where a splitter is not used. Air extractors shall be **Carnes**, **Tuttle and Bailey**, or equal. Extractors shall have synchronized steel curved blades, heavy side rails, and screw operator.

2.3 PIPING

A. Piping in air conditioning systems shall be galvanized steel in accordance with Section 15025 - Steel Pipe. Equipment drains shall be of Type "K" copper tube or Schedule 40 galvanized steel pipe.

2.4 CONTROLS

A. **General:** Heating, cooling, ventilating, and air conditioning equipment shall be provided with manual or automatic control systems as indicated. Where various items of equipment are operating in conjunction with one another, they shall be controlled by an integrated control system located in a control panel as indicated. Such systems shall have 12-hour timers and 7-day setback programming for automatic setback comfort time periods to meet requirement of the Energy Conservation Standards. Unless otherwise indicated, individual ventilating fans shall be controlled from HAND-OFF-AUTOMATIC line-voltage cooling thermostats, wall-mounted. Individual exhaust fans shall have manual switches for single or 2-speed motors as indicated. Exhaust fans operating in conjunction with central ventilating or air conditioning systems shall be interlocked with these systems. Electric unit heaters shall have unit-mounted contactors unless otherwise indicated and shall be controlled from wall-mounted line voltage heating thermostats.

B. **Thermostats:** Room thermostats shall be digital type with heating and cooling setpoints. Adjustment shall be by pressing the thermostat up or down arrows. Comfort setpoints shall be adjustable from 60 to 90 degrees. Setback setpoints shall be adjustable from 55 to 70 degrees for heating setback and 75 to 90 degrees for cooling setback. Automatic

setback time period shall be 7-day setback programming, with up to 2 automatic setback comfort time periods per day, a built-in setback override, adjustable from 10 minutes to 40 hours, a 7-day electric time clock, and a heat/cool/fan annunciators to indicate equipment operation and automatic heating/cooling changeover. Thermostats shall meet the Energy Conservation Standard approval where required by the State. An insulating back shall be provided where exterior wall mounting is indicated. Guards shall be provided for room thermostats installed in areas other than administrative offices or control rooms.

C. Controls shall be in accordance with Section 17100 - Process Control and Instrumentation System.

D. Manufacturers: Control system components and thermostats shall be as manufactured by **Honeywell, Johnson Controls Company, General Controls**, or equal.

2.5 FANS

A. **General:** Location, type, capacity, and motor horsepower shall be as indicated. Fans shall be complete with motors, adjustable motor bases, adjustable drives, safety cages, belt guards, flexible connections to supply and/or suction ducts, vibration isolators, and necessary accessories. All fans shall be suitable for continuous operation.

B. **Manufacturers: Greenheck** Model CWB-098-4, **Carne**, **Trane** or approved equal.

C. **Performance:** Fans shall be guaranteed to deliver the quantities of standard air against the respective static pressure without deviating by more than 5 percent. Every fan wheel, regardless of size, shall be statically and dynamically balanced and shall be free from objectionable vibration or noises.

D. **Wall-Mounted Fans:** Wall-mounted exhaust fans shall be direct motor-driven unless otherwise indicated and shall be supported on metal frames for mounting, with safety guards. Wall openings and louvers shall be of sufficient size for the fan capacity.

E. **Corrosion-Resistant Fans:** Fans in corrosive atmospheres and on fume hoods shall be of corrosion-resistant construction or shall be coated with a suitable protective coating in accordance with the manufacturer's printed recommendations.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Roughing-In:** The CONTRACTOR shall ascertain that all inserts, chassis, shafts, and openings are correctly located; if not, cut new openings as part of the WORK.

B. **Checking:** The CONTRACTOR shall test and tighten all WORK, furnish all equipment necessary to carry out the tests, and thoroughly clean the system before startup.

C. **System Balancing:** After completion of work, but before final acceptance, the CONTRACTOR shall have the system as a whole checked and balanced by an independent air balancing company, registered by the Associated Air Balancing Council and having one member of the company certified by the National Examination Board as a test and balance engineer. System balancing shall include the following:

1. Adjusting fans, dampers, diffusers, registers, and other devices so that the quantities of air called for on the Drawings are supplied, returned, or exhausted.

2. Measuring and recording at least once the air temperatures delivered through each coil on full heating and full cooling: making all necessary adjustments to obtain the required conditions.

3. Measuring and recording current on each fan and motor, and checking for proper operation of equipment.

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SECTION 16050 - ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electrical work, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section apply to all sections in Division 16, except as indicated otherwise.

C. The WORK of this Section is required for operation of electrically-driven equipment provided under specifications in other Divisions. The CONTRACTOR's attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment specifications, the WORK of instrumentation sections, and the WORK of Section 16460 - Electric Motors. CONTRACTOR to coordinate HVAC work with Division 16 and all HVAC requirements.

D. All concrete, excavation, backfill, and steel reinforcement work required for encasement, installation, or construction of the work of the various sections of Division 16 is included as a part of the work under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light hole bases.

E. CONTRACTOR to provide all work shown on Drawings, coordination and permits including fees as required by Roseville Electric and Surewest Telephone.

1.2 REFERENCE STANDARDS

A. The WORK of this Section and all sections in Division 16 shall comply with the following as applicable:

NEC (NFPA 70)	National Electrical Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
Title 8, Subchapter 5, California Administrative Code	Electrical Safety Orders

B. All electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 SIGNAGE

A. The CONTRACTOR shall provide the following signage at a minimum unless otherwise stated in individual equipment specifications sections.

1. Local Disconnect Switches: Each local disconnect switch for motors and equipment shall be legibly marked to indicate its purpose unless the purpose.

2. Warning Signs:

a. 600 volts nominal, or less - Entrances to rooms and other guarded locations that contain live parts shall be marked with conspicuous signs prohibiting unqualified person to enter. Provide sign on Emergency Generator Connection Panel.

1.4 PERMITS AND INSPECTION

A. Permits shall be obtained and inspection fees shall be paid according to Section 00700 - General Conditions.

1.5 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical systems which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

B. Protect all existing aboveground and underground utilities during construction. Pay for all repairs without increase in Contract cost should damage to underground utilities occur during construction.

1.6 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:

1. Complete systems functionally operational in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility and process equipment layouts and construction for all Specification Divisions which affect the work covered under Division 16.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Coordination with Division 17 and all other divisions for wiring and cable requirements.

5. Coordination with Divisions 11, 13, 14 and 15.

6. CONTRACTOR shall submit to the OWNER a complete copy of red line as-builts every month after Notice to Proceed date for OWNER information and review in accordance with the Record Drawing requirements of Section 01300 - Contractor Submittals.

7. CONTRACTOR responsible for all utility coordination, electric and telephone, to provide complete work as described in Specifications and shown on Drawings.

1.7 INTENT OF DRAWINGS

A. The Contract Drawings indicate the extent, general location, and arrangement of equipment. Duct bank and conduit runs are diagrammatic and may not show the exact locations for installation. The CONTRACTOR shall verify the locations of conduit stub-ups based upon conduit entry space of equipment furnished from the manufacturer's certified shop drawings and by inspection of the actual, equipment to be installed.

B. In general, where the background on Contract Drawings has been screened, the area screened is work other than electrical, unless otherwise noted. Work under Division 16 is shown heavier for contrast.

C. Standard details are typical for all locations which apply regardless of whether a callout is shown on the individual plan drawing or not.

D. Electrical design is based on minimum horsepower and current ratings. If the manufacturer and/or CONTRACTOR provides equipment with a larger horsepower or current rating, the CONTRACTOR shall be responsible for making all necessary changes to accommodate the larger unit, with the approval of the ENGINEER. CONTRACTOR shall pay for all such changes including engineering design by a professional electrical engineer currently registered in the State of California.

E. Number and size of wires which shall be installed in runs of conduit where not shown on the Contract Drawings shall be determined from the one-line, schematics, connection, interconnection, and control diagrams of actual equipment furnished.

1.8 RACEWAY ROUTING DRAWINGS

A. The CONTRACTOR shall submit prior to installation, raceway routing and installation drawings of all raceways, exposed and below ground, below slabs, below pads, in slabs, in ceiling spaces and in poured and block wall construction. The Drawings shall be to the same or larger scale as the Contract Drawings and shall show the number of conduits, size, type, and raceway identification number accurately dimensioned. All spare raceways shall be shown and so indicated. Where conduits form a concrete encased duct bank, cross sectional drawings shall be made between each manhole showing spacing, and approximate limits of concrete. Where cross section changes between manholes, etc., show all different cross sections. All cross sections shall show the number of conduits, size, type and raceway and circuit numbers. Exposed conduits need not be dimensioned.

1.9 CONTRACTOR SUBMITTALS

A. General

1. Provide manufacturers' descriptive information and shop drawings for all equipment, material, and devices furnished under Division 16, ELECTRICAL, including certified outline and arrangement drawings, schematic (elementary) diagrams, interconnection and connection diagrams, grounding diagrams, in accordance with Section 01300 - Contractor Submittals and this section. Device designations and symbols for schematic (elementary) connection or interconnection diagrams shall conform to the latest edition of NEMA ICS 1.

2. Submit complete interface schematic drawings for all equipment furnished in accordance with other Divisions that interface with electrical equipment. These drawings shall contain diagrams, terminal numbers, device names, tag numbers, control cable conductor colors and numbers, etc., to provide complete identification of the circuits and provide coordination between the equipment.

3. Check submittals for proper number of copies, adequate identification, correctness and compliance with Drawings and Specifications, and initial all copies indicating this has been done.

4. If the equipment installed during construction is not the exact same equipment that was approved by the ENGINEER before construction, then the CONTRACTOR shall resubmit all documentation related to the installed equipment as required herein for the ENGINEER 's approval.

5. Review of submittal information by the ENGINEER shall not relieve the CONTRACTOR from responsibility for deviations from Contract Drawings and/or Specifications, unless he has in writing at time of submission requested and received written approval from the ENGINEER for specific deviations. Review of submittal information shall not relieve the CONTRACTOR from responsibility for errors and omissions in shop drawings or literature.

6. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and nonapplicable portions deleted or crossed out.

7. Catalog cuts or photo copies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured materials. Catalog data sheets shall be stamped to indicate project names, applicable section and paragraph, model number and options.

8. Submittal shop drawing formats:

   a. Shop drawings shall be submitted in accordance with Section 01300 - Contractor Submittals.

9. Record as-built shop drawing formats:

   a. Record as-built shop drawings created utilizing Computer Aided Design and Drafting (CADD) software shall be full sized 22-inch by 34-inch plots on

vellum. Manually drafted shop drawings of pencil on vellum or other materials are not acceptable. Provide one set of vellum or mylar record as-built shop drawings with the approved Technical Manuals in addition to the number and type of shop drawings specified in Section 01300 - Contractor Submittals.

b. For record as-built shop drawings created utilizing CADD software, the CONTRACTOR shall also submit one copy of each of the CADD electronic record as-built shop drawings files in AutoCAD 2004 to the ENGINEER on CD, 12X, 700 MB or greater, along with the approved Technical Manuals.

c. The CONTRACTOR shall create raster files for all record as-built shop drawings which are not created by utilizing CADD software by digitally scanning each full sized shop drawing, and submitting a raster image of each full sized shop drawing to the ENGINEER on CD, 12X, 700 MB or greater, along with the approved Technical Manuals.

d. Provide record as-built shop drawings for the equipment listed in Paragraph 1.9.C.1 through 1.9.C.3; panels specified in Divisions 11, 13, 14 and 15; and for the Instrumentation Panels specified in Division 17.

B. Submit certified shop drawings and diagrams as follows:

1. Layouts indicating conformity with space requirements including front and rear access requirements. Detailed anchoring requirements, seismic requirements, and weight.

2. Assembly drawings in sufficient detail to identify every part of the specified equipment including bills of material.

3. General dimension, outline, and panel, cubicle, and structure layout drawings showing the principal dimensions of the equipment, the location of all devices therein, and the size of electrical conduits and connections. Include front, rear, side elevations and top view. Include front and rear access requirements. Provide finish and materials. Provide nameplate inscription schedule.

4. One-line, three-line, schematic (elementary), connections detailing all internal wiring, and interconnection diagrams detailing all field wiring. Voltage, phase, current and grounding requirements.

5. Control schematics shall use the ladder diagram type format incorporating line number, operation function statement, contact location line number with an underline for a normally closed contact, coil cross reference line number, a description of operation of each device and complete step-by-step written sequence of operation. Wire and terminal numbers shall be clearly shown. Actual device symbols shall be used to represent equipment such as limit switches, level switches, pressure switches, time delay relays, etc. Control schematics shall be shown with the electrical system in a deenergized state. Refer to the schematic (elementary) diagrams in the contract drawings for examples. Refer to Electrical Symbols Drawing GE-1 for device symbols.

6. Complete interconnection diagrams for each new system within the Woodcreek North Pump Station showing every wire by number, every junction terminal box or

device to which it connects from origination to final destination, and boxes, manholes, handholes, and cabinets through which it passes. These diagrams shall show wiring installed by CONTRACTOR between items of manufactured, prewired or non-prewired equipment. Submittals shall be provided and approved by the ENGINEER before any conduit installations may begin.

7. Furnish schematic (elementary) diagrams, including CONTRACTOR modifications, of all factory wired equipment and CONTRACTOR assembled or supplied equipment for ENGINEER's approval and record purposes. These wiring diagrams shall indicate point-to-point wire terminations, and wire color identifications with tags per Section 16120.

8. Characteristic curves for all protective devices.

9. Installation drawings for all electrical work showing conduit layout, conduit sizes and locations of equipment foundations, and details accurately dimensioned. Show conduit entrances and access plates.

10. Shop drawings for all grounding work not specifically indicated.

11. Temperature limitations.

12. Grounding requirements.

13. Factory test results by manufacturer.

C. Submit manufacturer's certified shop drawings and descriptive information on the following:

1. Low voltage motor control center including all components.

2. Control panels.

3. In addition to submittals for specific items mentioned above, furnish descriptive information on the following items:

   a. Low voltage fuses.

   b. Lighting and distribution panels.

   c. Separately mounted circuit breakers, and non-fused disconnect switches.

   d. Rigid steel conduit.

   e. Raceway supports and fittings.

   f. Expansion and deflection couplings.

   g. PVC-coated rigid steel conduit.

   h. PVC schedule 40 conduit.

i. Flexible metal conduit, liquid tight.

j. Wireway.

k. Outlet and device boxes.

l. Pull boxes and junction boxes.

m. Junction terminal boxes.

n. Terminal blocks.

o. Control relays.

p. Elapsed time meters.

q. Precast manholes and large handholes (larger than 3 feet by 3 feet) including covers.

r. Precast handholes (smaller than 3 feet by 3 feet) including covers.

s. 600V single- and multi-conductors power cable.

t. Multi-conductor control cable 0-600V.

u. Twisted shielded pair instrumentation cable, 0-600V.

v. Lighting fixtures and lamps.

w. Emergency lighting units.

x. Lighting sensor systems including occupancy sensors, daylight sensors, controls, panels, power supplies, wiring, contactors and design.

y. Receptacles.

z. Light switches.

aa. Device plates.

bb. Pushbuttons, indicating lights, and selector switches.

cc. Dry type small power transformers, 0-600V primary.

dd. Conduit tags.

ee. Warning tape.

ff. Conductor and cable tags.

gg. Ground rods.

hh. Ground conductors.

ii. Ground connections.

jj. Ground rod boxes.

kk. Nameplate schedules.

ll. Information for approval of the electrical equipment testing company.

mm. All testing forms, procedures, documentation covering Factory Tests, Field Tests, Systems Tests, etc.

D. Seismic

1. Submit proof of compliance that the following electrical equipment are seismically anchored. Proof of compliance shall include complete anchorage details coordinated with equipment mounting provisions showing weights, calculations, anchoring points, assumptions, anchor bolts size and type, and any special considerations. Proof of compliance to be prepared, stamped and signed by a licensed structural engineer in the State of California, for each listed piece of electrical equipment. Listing is not inclusive. For all electrical equipment 400 pounds and greater that is roof or floor mounted and equipment 50 pounds and greater that is wall mounted, the CONTRACTOR shall submit proof of seismic compliance.

a. Lighting, including outdoor pole mounted and surface mounted.

b. Motor Control Center.

c. PLC control panel.

d. Secondary seismic restraint for pendent and surface mounted indoor light fixtures.

E. Shop drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from shop drawings.

F. **Materials and Equipment Schedules:** The CONTRACTOR shall deliver to the ENGINEER, a complete list (schedule) of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

G. **Technical Manuals:** Complete information in accordance with Section 01300 - Contractor Submittals.

1.10 AREA DESIGNATIONS

A. General

1. Raceway system enclosures shall comply with Section 16110 - Electrical Raceway Systems.

2. Electric WORK specifically indicated in sections within any Division of the Specifications shall comply with those requirements.

3. Other electrical WORK not included in 1.10.A.1 and 1.10.A.2 shall comply with this Paragraph 1.10.A.3.

a. The following table lists the type of electrical equipment and materials to be used based on applied area.

Applied Area	Enclosure/PB /Jbox (Material)	Outlet/Device Box (Recessed)	Hardware	Exposed or Concealed Conduit System (Fittings)	Concrete Encased Conduit System (Fittings)
Interior Corrosive	NEMA 4X (Fiberglass or Stainless Steel)	PVC Coated Cast Steel (Concrete-PVC)	Stainless Steel Fiberglass	PVC Coated Rigid (PVC Coated)	PVC Sch 40 (PVC)
Interior Damp	NEMA 3R	Cast Steel (Concrete-PVC)	Galvanized Steel Hot Dipped	Galvanized Rigid Steel (Malleable Iron)	PVC Sch 40 (PVC)
Interior General	NEMA 12	Cast Steel (Concealed - Cast Steel) (Concrete - PVC)	Galvanized Steel Hot Dipped	Galvanized Rigid Steel (Malleable Iron)	PVC Sch 40 (PVC)
Interior Office	NEMA 1	Cast Steel (Concealed - Sheet Steel) (Concrete PVC)	Steel	Galvanized Rigid Steel (Malleable Iron)	PVC Sch 40 (PVC)
Exterior Corrosive	NEMA 4X (Stainless Steel)	PVC Coated Cast Steel (Concrete-PVC)	Stainless Steel Fiberglass	PVC Coated Rigid (PVC Coated)	PVC Sch 40 (PVC)
Exterior Damp	NEMA 3R	Cast Steel (Concealed - Cast Steel) (Concrete - PVC)	Galvanized Steel Hot Dipped	Galvanized Rigid Steel (Malleable Iron)	PVC Sch 40 (PVC)

b. The following identifies each building's area classification by room.

Building/Facility	Room	Area Classification
Pump Station	Chemical Room	Interior Corrosive
	Electrical Room	Interior General
	Pump Room	Interior Damp
	Rooftop and Exterior	Exterior Damp

4. Electrical WORK not included in 1.10.A.1, 1.10.A.2, or 1.10.A.3 shall be Exterior Corrosive.

5. Installations in hazardous locations shall conform strictly to the requirements of the Class, Group, and Division indicated.

B. Material Requirements

1. NEMA 4X enclosures shall be 304 stainless steel except in Chemical Room areas where non-metallic enclosures shall be provided, unless shown otherwise.

2. NEMA 1, 3R, and 12 enclosures shall be steel coated with ANSI 61 grey paint. NEMA 4X, 7 and 9 enclosures shall not be coated.

1.11 TESTS

A. The CONTRACTOR shall be responsible for all factory and field tests required by specifications in Division 16 and by the ENGINEER or other authorities having jurisdiction. The CONTRACTOR shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.

B. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the shop drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Final Completion.

C. Any equipment or material which fails a test shall be removed and replaced at no additional cost to the OWNER.

D. Field testing company shall be submitted for ENGINEER's approval prior to any field testing. Submit all test forms for approval four weeks prior to testing. Provide two weeks notification of Field Tests to ENGINEER, minimum. Field test shall be witnessed and signed off by ENGINEER to be considered complete. Any test results without ENGINEER signature is considered invalid and will be done again.

1.12 TEMPORARY LIGHTING

A. The CONTRACTOR shall provide temporary lighting for all trades within the buildings. The average lighting level (foot-candle) shall meet OSHA, CAL-OSHA.

1.13 DEFINITIONS (APPLICABLE TO SPECIFICATIONS AND DRAWINGS)

Above grade: Not buried in ground and not embedded in concrete slab on ground.

Below grade: Buried in ground and not embedded in concrete slab on ground.

Certified: Confirmed to be accurate, or as represented, or as meeting standards.

Concealed: Inside building above grade and located within walls, furred spaces, crawl spaces, attics, above suspended ceiling, etc. In general, any item not visible or directly accessible.

Connect: Complete hookup of item with required services, including conduits, wires, and other accessories.

Exposed: Either visible or subject to mechanical or weather damage, indoor or outdoor, include areas such as mechanical and storage rooms. In general any item that is directly accessible without removing walls, panels, ceilings or other parts of structure.

Furnish: Supply and deliver complete.

Install: Place, secure and connect as required to make fully operational.

Provide: Furnish and install as defined above: perform work.

Underground: Buried in ground, including under building slabs.

Use (verb): Furnish and install as defined above.

Wiring: Electrical conduit, raceway, conductors and connections.

1.14 WARRANTY

A. The warranty for all provided equipment shall be not less than one year after initial startup or OWNER beneficial use, whichever is later, and shall include all costs for repairs, parts, travel and living expenses, and labor. This warranty, provided by the CONTRACTOR, shall cover all equipment, including but not limited to: Cables, motor control centers, panelboards and transformers, PLC, radio, motors, controls, grounding systems, and wiring devices.

B. CONTRACTOR responsible to reimburse OWNER for all materials, labor, and indirect costs incurred by OWNER to support warranty repairs.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All equipment and materials shall be new, shall be listed by UL, and shall bear the UL label where UL requirements apply. All equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK shall

be products of the same manufacturer. All equipment and materials shall be of industrial grade standard of construction.

B. Where a NEMA enclosure type is indicated in a non-hazardous location, the CONTRACTOR shall utilize that type of enclosure, despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

C. On all devices indicated to display dates, the year shall be displayed as 4 digits.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. All nuts, bolts, and washers shall be stainless steel.

2. Threaded rods for trapeze supports shall be continuous threaded, galvanized steel, 3/8" diameter minimum.

3. Strut for mounting of conduits and equipment shall be galvanized steel unless area classification calls for stainless steel hardware. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion. Where ends are exposed from cutting, coat ends of strut with zinc rich galvanizing compound. Strut shall be as manufactured by **Unistrut, B-Line,** or equal.

4. Anchors for attaching equipment to concrete walls, floors and ceilings shall be stainless steel expansion anchors, such as **"Rawl-Bolt," "Rawl-Stud" or "Lok-Bolt" as manufactured by Rawl; similar by Star,** or equal. Wood plugs shall not be permitted.

2.3 ELECTRICAL IDENTIFICATION

A. **Nameplates:** Nameplates shall be fabricated from black-letter, white-face laminated plastic phenolic engraving stock, **Formica type ES-1,** or equal. Each shall be fastened securely, using fasteners of stainless steel screws, screwed into inserts or tapped holes, as required or attached by adhesive cement glue. Engraved characters shall be block style with no characters smaller than 1/8-inch high. All electrical equipment shall have a nameplate attached. This applies to exterior conduits, pullboxes, splice boxes, manholes, MCC's, control panels, UPS, transformers switches, etc. Exterior conduits shall have phenolic tags adhesive epoxied to the interior of manholes. Interior conduits shall have stamped tags with stainless steel tie wire. Every conduit shall be labeled, both ends.

B. **Conductor Identification:** All cables and conductors shall be identified as outlined in Specification 16120.

2.4 EQUIPMENT FINISH

A. Provide materials and equipment with manufacturers, standard finish application system with ANSI 61, light grey color. Provide two quarts of ANSI 61 touchup paint. Some exterior equipment shall have further finish applied, refer to individual specifications.

2.5 OUTDOOR EQUIPMENT

A. Provide equipment and devices to be installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 20 degrees F to 115 degrees F. Equipment must be capable of proper operation at rated output continuously in this ambient temperature range in direct sun. Provide any additional equipment such as enclosures, sunshades, and cooling equipment so that this performance requirement can be met.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Incidentals:** The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.

B. **Field Control of Location and Arrangement:** The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined by the CONTRACTOR in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

1. Where "home runs" are shown, the CONTRACTOR shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.

2. All conduit, cable trays and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, such locations shall be determined by the ENGINEER. If equipment is installed without instruction and must be moved, it shall be moved without additional cost to the OWNER. Lighting fixture locations shall be adjusted to avoid obstructions and to minimize shadows.

3. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR’s responsibility to provide all lighting and receptacle-related conducts and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated. Wiring shall be #12 AWG minimum, and conduits shall be 3/4-inch minimum (exposed) and 1-inch minimum (encased). Where circuits are combined in the same raceway, the CONTRACTOR shall derate conductor ampacities in accordance with NEC requirements.

C. **Workmanship:** All materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interferences.

D. **Protection of Equipment and Materials:** The CONTRACTOR shall fully protect all materials and equipment against damage from any cause. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, dust, dirt, plaster, or paint. All moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish all damaged materials or equipment, including face plates of panels and switchboard sections, at no additional expense to the OWNER. Cap all spare conduits.

3.2 CONCRETE HOUSEKEEPING PADS

A. Concrete housekeeping pads shall be provided for all indoor floor standing electrical equipment including motor control centers, floor mounted panelboards, transformers, instrumentation cabinets, and local control panels. Housekeeping pads for all equipment, including future units, shall be 4 inches above surrounding finished floor or grade and 2 inches larger in both dimensions than the equipment, unless otherwise indicated.

B. Concrete housekeeping curb shall be provided for all conduit stub-up in indoor locations that are not concealed by equipment enclosures. Such curb shall be 3 inches above finished floor or grade.

3.3 EQUIPMENT ANCHORING

A. Floor supported, wall, or ceiling hung equipment and conductors shall be anchored in place by methods that will meet seismic requirements 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 pedestals. If the supported equipment is a panel or cabinet enclosed within removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

B. Leveling channels anchored to the concrete pad shall be provided for all switchgear and pad-mounted transformer installations.

C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract. Such recommendations shall be submitted as shop drawings in Section 01300 - Contractor Submittals.

3.4 EQUIPMENT IDENTIFICATION

A. **General:** Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.

2. All conduits and cables shall be labeled as outlined in Specifications and shown on Contract Drawings. If no number is provided, CONTRACTOR shall provide unique number based on number system shown on Contract Drawings, and as approved by the ENGINEER.

3. Toggle switches shall have suitable inscribed finish plates.

4. Empty conduits shall be tagged at both ends to indicate the conduit number and the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by adhering a phenolic tag to an adjacent surface.

5. Equipment names and tag numbers, where indicated on the Drawings, shall be utilized on all nameplates. If no number given, CONTRACTOR to assign unique number, as approved by the ENGINEER.

6. The CONTRACTOR shall furnish typewritten circuit directories for all panelboards; circuit directory shall accurately reflect the load description connected to each circuit.

3.5 CUTTING AND PATCHING

A. Lay out work carefully in advance. Do not cut, drill, or notch any structural member or building surface without specific approval of ENGINEER. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition. Use skilled craftsmen of the trades involved.

3.6 LOAD BALANCE

A. The Contract Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on lighting and distribution panelboards, etc.

3.7 MOTOR ROTATION

A. After final service connections are made, check and correct the rotation of all motors.

B. Coordinate rotation checks with the ENGINEER and the CONTRACTOR responsible for the driven equipment. Submit a written report to the ENGINEER for each motor verifying that rotation has been checked and is correct.

3.8 CLEANING AND TOUCHUP PAINTING

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the ENGINEER.

B. The interior of all electrical equipment, including windings of dry type transformers, shall be vacuumed and wiped free of dust just before final acceptance. De-energization of equipment shall be at times approved in writing by the ENGINEER.

C. Painting shall be in accordance with Section 09800 - Protective Coating. Unpainted boxes, cabinets, and raceways that are mounted on walls that are painted or to be painted shall be painted the same color as the walls.

3.9 INSPECTION

A. Allow materials, equipment, and workmanship to be inspected at any time by the ENGINEER and OWNER or their representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the ENGINEER.

3.10 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish, install, and test all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

1. Local Laws and Ordinances.

2. State and Federal Laws.

3. National Electrical Code (NEC).

4. State Fire Marshal.

5. Underwriters' Laboratories (UL).

6. National Electrical Safety Code (NESC).

7. American National Standards Institute (ANSI).

8. National Electrical Manufacturer's Association (NEMA).

9. National Electrical CONTRACTOR 's Association (NECA) Standard of installation.

10. Institute of Electrical and Electronics Engineers (IEEE).

11. Insulated Cable Engineers Association (ICEA).

12. Occupational Safety and Health Act (OSHA).

13. National Electrical Testing Association (NETA).

14. American Society for Testing and Materials (ASTM).

15. California Electrical Code.

B. Conflicts, if any, that may exist between the above items will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency or utility having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

3.11 TECHNICAL MANUALS

A. Provide Technical Manuals in hard cover, 3-ring binders, separately bound volumes, number as required to accommodate material 8-1/2” x 11” for text and 22” x 34” full-sized drawings and also in accordance with provisions of Section 01300 - Contractor Submittals. Provide the number of copies specified therein containing:

1. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.

2. Set of complete, final, as-reviewed and accepted manufacturer's or vendor's descriptive information.

3. As-built electric circuit, equipment, and installation drawings showing equipment as it was actually installed and connected.

4. Index of all equipment suppliers listing current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.

5. All field and factory test results (include in the final O&M manuals).

6. Information listed under individual specification submittal requirements.

7. Complete interconnection diagrams between all instrumentation and control devices showing field wiring from numbered terminal to another numbered terminal in block diagram format.

8. Use only clean, legible material. File under dividers with heading in accordance with Specification item title.

9. Submit material to the ENGINEER for review prior to delivery of the final Technical Manuals to the OWNER. Make additions or changes required by the reviewer.

3.12 RECORD DRAWINGS

A. Provide two sets of full sized marked up as-built Contract Drawings in accordance with Section 01300 - Contractor Submittals. Show all departures from original Drawings, underground cable, conduit, or duct runs dimensioned from established building lines, and all electrical work revisions; prepare by obtaining two new, clean sets of Contract Drawings from ENGINEER. CONTRACTOR shall pay all costs for reproduction; field marked as-built drawings shall be initialed by the ENGINEER. The CONTRACTOR shall be responsible for making additional copies of the Contract Drawings.

3.13 SERVICE CONTINUITY

A. Make no outages without prior written authorization of the ENGINEER. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work. Shutdowns and startups shall be scheduled two weeks in advance, upon approval from ENGINEER and OWNER. Schedule of shutdowns and startups shall be limited between Monday to Thursday from 9:00 am to 3:00 pm, unless prior approval has been given from ENGINEER and OWNER.

3.14 TESTING

A. All testing sheets need to be signed off by ENGINEER and OWNER.

- END OF SECTION -

SECTION 16110 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electrical raceway systems, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Sections 01300 - Contractor Submittals and 16050 - Electrical Work, General.

B. **Shop Drawings:** Complete catalog cuts of all raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

1.3 QUALITY ASSURANCE

A. **Seismic Design Requirements:** All raceway systems to be furnished under this section shall be designed and constructed to meet the seismic requirements of Section 16050.

B. The CONTRACTOR shall demonstrate to the ENGINEER that the approved manufacturer's recommended installation tools and methods are being utilized on the job site by all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings. These tools and methods shall include, but not limited to, clamp inserts for use on power driven units of chain vises, new die heads and enlarged pipe guides in conduit threading machines, and strap wrenches and extra wide wrench jaws for use in conduit assembly.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures which are dedicated to the raceway system, shall comply with the requirements of this Section.

B. Set screw type couplings, bushings, elbows, nipples and other fittings are not allowed.

C. No conduit shall be smaller than 3/4-inch. All underground conduits shall be 1-inch minimum.

2.2 CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit

1. Rigid steel conduit shall be mild steel, hot-dip galvanized inside and out.

2. Rigid steel conduit and all appurtenances shall be manufactured in accordance with ANSI C80.1 - Rigid Steel Conduit, Zinc Coated, and UL-6.

3. Manufacturers, or equal:

    a. **Allied Conduit**
    b. **Western Tube and Conduit**

B. Rigid Non-Metallic Conduit (PVC)

1. Rigid non-metallic conduit shall be Schedule 40 PVC, sunlight resistant, UL listed for concrete encasement. Conduit shall have factory formed bell on one end.

2. Rigid PVC conduit shall be manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit standards.

3. Conduit shall be marked for use with conductors having 90 degrees C insulation.

4. Manufacturers, or equal:

    a. **Carlon Plus Rigid PVC**
    b. **PW Pipe**

C. Rigid PVC Coated Galvanized Steel (RPGS) Conduit

1. The conduit, prior to PVC coating, shall meet the requirements for RGS conduit above.

2. A PVC coating shall be bonded to the outer surface of the galvanized conduit. The bond between the coating and the conduit surface shall be greater than the tensile strength of the coating.

3. PVC coating thickness shall be not less than 40 mils. Interior coating shall be minimum 2 mil urethane. All male threads on conduit, elbows and nipples shall be protected by urethane coating.

4. PVC coated RGS shall be manufactured in accordance with the following standards:

    a. UL-6
    b. ANSI C80.1
    c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
    d. Federal Specification WW-C-581E.

5. Conduits shall be suitable for conductors with 75 degrees C insulation.

6. Manufacturers:

    a. **Robroy Plasti-Bond Red**
    b. **Occidental Coating Company OCAL-Blue Double-Coat**
    c. **Perma-Cote Industries Supreme Conduit**

D. Liquidtight Flexible Metal Conduit

1. Liquidtight flexible metal conduit shall be constructed of a flexible galvanized metal core with a sunlight resistant thermoplastic outer jacket.

2. Liquidtight flexible metal conduit shall be manufactured in accordance with UL-360 - Steel Conduits, Liquid-Tight Flexible.

3. Conduits shall have insulated throat and stainless steel sealing o-ring.

4. Manufacturers, or equal:

a. **Anaconda, "Sealtite" Type UA**
b. **Electriflex, "Liquatite" Type LA**

E. Electrical Metallic Tubing and Intermediate Metallic Conduit will not be accepted.

2.3 FITTINGS AND CONDUIT BODIES

A. General

1. All cast and malleable iron fittings for use with metallic conduit shall be the threaded type with five full threads.

2. All fittings and conduit bodies shall have neoprene gaskets and non-magnetic stainless steel screws. All covers shall be attached by means of holes tapped into the body of the fitting. Covers for fittings attached by means of clips or clamps will not be allowed.

3. Conduit, fittings, and conduit bodies in hazardous locations shall be suitable for the Class and Division indicated.

B. Fittings and Conduit Bodies for Rigid Steel Conduit

1. Use insulated throat grounding bushings for rigid steel conduit. Provide threaded zinc-plated malleable iron grounding bushings with bonding screw and insulated throat rated for 150 degrees C. Acceptable products**: Thomas & Betts Grounding and Bonding Bushings, OZ Gedney Type BLG, Appleton Threaded Grounding Bushings,** or equal.

2. Watertight hubs for rigid steel conduit shall be male thread type zinc-plated malleable iron with recessed “O” ring seal. Acceptable products: **OZ Gedney Type CHM, Appleton HUB Series, Myers Scru-Tite Hubs,** or equal.

3. For conduits bodies for rigid steel conduit sized as required by the NEC, use cast iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets. Acceptable products: **Appleton Form 35 threaded Unilets, Crouse-Hinds Form 7 threaded condulets, OZ Gedney Form 7 threaded conduit bodies,** or equal. Conduit bodies for rigid steel conduit required to be approved for hazardous (classified) locations shall be manufactured by **Appleton, Crouse-Hinds, Killark,** or equal.

4. Sealing fittings for rigid steel conduit shall be **Appleton Type EYF, EYM, or ESU; Crouse-Hinds Type EYS or EZS; Killark Type EY or EYS;** or equal. Where condensation may collect on top of the seal, a drain shall be provided by using **Appleton Type SF, Crouse-Hinds Type EYD or EZD,** or equal.

C. Fittings and Conduit Bodies for Liquid-Tight Flexible Metal Conduit

1. For areas not designated as corrosive use zinc-plated malleable iron or galvanized steel insulated throat connectors for liquid-tight flexible metal conduit, suitable for use in wet locations. Acceptable products: **Thomas & Betts Nylon Insulated Connectors, OZ Gedney Type 4Q Liquid-tight connectors, Appleton Liquid-tight STB Insulated Flexible Metal Conduit Connectors,** or equal.

2. For areas designed as corrosive use zinc-plated malleable iron or galvanized steel insulated throat connectors for liquid-tight flexible metal conduit, suitable for use in wet locations, with a minimum 40 mil PVC exterior coating and pressure sealing sleeves. Acceptable products: **Robroy Plasti-Bond Red Liquid-tight Connectors, Occidental Coating Company OCAL-Blue Double-Coat Sealtight Connectors, Perma-Cote Industries Supreme Liquid-tight Connectors,** or equal.

3. Use insulated throat grounding bushings for liquid-tight flexible metal conduit. Provide threaded zinc-plated malleable iron grounding bushings with bonding screw and insulated throat rated for 150 degrees C. Acceptable products: **Thomas & Betts Grounding and Bonding Bushings, OZ Gedney Type BLG, Appleton Threaded Grounding Bushings,** or equal.

4. For areas not designated as corrosive, watertight hubs for liquid-tight flexible metal conduit shall be male thread type zinc-plated malleable iron with recessed “O” ring seal. Acceptable products: **OZ Gedney Type CHM, Appleton HUB Series, Myers Scru-Tite Hubs,** or equal.

5. For areas designated as corrosive, watertight and corrosion resistant hubs for liquid-tight flexible metal conduit shall have a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves. Acceptable products: **Robroy Plasti-Bond Red Type ST Hub, Perma-Cote Industries Supreme Type ST Hub, Occidental Coating Company OCAL-Blue Double-Coat Type ST Hub,** or equal.

6. For areas not designated as corrosive for conduit bodies for use with liquid-tight flexible metal conduit sized as required by the NEC, use cast iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets. Acceptable products: **Appleton Form 35 threaded Unilets, Crouse-Hinds Form 7 threaded condulets, OZ Gedney Form 7 threaded conduit bodies,** or equal.

7. For areas designated as corrosive for corrosion resistant (CRE) conduit bodies for use with liquid-tight flexible metal conduit sized as required by the NEC, use cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating and nominal 2 mil internal coating, and pressure sealing sleeves on all conduit openings. Acceptable products: **Robroy Plasti-Bond Red Conduit Bodies, Occidental Coating Company OCAL-Blue Double-Coat Conduit Bodies, Perma-Cote Industries Supreme Conduit Bodies,** or equal.

D. Fittings and Conduit Bodies for PVC

1. All fittings for use with rigid non-metallic conduit shall be PVC, solvent welded type.

2. Conduit bodies shall be PVC or fiberglass reinforced polyester (FRP).

3. Provide all welding solvent as required for installation of non-metallic conduit and fittings.

4. Manufacturers, or equal:

a. **Carlon**
b. **Crouse-Hinds**

E. Fittings and Conduit Bodies for PVC Coated Rigid Steel Conduit

1. Use insulated throat grounding bushings for PVC Coated Rigid Steel conduit. Provide threaded zinc-plated malleable iron grounding bushings with bonding screw and insulated throat rated for 150 degrees C. Acceptable products: **Thomas & Betts Grounding and Bonding Bushings, OZ Gedney Type BLG, Appleton Threaded Grounding Bushings,** or equal.

2. Watertight and corrosion resistant hubs for PVC Coated Rigid Steel conduit shall have a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves. Acceptable products: **Robroy Plasti-Bond Red Type ST Hub, Perma-Cote Industries Supreme Type ST Hub, Occidental Coating Company OCAL-Blue Double-Coat Type ST Hub,** or equal.

3. For corrosion resistant (CRE) conduit bodies and seal fittings for use with PVC Coated Rigid Steel conduit sized as required by the NEC, use cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating and nominal 2 mil internal urethane coating, and pressure sealing sleeves on all conduit openings. Acceptable products: **Robroy Plasti-Bond Red Conduit Bodies, Occidental Coating Company OCAL-Blue Double-Coat Conduit Bodies, Perma-Cote Industries Supreme Conduit Bodies,** or equal.

2.4 JUNCTION AND PULL BOXES

A. Junction and pull box sizes shown on the Contract Drawings are considered minimum. If sizes are not shown, size junction and pull boxes in accordance with the NEC for the number of conductors enclosed in the box.

B. Where outlet boxes are used as junction or pull boxes, use materials as specified in Section 16140 - Wiring Devices.

C. Where boxes larger than outlet or device boxes are required for junction of pull boxes, provide the following:

1. Utilize NEMA 1 enclosures for flush mounting within Interior Office Area locations. Furnish 12 gauge hot dipped galvanized steel boxes with flat removable covers, keyhole type screw slots in the cover to permit removal of the cover without

extracting the screws, and galvanized or plated steel screws. Acceptable products: **Hoffman Screw Cover Pull Boxes,** or equal.

2. Utilize NEMA 12 enclosures for surface mounting within Interior Office Area and Interior General Area locations. Furnish 14 or 16 gauge steel enclosures with continuously welded seams, continuous door hinge, external quick-release latches to secure cover, external mounting feet, oil-resistant gasket and adhesive, and a polyester powder coating inside and outside. Acceptable products: **Hoffman Type CHQR Boxes,** or equal.

3. Utilize NEMA 4 watertight and raintight enclosures for outdoor locations or where the subscript WP (weatherproof) is indicated at the box location on the Drawings.

   a. For surface mounted installations, use neoprene gasketed watertight and raintight hot-dipped galvanized cast iron boxes and full-access covers, with stainless steel cover hardware. Acceptable products: **Crouse-Hinds Type WJB Heavy Duty Junction Boxes,** or equal.

   b. For flush mounted installations, use neoprene gasketed watertight and raintight hot-dipped galvanized cast iron boxes and full-access covers, with stainless steel cover hardware. Boxes shall be suitable for installing in concrete. Provide with checker plate cover for boxes installed on floors and decks. Provide with required drilled and tapped conduit openings. Acceptable products: **Crouse-Hinds Type WJBF Heavy Duty External Flanged Junction Boxes,** or equal.

D. Stainless Steel Boxes

1. Stainless steel boxes shall be used with PVC coated RGS conduit or where indicated, or where the subscript CRE (corrosion resistant enclosure) is indicated at the box location on the Drawings.

2. Stainless steel boxes shall be NEMA 4X, Type 304.

3. Stainless steel shall be minimum 14-gauge thickness, with a brushed finish.

4. Doors shall have full length stainless steel piano hinges. Non-hinged boxes are not acceptable.

5. Manufacturers, or equal:

   a. **Hoffman**
   b. **Rohn**
   c. **Hammond**

E. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.

2. Manufacturers, or equal:

   a. **Raco**
   b. **Steel City**

2.5 JUNCTION TERMINAL BOXES (JTB)

A. Provide hinged-cover junction terminal boxes of the required type as outlined in Specification 16050. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide 25 percent spare terminal points.

1. Utilize NEMA 12 enclosures for surface mounting within indoor dry locations. Furnish 16 or 14 gauge steel enclosures with continuously welded seams, continuous door hinge, external quick release latches to secure cover, external mounting feet, oil-resistant gasket and adhesive, and a factory applied polyester powder coating inside and outside. Acceptable products: **Hoffman Type CHQR Boxes,** or equal.

2. Utilize NEMA 4 weatherproof enclosures for surface mounting outdoor or indoor damp locations, or where subscript WP is indicated at the box location on the Drawings. Furnish 16 or 14 gauge steel enclosures with continuously welded seams, continuous door hinge, fast operating clamps, external mounting feet, and a factory applied polyester powder coating inside and outside. Acceptable products: **Hoffman Type CHNFSS Enclosures,** or equal.

3. Utilize NEMA 4X weatherproof enclosures for indoor and outdoor corrosive locations, or as indicated on the Drawings, or where subscript CRE is shown at box location. Furnish stainless steel or fiberglass enclosures as indicated, with fast operating clamps. If material type is not specified, submit stainless steel. Acceptable products: **Hoffman Type CHNFSS Stainless Steel, Hoffman A-24H2006SS6LP, Hoffman Fiberglass Medium Enclosures Bulletin A-17,** or equal.

B. The CONTRACTOR shall size the JTB based on:

1. Number of required connection points and conduits connected to the JTB.

2. Size and number of conductors and cables.

3. Eight inches between terminal strips.

4. Six-inch clearance between terminal strips and box, all sides, including a 2-inch stand-off.

C. Provide a removable interior mounting panel; do not stack terminal strips, back-to-front, one on the other. Provide an internal copper grounding bus for all ground connections.

D. Terminal Blocks

1. Terminal blocks shall be tubular clamp rated 600 VAC minimum. Provide 20 percent spare terminals for every terminal strip. Terminals shall be clearly and permanently labeled with embossed numbers as shown on Drawings. Handwritten labels are not acceptable.

2. Terminal block jumpers if indicated on the Drawings shall be manufacturers pre-made item specifically designed for the type of application. Jumpers designed to screw-in on top of the terminal block is preferred.

3. Provide all necessary accessories, partition plates, separating plates, end cover etc. as required for proper installation of terminal block.

    a. Acceptable products: **Phoenix Contact Universal UK Terminal Block**, or equal.

2.6 TELEPHONE BACKBOARD

A. Provide telephone plywood backboards for future telephone service. Provide 3/4-inch marine plywood backboard. Utilize backboard for incoming service conforming to the requirements of the telephone company. Paint plywood backboard white, two coats minimum.

B. **Acceptable Manufacturers: Hoffman, Circle AW,** or equal.

2.7 EXPANSION/DEFLECTION COUPLINGS

A. Provide expansion/deflection couplings for use where shown and wherever conduit crosses an expansion joint. The couplings shall alleviate longitudinal, angular, and shear conduit stress caused by differential settlement. Acceptable products: **Crouse-Hinds Type XD, O.Z. Gedney Type DX, Appleton Deflection and Expansion Couplings,** or equal.

2.8 CONDUIT TAGS

A. Provide permanent, 316 stainless steel round “dog tags” with conduit numbers as designated on the conduit schedule drawings, pressure stamped onto the tag. Tags relying on adhesives or taped-on markers are not acceptable. Attach tags to conduits with 316 stainless steel tie wire at each end of the conduit and at least once every 50 feet, where the conduit is exposed. Conduit tags in underground installations shall be engraved phenolic tags and applied with epoxy to the wall of the manhole or handhole above the conduit entrance.

B. Conduits installed higher than 10 feet above ground or floor elevations shall also be provided with large plastic identification nameplates appropriate for the conduit size. Minimum character size shall be 1/2 inch. Attach nameplates with plastic ties.

C. **Acceptable Products: Panduit Model MMP Stainless steel maker plates and PAN-STEEL stainless steel clamps, Thomas & Betts Ty Rap,** or equal.

2.9 SUPPORTS AND FITTINGS

A. For areas not designated as corrosive in this specification section; supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet seismic requirements. Finish shall be hot-dipped galvanized steel after fabrication for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-bolts, beam clamps, and other supports and fittings. Acceptable product: **Unistrut, B-Line, Power Strut,** or equal.

B. For areas designated as corrosive in this specification section; supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet seismic requirements. Materials of construction shall be 40 mil PVC coated hot-dipped galvanized steel, or self-extinguishing fiberglass which meets UL-94V-0 flammability tests, for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-

bolts, beam clamps, and other supports and fittings. Acceptable products: **Robroy Plastibond-Red PVC Coating Steel Strut and accessories or Fiberglass Strut and accessories, Occidental Coating Company OCAL-Blue PVC Coated Steel Struct and accessories, Perma-Cote Supreme PVC Coated Steel Channel and accessories,** or equal.

2.10 WIREWAYS

A. For Interior Office Area and Interior General Area locations, provide UL listed, hinged cover, NEMA 12 wireway bodies and covers fabricated from 16 gauge steel minimum, with an enamel or epoxy finish. Acceptable products: **Circle AW Type 12 Hinge Cover Wireway, Square D Square-Duct Wireway,** or equal.

B. For Exterior Damp Area and Interior Damp Area locations, provide UL listed, raintight, screw cover NEMA 3R wireway bodies and covers fabricated from 16 gauge steel minimum, with an enamel or epoxy finish. Acceptable products: **Circle AW Type 3R Screw Cover Wireway, Square D Raintight Trough,** or equal.

C. For Interior Corrosive and Exterior Corrosive Area use NEMA 4X wireways.

2.11 CONDUIT PENETRATION SEALS AND SLEEVES

A. Conduit penetration seals shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the opening. The elastomeric element shall be sized and selected per the manufacturer' recommendations and shall be suitable for use in standard service applications (-40 degrees F to 250 degrees F).

B. Sleeves shall be the thermoplastic type with water stops, suitable for poured wall construction.

C. Conduit penetration seals and sleeves shall be complete assemblies supplied by a single manufacturer.

D. **Acceptable Products: Thunderline Corporation Link-Seal and Plastic Sleeves, Calpico Inc. Pipe Linx and Plastic Sleeves,** or equal.

2.12 DUCT SEAL

A. Duct seal shall be a non-hardening compound designed as a waterstop and moisture barrier for sealing the annular space between conduit and electrical conductors and cables.

B. **Acceptable Products: O-Z Gedney DUX,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Raceways shall be installed between equipment 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 this purpose. Factory elbows shall be utilized wherever possible.

B. Where raceway routings are indicated on plan views, the CONTRACTOR shall follow those routings to the extent possible.

C. Where raceways are indicated but routing is not shown, such as home runs or on conduit developments and schedules, raceway routings shall be the CONTRACTOR's choice and in strict accordance with the NEC, customary installation practice. Raceway shall be encased or concealed, unless specifically noted otherwise. Locate 12 inches away from heated piping.

D. Routings shall be adjusted to avoid obstructions. Coordinate with all other trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be at no extra cost to the OWNER.

E. Support rod attachment for ceiling-hung trapeze and cable tray installations shall meet the seismic requirements in the area where the project is located.

F. Exposed raceways shall be installed parallel or perpendicular to structural beams. Do not run raceways up the exterior faces of buildings or walls. Do not run raceways across walkways.

G. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

H. All exposed raceways shall be installed at least 1/2-inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways shall be installed 1/4-inch minimum from the face of walls or ceilings by the use of clamp backs or struts.

I. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.

J. In block walls do not run raceways in the same horizontal course with reinforcing steel.

K. Pull boxes shall be provided every 200 feet of straight run, every 150 feet with 90 degrees of bends, every 100 feet with 180 degrees of bends, and every 50 feet with 270 degrees of bends, unless approved by ENGINEER.

L. Conduits must be kept within the furring lines of building walls and ceilings unless specifically noted to be exposed.

M. Provide all necessary sleeves and chases required where conduits pass through floors or walls; seal all openings and finish to match adjacent surfaces.

N. Support

1. Support raceways at intervals not exceeding NEC requirements unless otherwise indicated. Support multiple raceways adjacent to each other by ceiling trapeze. Support individual raceways by all brackets, strap hangers, or ceiling trapeze,

fastened by toggle bolts on hollow masonry units, expansion shields on concrete or brick, and machine screws or welded thread studs on steelwork.

2. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion shields.

3. Support all raceways from structural members only. Do not support from pipe hangers or rods, cable tray, or other conduit.

4. Do not use nails anywhere or wooden plugs inserted in concrete or masonry as a base for raceway or box fastenings. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

5. Support flexible metal conduit with conduit clamps, except where the flexible metal conduit is fished and where sections less than 4 feet in length are used in concealed areas to supply lighting fixtures in accordance with the NEC.

O. Bends

1. Make changes in direction of runs with symmetrical bends or cast metal fittings. Make bends and offsets of the longest practical radius. Avoid field-made bends and offsets where possible, but where necessary, make with an acceptable hickey or conduit bending machine. Do not heat metal raceways to facilitate bending.

2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel and of neat appearance. Factory elbows may be used in parallel or banked raceways if there is a change in the plane of the run and the raceways are of the same size. Otherwise, make field bends in parallel runs.

3. For PVC Schedule 40 and Schedule 80 conduits, use factory made elbows for all bends 30 degrees or larger. Use acceptable heating methods for forming smaller bends.

4. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduits flexibility.

P. Bushing and Insulating Sleeves

1. Where rigid steel conduit, PVC coated rigid steel conduit, or liquid-tight flexible metal conduit enters metal enclosures, install an insulated throat grounding bushing on the end of each conduit. Install a bonding jumper from the bushing to any equipment ground bus or ground pad. Interconnection of bonding jumpers from each conduit grounding bushing to the equipment ground bus or ground pad is acceptable.

2. If neither a ground bus or ground pad exists, connect the bonding jumper to the metallic enclosure with a bolted-lug connection.

3. Conduit connections to NEMA 3R, NEMA 4, or NEMA 4X enclosures, junction boxes, terminal junction boxes, or device outlet boxes, shall be made with watertight, corrosion resistant hubs. The conduit connections shall maintain the integrity of the enclosure NEMA rating.

Q. **Expansion Joints:** Provide expansion/deflection fittings for raceways crossing expansion joints in structures, between structures and walkways or concrete slabs to compensate for expansion, contraction, and deflection. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joins as recommended by the manufacturer and as required. Provide expansion only fittings in every 200 feet of exposed, straight, rigid steel conduit runs.

R. **PVC Schedule 40 Conduit:** Solvent weld PVC conduit joints with solvent recommended by the conduit manufacturer. Follow manufacturer's solvent welding instructions and provide watertight joints. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings. Use acceptable PVC female adapters when joining PVC conduit to galvanized rigid metal conduit or PVC coated rigid steel conduit.

S. **PVC Coated Rigid Steel Conduit:** Install in strict accordance with the manufacturer's instructions. Touch up any damage to the coating with conduit manufacturer acceptable patching compound. PVC boot shall cover all threads. Where belled conduits are used, bevel the unbelled end of the joint before joining. Leave no metallic threads uncovered. Clean field threads with solvent and coat with urethane touch-up. Keep two cans of urethane touch-up at each threading station.

T. Penetrations

1. Seal the interior of all raceways at the first exterior pullbox or manhole, just prior to entering a new or existing structure, with duct seal compound to prevent the entrance into or exit from the structure with gases, liquids, or rodents. At the new or existing structure penetration, seal the interior of all raceways that enter above or below grade, with duct seal.

2. Where conduit enters a new structure above ground through a concrete wall or roof, install a watertight conduit penetration seal and sleeve. Install the sealing assembly such that it may be tightened at any time from the interior side. For wall and roof penetrations, dry pack with non-shrink grout around the conduit and the sealing assembly on the exterior side. Where conduit enters a new structure below grade through a concrete wall or floor, cast the conduit directly into the concrete wall or floor slab.

3. Where raceways penetrate fire-rated walls, floors, or ceilings, provide fire stop openings around electrical penetrations to maintain the fire-resistance rating.

U. All connections between conduits and NEMA 1, 1A, and 12 enclosures shall be made with double locknuts. All NEMA 3R, 4, and 4X enclosures without integral watertight hubs shall have watertight, threaded, rigid, conduit hubs.

3.2 CONDUIT

A. All exposed conduit shall be as noted in Area Designations, see Specification 16050.

B. Where conduit emerges from concrete encasement, a PVC coated RGS elbow shall be utilized for transition from the concrete to exposed. Conduit shall emerge from the concrete perpendicular to the surface whenever possible.

C. Exposed conduit shall be 3/4-inch minimum trade size. Encased conduit shall one-inch minimum trade size. Supports shall be installed at distances required by the NEC.

D. Conduit shall not be encased in the bottom floor slab below grade.

E. Encased conduit shall have outer diameters not exceeding 1/3 of the concrete slab thickness. Encased conduit shall be routed between reinforcing bar mats. Encased conduits in walls shall be spaced three time largest conduit diameter, measured from conduit edge to edge.

F. All threads shall be coated with a conductive lubricant before assembly. Acceptable products: **Appleton Type TLC, Thomas & Better KOPR-Shield,** or equal.

G. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. All conduit shall be adequately reamed to prevent damage to the wires and cables inside. Strap wrenches and vises shall be used to install conduit to prevent wrench marks on conduit. Conduit with wrench marks shall be replaced at no additional cost to the OWNER.

H. Wherever possible, conduit runs shall slope to drain at one or both ends of run. Wherever conduit enters substructures below grade, the conduit shall be sloped to drain water away from the structure. Extreme care shall be taken to avoid pockets or depressions in conduit.

I. All conduit, fittings, and boxes required in hazardous classified areas shall be suitably rated for the area and shall be provided in strict accordance with NEC requirements.

3.3 REQUIRED RACEWAY TYPE FOR SPECIAL LOCATION AND INSTALLATION METHOD

A. Special Locations

1. In exterior light pole foundations; extend PVC schedule 40 conduit 6 inches above the top of the foundation.

2. Where conduit changes from underground direct burial to exposed; extend PVC coated rigid steel conduit up to 18 inches above finished grade.

3. Where conduit changes from concrete embedded within walls, slabs, and floors to exposed; embed PVC coated rigid steel conduit and elbows in concrete a minimum of 1-foot from where the conduit emerges from the concrete to exposed, and extend PVC coated rigid steel conduit a minimum of 18-inches beyond the concrete walls, slabs, and floors.

4. Under equipment mounting pads; use PVC coated rigid steel conduit.

B. Final Connection to Certain Equipment

1. Make final connection to motors, wall or ceiling mounted fans and unit heaters, dry type transformers, valves, local instrumentation, and other equipment where flexible connection is required to facilitate removal or adjustment of equipment with 18-inch minimum, 60-inch maximum lengths unless otherwise approved by the ENGINEER, of liquid-tight, PVC-jacketed flexible conduit where the required conduit size is 4 inches or less. For larger sizes, use rigid steel conduit as specified.

2. The flexible conduit shall be long enough to allow the item to which is connected to be withdrawn or moved off its base. Use liquid-tight flexible metal conduit in all locations except Office General as described in 16050.

3.4 WIREWAYS

A. Mount wireways securely in accordance with the NEC and manufacturer's instructions. Locate hinged cover on accessible vertical face of wireway unless otherwise indicated.

3.5 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Avoid traps in raceways. Take care to prevent the lodging of plaster, concrete dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

B. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a bristle through each raceway to remove debris. Then pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway.

D. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.

3.6 EMPTY RACEWAYS

A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty raceway. Provide a removal cap over each end of empty raceways. Provide a nylon pull rope in each empty raceway.

3.7 JUNCTION AND PULL BOXES

A. Where indicated on the Contract Drawings, and where necessary to terminate tap-off, or redirect multiple conduit runs, provide and install appropriately designed junction boxes. Furnish and install pull boxes where necessary in the raceway system to facilitate conductor installation. Provide bull boxes to limit straight conduit runs to 200 feet and subtract 50 feet for every 90 degrees of bend in accordance with Section 16110.

1. Installation:

a. Make all boxes accessible. Do not install boxes in finished areas unless accepted in writing by the ENGINEER. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits. Make edges of boxes flush with the final surface.

b. Install boxes in a secure, substantial manner, supported independently of conduit by attachment to the building structure or a structural member. Use bar

hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork. Threaded studs driven in by a powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields. Boxes embedded in concrete or masonry need not be additionally supported. Utilize galvanized mounting hardware.

c. Install boxes for conduits under grade flush with finished grade in locations outside of paved areas, roadways, or walkways.

d. If adjacent structure is available, the box may be mounted on the structure surface just above finished grade in accessible but unobtrusive location. If it is found desirable to locate boxes in paved areas, roadways, or walkways, obtain ENGINEER's written approval and utilize boxes and covers suitable for the weights to which they may be subjected.

3.8 JUNCTION TERMINAL BOXES (JTB)

A. Install in accordance with all the requirements detailed under JUNCTION AND PULL BOXES above. Label each block and terminal with a permanently attached nameplate as specified in this section.

3.9 ELECTRICAL CONTINUITY

A. The entire electrical raceway system shall form a continuous metallic electrical conductor from service point to every outlet and shall be grounded by connection to the main service ground.

B. Rigid steel conduit shall have threads filled with conductive sealant before screwing into fittings.

C. A ground wire shall be installed in all conduits. Conduits shall not be substituted for the grounding wire.

3.10 CONDUIT IDENTIFICATION

A. All conduits containing power, controls, feeders, alarms, instrumentation and communication wiring shall be identified at each end. Labels shall be permanent, waterproof, legible, non-metallic and attached with stainless steel wire.

B. All conduit shall be labeled with type, number and destination. The conduit type and number shall be separated from the destination with a slash (/). Conduit tags shall be where they can be read without having to open instruments and instrument cabinets.

C. Conduit shall be designated with an alpha character prefix denoting the predominant type of wiring in the conduit:

"P" for power
"I" for instrumentation and control
"L" for lighting
"G" for grounding

"S" for spare
"C" for communication or telephone

Control wire shall include 120 VAC and 24 VDC discrete PLC inputs and outputs.

D. Conduit numbers shall be six alphanumeric characters in length. The first three characters shall be the pump station name or number, building number or area designation. The next three characters shall be the conduit number from the Contract Documents.

E. For example a power conduit shown as number 9 on the Contract Documents between the MCC and Pump No. 1 at Northeast Pump Station No. 3 would be tagged P-NE3009/PUMP-1 in the MCC.

- END OF SECTION -

SECTION 16111 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide underground raceway systems, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Sections 01300 - Contractor Submittals and 16050 - Electrical Work, General.

B. Shop Drawings

1. Complete catalog cuts of all raceways, fittings, pullboxes, manholes, handholes, and transformer pads marked where applicable to show proposed materials and finishes.

2. Surveyed as-built drawings of all installed ductbanks providing top of ductbank elevation, station numbers and routing.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Manholes, handholes, transformer pads, pullboxes and fittings which are dedicated to the underground raceway system shall comply with the requirements of this section.

2.2 MANHOLES AND LARGE HANDHOLES (3 FEET WIDE BY 3 FEET LONG AND LARGER SIZES)

A. For manholes and handholes, use precast with 28-day 3,000 psi minimum compressive strength concrete reinforced with Grade 60 rebar. Manholes, handholes, and covers shall be designed for AASHTO H-20 full traffic loading. Minimum dimensions for manholes and handholes are shown on the Drawings. Increase the depths of manholes and handholes by use of extension sections to accommodate the conduit entrances at their required elevations.

B. Slope floors toward drain points, leaving no pockets for other nondraining areas. Provide a sump at the low point of the floor constructed with a heavy duty hot-dipped galvanized steel, slotted or perforated cover. Sump shall be 6-inches in diameter minimum.

C. Provide conduit entrances on all four sides. For conduits installed under this Contract, knockout panels or precast individual conduit openings shall be used. On sides where no conduits are installed under this Contract, provide 16-inch high by 16-inch wide minimum knockout panels for future conduit installations.

D. Manholes and handholes shall have single leaf or double leaf access frames and covers. Covers shall have 1/4 inch thick, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor. Covers shall be same size as interior

dimensions of manhole. The inside of the frame shall have a door-support ledge on two sides. Both frame and ledge must be supported by a full bed of Class A concrete. The door panels shall be 1/4 inch aluminum diamond plate, reinforced to withstand a live load of the H-20 designation. Doors shall open to 90 degrees and automatically lock with a stainless steel hold open arms with release handles. For ease of operation, doors shall incorporate enclosed stainless steel compression spring assists. Doors shall close flush with the frame. Hinges and all fastening hardware shall be stainless steel. Unit shall lock with a stainless steel slam lock with removable keys and have a non-corrosive handle. Unit shall be guaranteed against defects in material and/or workmanship for a period of 10 years. Access covers to be manufactured by **Halliday Products Series H-R,** or equal.

E. Manholes and handholes for electrical, and telecommunications and control, shall have letters 3" high and 1-1/2" wide cast in the covers indicating ELECTRIC LV (600 volts or less), or TELCOM/I&C, as applicable.

F. Provide heavy weight cable racks with adjustable arms and acceptable insulators for all cables in each manhole and handhole. Set adjustable inserts into the concrete walls for the attachment racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole or handhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the manhole, including spares.

G. Provide a pulling iron embedded in the concrete wall opposite each conduit entrance and one in the floor vertically below the center of the manhole or handhole cover. Utilize 3/4-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.

H. Utilize manhole and handhole hardware of steel, hot-dip galvanized after fabrication.

I. Provide phenolic tags on conduit ends inside manholes and handholes, adhesive epoxied to interior wall of manhole. Provide phenolic tags on cables, attached with nylon wire ties inside manholes and handholes.

J. Stainless steel identification nameplates shall be bolted with stainless steel bolts to manhole and handhole covers. Plates shall be 12 gauge, 3-1/2" x 1-1/2" with engraved block letters and numbers, 1" high and 3/4" wide. Manhole and handhole identification shall be, as indicated on the drawings.

K. **Acceptable products: Brooks Products, Inc., Utility Vault Company, Associated Concrete Products,** or equal.

2.3 SMALL HANDHOLES (SMALLER THAN 3 FEET WIDE BY 3 FEET LONG)

A. Typical inside dimensions for small handholes are as follows; 11-inches by 17-inches, 13-inches by 24-inches, 17-inches by 30-inches, and 24-inches by 36-inches. Use open bottom precast handholes with 28-day 3,000 psi minimum compressive strength reinforced concrete. Handholes and covers for size 17-inches by 30-inches and 24-inches by 36-inches in traffic areas shall be designed for AASHTO H-20 full traffic loading unless otherwise noted on the Drawings. Minimum dimensions for small

handholes are shown on the Drawings. The depths of small handholes shall be 24-inches minimum; increase these depths by use of extension sections to accommodate the conduit entrances at their required elevations.

B. Provide conduit entrances on all four sides. For conduits installed under this Contract, knockout panels or precast individual conduit openings may be used. On sides where no conduits are installed under this Contract, provide 3-inch high by 3-inch wide minimum knockout panels for future conduit installations.

C. Small handholes for electrical, and telecommunications and control, shall have letters 1-inch high and 3/4-inches wide minimum cast in the covers indicating ELECTRIC LV (600 volts or less) or TELCOM/I&C, as applicable. Each handhole shall have identification letters and numbers cast into the cover; letters and numbers shall be 1-inch high and 3/4-inches wide minimum. Handhole identification shall be as indicated on the drawings.

D. For handholes 17-inches by 30-inches, and 24-inches by 36-inches, utilize handhole hardware, frames, and covers of steel, hot-dip galvanized after fabrication and provided with bolt down or screw down covers. For handholes 11-inches by 17-inches and 13-inches by 24-inches, provide precast concrete covers.

E. Provide phenolic tags on conduit ends inside handholes attached to conduit with stainless steel tie wire. Provide phenolic tags on cables, attached with nylon tie wires inside manholes and handholes.

F. Acceptable products: **Associated Concrete Products, Inc., Brooks Products, Inc., Christy Concrete Products, Inc,** or equal.

2.4 DUCTBANKS

A. Underground ducts shall be Schedule 40 PVC. Refer to Section 16110 for specification. Provide end bells on all conduits entering manholes and handholes.

B. Ducts shall be encased in red-dyed concrete with steel reinforcing bars. Concrete shall have 3,000 psi compressive strength conforming to Section 03300 - Cast-In-Place Concrete. Colorant shall be an integral red-oxide coloring pigment in the proportion of 5 pounds per cubic yard of concrete. Concrete shall be dyed red throughout the ducts. Surface treatment will not be accepted. The costs, if any, of cleaning coloring pigment from the concrete delivery equipment and other related cleanings shall be included in the Bid.

C. Ductbanks shall contain a No. 4/0 bare stranded copper ground wire. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and grounding grid.

2.5 WARNING TAPE

A. Provide heavy-gauge, yellow, non-adhesive polyethylene tape of 6-inch minimum width, 4 mils nominal thickness, with black lettering, for use in trenches containing electric circuits. Use tape with printed warning “CAUTION-ELECTRIC LINE BURIED BELOW”.

B. Acceptable products: **Harris Industries, Inc. Underground Tape Catalog No. UT-28, Panduit Corp. Hazard Tape Part No. HTU6Y-E, Terra Tape Standard 250,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation unless otherwise authorized by the ENGINEER.

B. Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.

C. Do not use union type fittings underground.

D. Provide a minimum cover of 2 feet 6 inches over all underground raceways unless otherwise indicated. If conditions do not allow for 2 feet 6 inches of cover, provide concrete encasement with minimum 6” backfill cover over 4” concrete cap.

E. Where a concrete-encased duct bank is installed over an extensive area of disturbed earth such as that within the periphery of a building, provide a separate concrete base under the duct bank to ensure stability of raceways during installation. Allow this base to set before the duct bank is installed. Compact all underlayment of proposed ductbanks to 95% compaction, and approved by ENGINEER.

F. Do not concrete-encase or backfill underground raceways until they have been inspected by the ENGINEER.

G. Warning Tapes: Bury warning tapes approximately 18 inches above top of conduits in all underground conduit runs or duct banks. Align parallel to and within 6 inches of the centerline of runs that are 12 inches wide or less. Provide two tapes and align parallel to and within 6 inches of the centerline of each side of runs that are more than 12 inches wide. Provide three tapes and align parallel to and within 6 inches of the centerline of each side of runs that are more than 30 inches wide.

3.2 DUCTBANKS

A. Separation and Support

1. Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type raceways used, and in no case greater than 5 feet.

2. Support raceways installed in fill areas to prevent accidental bending until backfilling is complete. Tie raceways to supports, and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.

3. Separate duct banks no less than 2 feet 0 inches between adjacent sides except where shown otherwise.

B. Arrangement and Routing

1. Arrange multiple conduit runs substantially in accordance with any details shown on the drawings. Locate underground conduits where indicated on the drawings.

2. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the ENGINEER for instructions before further work is done. Determine exact alignment and depth as required to avoid other utilities.

3. Where other utility piping systems are encountered or being installed along a raceway route, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the ENGINEER for instructions before further work is done.

4. Duct bank alignments shown on Drawings are diagrammatic. Actual alignments shall contain no sharp bends and shall be installed with minimum radius bends as required in the NEC.

5. Provide insulated grounding bushings on all galvanized rigid steel or PVC coated rigid steel conduit entering manholes and handholes. Provide bell-ends flush with walls on all PVC Schedule 40 conduit entering manholes and handholes.

6. In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.

7. All conduits shall enter manholes, handholes, buildings, and structures at right angles.

C. Direct Earth Burial Conduit Zone Backfill installation

1. Backfill material for the conduit zone of direct burial conduit trenches shall be imported sand. Provide 4-inch minimum sand bed prior to conduit placement in bottom of trench.

2. Provide 12-inch sand cover on top of conduit.

3. After conduits have been properly installed and covered with 12 inches of sand, backfill the trench with specified material. Backfill material may be selected from the excavated material if it is free from roots, foreign material and particles greater than 3 inches. Final cover shall be 30 inches minimum.

D. Concrete Encasement

1. Where indicated, encase conduits in a red concrete envelope sized as indicated and located at the elevation shown. Use 3,000 psi concrete and reinforcing as specified in Section CONCRETE. Use five pounds of red oxide per cubic yard of concrete.

2. In order to drain water and condensation accumulated in conduits, maintain a grade of at least 4 inches per 100 feet, either from one manhole or pull box to the next, or from a high point between them, depending on the surface contour.

3. Hold conduits for concrete-encased raceways securely in place by acceptable window type spacer supports. Where, in the opinion of the ENGINEER, ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to the ENGINEER. No variations greater than 1/2 inch in 50 feet will be permitted from a straight line.

4. Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade concrete during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.

5. Do not use power-driven tampers or agitators unless they are specifically designed for the application, in order to ensure that the watertight integrity of the raceways is maintained.

6. Generally, pour an entire concrete envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4-inch reinforcing rod dowels extending into the concrete 18 inches minimum on each side of the joint. Obtain ENGINEER 's approval for the number and location of dowels.

E. Backfill Installation Above Conduit Zone of Direct Burial Conduit or Above Concrete Envelope of Concrete Encased Conduit

1. Backfill material above the conduit zone of direct burial conduit or above concrete envelope of concrete-encased conduit may be selected from the excavated material, if it contains no particles larger than 3 inches in diameter and is free from roots or debris. Imported material meeting these same requirements may be used in lieu of material from the excavation. Compact backfill in maximum 12-inch layers to at least 95 percent of the maximum density at optimum moisture content as determined by AASHTO T 180.

3.3 MANHOLES AND HANDHOLES

A. Install manholes and handholes where shown on the Drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified elsewhere in these Contract Documents.

B. Do not install manholes or handholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.

C. Make installation so that raceways enter manholes or large handholes at nearly right angles and as near as possible to one end of a wall, unless otherwise indicated.

D. Install one ground rod in each manhole and large handhole. Connect all noncurrent-carrying metal parts in the manhole or large handholes and any metallic

raceway grounding bushings to this ground rod. See Section 16450 for additional requirements.

E. All construction of manholes and handholes shall include over excavation of the foundation area and placement of a minimum of 1 foot of 3/4-inch drain rock below the unit.

F. Place and compact backfill material as specified in Section 02200.

3.4 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Avoid traps in raceways. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

B. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a bristle brush through each raceway to remove debris. Then pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway.

D. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.

3.5 EMPTY RACEWAYS

A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty raceway. Provide a removable cap over each end of empty raceways. Provide a nylon pull rope in each empty raceway.

3.6 CONDUIT IDENTIFICATION

A. Refer to Specification 16110 for conduit identification.

3.7 TRENCH SETTLING

A. If at any time during a period of one year dating from the date of final acceptance of the project, there shall be any settlement of conduit trenches, the ENGINEER may notify the CONTRACTOR to immediately provide additional fill and to make such repairs or replacements in paving, planting, or structures, as may be deemed necessary at the CONTRACTOR’s expense.

3.8 TRENCHING

A. Verify the location of all existing cables, conduits, piping, and other equipment in or near the areas to be trenched, prior to starting trenching. Repair any equipment damaged during trenching. Trenches shall not be left unattended unless the area is fenced or

barricaded to restrict entry to the area. Call an Underground Service firm before trenching.

- END OF SECTION -

SECTION 16120 - WIRES AND CABLES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wires and cable, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATION, CODES, AND STANDARDS

A. **Reference Codes:** All work specified herein shall conform to or exceed the applicable requirements of the National Electrical Code (NEC); provided, that where a local code or ordinance is in conflict with the NEC, the provisions of said local code or ordinance shall take precedence. For additional requirements, see paragraph Reference Codes and Standards of Section 16050 - Electrical Work, General.

B. Commercials Standards

ANSI/IEEE C2	National Electrical Safety Code.
ANSI/NFPA 70	National Electrical Code.
ICEA S-95-658/NEMA/WC70	Non-shielded 0-2 kV Cables.

1.3 CONTRACTOR SUBMITTALS

A. **General:** The CONTRACTOR shall submit Shop Drawings in accordance with Sections 01300 - Contractor Submittals and 16050 - Electrical Work, General.

B. Shop Drawings

1. Product Data: Provide complete catalog cuts of all cables, wires, terminations, splices, fittings, identification systems, and tape.

2. Test Reports: Indicate results of cable test with terminations and splices installed in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

3. Manufacturer’s Instructions: Manufacturer shall provide illustrated step-by-step instructions describing installation on cable construction as specified herein.

1.4 QUALIFICATIONS

A. **Manufacturer:** Company specializing in manufacturing Products specified in this Section with minimum 15 years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of Section 16050.

B. Accept cable and accessories on site in manufacturer’s packaging. Inspect for damage.

C. Store and protect in accordance with manufacturer’s instructions.

D. Protect from weather. Provide adequate ventilation to prevent condensation.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All conductors, include grounding conductors, shall be copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400 and fixture wires shall conform to Article 402. The use of manufacturer’s name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.2 LOW VOLTAGE WIRE AND CABLE

A. Power and Lighting Wire

1. All wire rated for 600 volts in duct or conduit for all power and lighting circuits shall be Class B stranded copper. Cable jacket shall be THHN/THWN. Wire size for lighting and receptacles shall be No. 12 AWG minimum.

2. Wiring for single conductor 600 volt class power and lighting shall be as manufactured by **Okonite: Okoseal-N THHN/THWN 75 degrees C wet,** or equal.

B. Control Wire

1. Multi-conductor control wiring shall be No.14 AWG rated 600 VAC for cable tray use. CONTRACTOR to provide, as a minimum, the number of control wires listed in the cable schedule including one grounding conductor. Conductors shall be stranded copper per ASTM B-33, Class B stranded per ASTM B-8. Insulation shall be THHN/THWN, rated with a 75 degree C wet minimum rating. Color coding shall be per WIRE COLOR CODING table at the end of this section. Grounding conductor, shall be copper per ASTM B-8, Class B and sized per NEC and green color insulation. Conductors shall be assembled in accordance to UL 1277 using tape fillers and a cable tape overall. Overall jacket shall comply with UL 1277, UL 1581, and be rated for cable tray installations with sunlight resistant jacket. Cable shall be as manufactured by **Okonite FMR Okolon,** or equal.

2. Control wires at panels and cabinets shall be as specified in Sections 16485 or 17200 depending on type of panel and cabinet.

C. Instrumentation Cable

1. Instrumentation cable shall be rated at 600 volts.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color-coded polyethylene, black and white.

3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a minimum No. 20 AWG stranded tinned copper drain wire, and a PVC outer jacket with a thickness of 0.032 inches minimum.

4. Single pair, No. 16 AWG, twisted, shielded cable shall meet UL 1581 as manufactured by **Belden Part No. 8719,** or equal.

D. **RTD Cable:** RTD cables for motors shall be **Beldon No. 85103,** or as required by the motor manufacturer.

2.3 INSULATED GROUND WIRE

A. All insulated ground wire shall be rated for 600 volts and Class B stranded copper. Cable jacket shall be THHN/THWN and colored green. Insulated ground wire shall be manufactured by **Okonite: Okoseal-N Type THHN/THWN,** or equal.

2.4 DIRECT BURIED GROUNDING CONDUCTORS

A. Provide bare concentric stranded copper conductors conforming to ASTM B-8, size as indicated on the drawings, or minimum size as specified in Section 16450, for the ground system at ground grids, transformers, switchgear, motor control centers, and where indicated.

B. **Acceptable Products: Anixter, American Insulated Wire Company,** or equal.

2.5 RADIO COAXIAL CABLE

A. Radio antenna cable shall be **Times Microwave Systems 3/8-inch Coax Model Number LMR400,** no substitutions.

2.6 600V CABLE TERMINATIONS

A. Compression connectors shall be **Burndy "Hi Lug", Thomas & Betts "Sta-Kon,",** or equal. Threaded connectors shall be split bolt type of high strength copper alloy. Pressure type, twist-on connectors will not be acceptable.

B. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy,** or equal.

C. General purpose insulating tape shall be **Scotch No. 33, Plymouth "Slip-knot",** or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.

2.7 MOTOR CONNECTION KITS

A. Motor connection kits shall consist of two layers of heat-shrinkable radiation crosslinked insulation and heat activated sealant for environmental sealing. Kits shall be factory engineered and shall accommodate a wide range of cable sizes and be completely independent of cable manufacturers' tolerances. Utilize 1,000 volt rated kits for 600 volt applications.

B. **Acceptable Products: Raychem Corporation Model MCK,** or equal.

2.8 CONDUCTOR AND CABLE TAGS

A. Tags relying on adhesives or taped-on markers are not acceptable for conductor and cable tags.

B. Provide tags for individual wires, at termination ends, for wires 1/0 and smaller. Tags shall be white heat-shrink with thermal transfer printing, 3 to 1 shrink ratio, 2 inches long and meet UL224. Acceptable products: **Raychem Tyco Shrink Mark Heat Shrinkable Sleeves,** or equal.

C. Provide tags for conductors and cables in non-corrosive environments with legible permanent sleeve of white heat-shrink polyolefin with thermal transfer black marking. Install markers with black nylon-tie wraps. Acceptable products: **Raychem Tyco Shrink Mark CM Cable Markers,** or equal.

D. Provide tags for conductors and cables in corrosive environments consisting of permanent stainless steel marker plates with legible designations deep surface marked on the plate. Attach these marker plates to conductors and cables with black nylon tie cord. Acceptable products: **Raychem Tyco Premark 316,** or equal.

2.9 ELECTRICAL TAPE FOR COLOR CODING

A. Electrical tape shall be premium grade, not less than 7 mils thick, rated for 90 degrees C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

B. **Acceptable Products: 3M 35 Scotch Vinyl Electrical Tape for Color Coding, Plymouth Rubber Company Premium 37 Color Coding Tape,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall provide and terminate all power, control, and instrumentation conductors except where indicated.

3.2 INSTALLATION

A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris. If mechanical means are used to pull cable the pulling tension shall be monitored, recorded and submitted to ENGINEER.

B. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

C. Single conductors and cables in manholes, handholes, and other indicated locations shall be bundled with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

D. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

E. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

F. Install bare ground conductor 3'-0" below finished grade as shown on Drawings. Reference Specification Section 16450 for further requirements.

3.3 SPLICES AND TERMINATIONS

A. General

1. There shall be no cable splices without the approval of the ENGINEER.

2. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

3. Excess control and instrumentation wire shall be properly taped and terminated as spares.

B. Control Wire and Cable

1. Control conductors shall be terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. All control wire and spare wire shall be terminated to terminal strips in junction boxes, motor control centers, and control panels.

C. **Instrumentation Wire and Cable:** Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.

D. **Power Wire and Cable:** Splices to motor leads in motor terminal boxes shall be 1,000 volt rated motor connection kits for 600 volt applications.

3.4 CABLE IDENTIFICATION

A. **General:** Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance efforts. All cables and conductors shall be identified by a cable tag at each end and along run within every manhole, handhole, junction box, and pullbox. Cable tags shall appear within 3 inches of terminals at the cable ends, on the loop at each manhole, handhole, junction box and pullbox.

B. **Identification Numbers:** All power, control, and alarm wiring shall be numbered and identified by means of wire markers at all switchboards, MCCs, panelboards, auxiliary gutters, junction boxes, pull boxes, receptacle outlets, light outlets, manholes, disconnect switches, and circuit breakers. These markers shall correspond to numbers on shop

drawings and wiring diagrams. Wire markers shall consist of machine engraved numbers applied by an approved marking device. Provide Brady heat shrink labels or equal.

1. All individual conductors shall be labeled origin, destination and sequence number. The information shall be separated by slashes (/). The origin and designation shall be designated with the names shown on the Contract Documents. The sequence number shall be a unique sequential number for that particular cable run. At the PLC wire labels shall include the rack, slot and terminal number.

2. Multi-conductor cables shall be labeled origin, destination and sequence number. The information shall be separated by slashes (/). The origin and designation shall be designated with the names shown on the Contract Documents. The sequence number shall be a unique sequential number for that particular cable run. Twisted shielded cables shall be considered multi-conductor cables.

3. All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A-black, Phase B-red, Phase C-blue, and Neutral-white. The 120/240-volt system conductors shall be color coded as follows: Line 1-Black, Line 2-Red, and Neutral-White. The 480/277-volt system conductors shall be color coded as follows: Phase A-Brown, Phase B-Orange, Phase C-Yellow, and Neutral-Gray. Color coding tape shall be used where colored insulation is not available. 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. Color coding of multi-conductor cables shall be per ICEA Method 1, Table E-2 for control cables, Option D for power cables. These cables, while color coded, are still required to have cable tags.

4. General purpose AC control cables shall be violet. General purpose DC control cables shall be violet with white tracer.

5. DC power supply wires shall be red. DC system signal commons shall be black.

6. DC analog signal wires shall be black for positive and clear for negative.

7. All spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

8. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.5 LACING OF WIRES AND CABLES

A. All wires and cables shall be laced in pull or junction boxes, manholes and handholes. Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit and the laced-together circuit or cable shall be tagged with the cable number. All wiring entering and exiting the control panels shall be bundled into groups. Power, lighting, control, alarm, annunciator, and instrumentation wiring shall be bundled, laced, and tagged, as specified herein.

B. Cables passing through manholes and handholes shall be trained along the walls on cable racks. Allow 2 feet of slack in each run in a "drip loop" at least once along a wall. Loops and cables shall be organized, trained, and neatly installed.

3.6 TESTING

A. **Cable Testing:** The following field tests shall be the minimum requirements:

1. All conductors and control cables under 600 volts:

a. Perform insulation resistance testing of all power and control circuits, measured with respect to ground and adjacent conductors, rated 600 volts with a 1000-volt dc megger. Test duration shall be one minute. Perform insulation resistance testing in the presence of the ENGINEER.

b. Prepare a written test report of the results and submit to the ENGINEER prior to final inspection.

c. Minimum acceptable value for insulation resistance is 50 megohm.

d. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.

2. All field testing shall be done after cables are installed in the raceways.

3. Field tests shall be performed by a certified test organization acceptable to the ENGINEER. Test forms shall be submitted to the ENGINEER for review and acceptance prior to testing. Results shall be submitted to the ENGINEER for review and acceptance. Refer to Specification of 16950 for further testing requirements.

4. Cables failing the tests shall be replaced with a new cable. Replaced cables must pass same test.

B. **Continuity Test:** All control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cables in service.

- END OF SECTION -

WIRE COLOR CODING

DESCRIPTION	PHASE / CODE LETTER	NON-FIELD WIRE COLOR (ENCLOSURE)	FIELD WIRE COLOR
480 VAC, 3-PH	A	BROWN	BROWN
	B	ORANGE	ORANGE
	C	YELLOW	YELLOW
240/208 VAC, 3-PH	A	BLACK	BLACK
	B	RED, ORANGE IF HIGH LEG	RED, ORANGE IF HIGH LEG
	C	BLUE	BLUE
240/120 VAC, 1-PH	L1	BLACK	BLACK
	L2	RED	RED
12 VDC, POSITIVE	12P	DARK BLUE	DARK BLUE
12 VDC, NEGATIVE	12N	BLACK / RED STRIPE	BLACK / RED STRIPE
24 VDC, POSITIVE	24P	RED	RED
24 VDC, NEGATIVE	24N	GRAY	GRAY
AC CONTROL		VIOLET	VIOLET
DC CONTROL		BLUE	BLUE
NEUTRAL	N	WHITE	WHITE
GROUND	G	GREEN	GREEN
SHIELDED PAIR	+	BLACK	BLACK
	-	CLEAR	CLEAR

SECTION 16140 - WIRING DEVICES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wiring devices, complete and operable, in accordance with the Contract Documents.

B. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Contract submittals shall be in accordance with Sections 01300 - Contractor Submittals and 16050 - Electrical Work, General.

B. Shop Drawings

1. Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials.

2. Documentation showing that proposed materials comply with the requirements of NEC and U.L.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All devices shall carry the U.L. label.

B. General purpose duplex receptacles and toggle switch handles shall be brown. Receptacles and switches shall conform to Federal Specifications W-C-596E and W-S-896E, respectively.

2.2 LIGHTING SWITCHES

A. Local branch switches shall be automatic self-adjusting wall switch type, rated at 6.7 amperes, 120 VAC, passive infrared detection technology, with automatic off, auto or manual on, five year warranty, and shall be **Novitas Super Switch 2,** or equal.

B. Local branch switch for Electrical Room shall be toggle type, 20 amperes, 120-277 VAC, and shall be **Leviton No. 1221-2,** or equal

2.3 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles rated 120 V, 20 amperes shall be polarized 3 wire type for use with 3 wire cord with grounded lead and 1 designated stud shall be permanently grounded to the conduit system (NEMA 5-20R). Duplex 120 V receptacles shall be **G.E. 5362, Hubbell 5362,** or equal. Single receptacles shall be **G.E. 4102, Hubbell 4102,** or equal.

B. Ground-fault circuit interrupting receptacles (GFCI's) shall be installed at the locations indicated. GFCI's shall be rated 125 V, 20 amperes and shall be **Hubbell GF-5362,** or equal.

C. In Corrosive Areas use corrosion resistant receptacles, 125 V, 20 amperes and shall be **Hubbell,** or equal.

2.4 INTRUSION TIMER

A. Spring wound timers shall be industrial grade, 0-12 hours, with 10 amp switch ratings. Timers shall be compact design to fit within 2-1/2-inch deep junction box. Spring wound timer to be **Intermatic FF312H,** or equal.

2.5 OUTLET AND DEVICE BOXES

A. **General:** Provide boxes not less than 2 inches deep, unless shallower boxes are required by structural conditions and are specifically accepted by the ENGINEER. Do not use box extensions to provide wiring space required by the NEC. For hollow masonry construction, provide boxes of sufficient depth so that conduit knockouts or hubs are in the masonry void space.

1. Cast Metal Boxes: Provide zinc-plated malleable iron cast metal boxes with gasketed, watertight, zinc-plated malleable iron cast metal covers and stainless steel screws. Provide boxes with threaded conduit hubs and cast mounting lugs where lugs are required. Acceptable products: **Crouse-Hinds Type FS Condulet Cast Device Boxes and Covers, Appleton Type FS Cast Device Boxes and Covers, or OZ Gedney type FS Outlet Boxes and Covers.**

2. Sheet Steel Boxes: Provide zinc or cadmium plated boxes of the one piece drawn type. Install 4-inch minimum octagonal boxes for ceiling outlets, except where smaller boxes are required for the particular fixture being installed. Use concrete type boxes in poured concrete slabs. Provide 2-inch by 4-inch minimum size boxes for switches and receptacles. Provide plaster rings where required. Acceptable products: **Appleton Outlet Boxes, Raco Steel Boxes, or Steel City Outlet Boxes.**

3. Corrosion Resistant Boxes: Provide corrosion resistant boxes for Corrosive Areas. PVC boxes to be used when PVC conduit is cast in walls. Acceptable products: **Hubbell,** or equal.

2.6 DEVICE COVERS

A. All switch and receptacle covers on surface mounted boxes shall be die cast copper-free aluminum.

B. In corrosive areas, switch and receptacle boxes shall be provided with stainless steel covers as manufactured by **Harvey Hubbell, Arrow Hart, Bryant,** or equal.

C. In areas where cast boxes are used, switch and receptacle covers shall be **Crouse-Hinds Catalog No. DS185 and WLRD-1, or Adalet No. WSL and WRD,** or equal.

D. Receptacles in wet locations shall be with a hinged cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed." There shall be a gasket between the

polycarbonate enclosure and the mounting surface and between the hinged cover and mounting plate/base. The cover shall be **Hubbell, TayMac Specification Grade #20310**, or equal.

2.7 NAMEPLATES

A. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. ON and OFF for 3-way or 4-way switches is not acceptable. Provide receptacles for special purposes with nameplates indicating their use. Conform to requirements of Section 16050 - Electrical Work, General.

2.8 CIRCUIT BREAKERS, INDIVIDUAL, 0 TO 600 VOLTS

A. Mount individual circuit breakers in NEMA rated enclosures as specified in Section 16050-1.9.A.3. Provide circuit breakers with handles that can be locked in the OFF position. Provide quick-make, quick-break, thermal magnetic circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the opening handle. Do not use single-pole circuit breakers with handle ties where multipole circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB I and having a minimum interrupting rating of 25,000 amps rms symmetrical at 480 volts AC and 10,000 amps rms symmetrical at 125 volts DC. Provide circuit breakers suitable with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. **Acceptable manufacturers: Culter-Hammer/Westinghouse, General Electric, Square D,** or equal.

2.9 NONFUSED DISCONNECT SWITCHES, INDIVIDUAL, 0 TO 600 VOLTS

A. Provide disconnect switches in NEMA rated enclosures as specified in Section 16050-1.9.A.3. Provide switches that can be locked in the OFF position. Interlock enclosure and switches to prevent opening the cover with the switch in the ON position. Provide switches which are quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type, having external marking clearly indicating ON and OFF positions. Furnish switches meeting the requirements of NEMA KS 1. Provide switches suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. Provide disconnect switches with factory installed, engraved, laminated nameplates (black lettering on white background) citing the name of the equipment as shown on the drawings.

C. **Acceptable Products: Cutler-Hammer/Westinghouse Heavy Duty Safety Switches, Square D Class 3110, or General Electric Type TH.**

2.10 COMBINATION STARTERS, 0 TO 600 VOLTS

A. Provide full voltage combination starters in NEMA rated enclosures. Provide switches that can be locked in the OFF position. Interlock enclosure and switches to prevent opening the cover with the switch in the ON position. Include external marking clearly indicating ON and OFF positions. Combination starters shall be NEMA rated, magnetic, non-reversing, with HMCP motor circuit protector with control transformer and control devices as shown on the electrical schematics. Provide external reset button. Provide heaters based on

actual connected motor nameplate data. Provide equipment suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. Provide combination starters with factory installed, engraved, laminated nameplates (black lettering on white background) citing the name of the equipment as shown on the drawings.

C. **Acceptable Products: Cutler-Hammer/Westinghouse Catalog No. AN40, Square D, or General Electric.**

2.11 FUSES, 0 TO 600 VOLTS

A. Provide a complete set of fuses wherever fuses are used. Supply a set of six spare fuses of each type and each current rating installed. Utilize fuses that fit mountings. Provide the following types:

1. For 0- to 600-volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay, **Bussmann Type LPS-RK, Shawmut Type A6D-4,** or equal.

2. For 0- to 250-volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay, **Bussmann Type LPN-RK, Shawmut Type A2D-R,** or equal.

3. For 0- to 600-volt feeder and service circuits, 0 to 600 amps, UL Class RK-1, **Bussmann Type KTS-R, Shawmut Type A6K-R,** or equal.

4. For 0- to 250-volt feeder and service circuits, 0 to 600 amps, UL Class RK-1, **Bussmann type KTN-R, Shawmut Type A2K-R,** or equal.

2.12 TIME SWITCHES

A. Provide UL listed electromechanical, 24 hour time switches with an adjustable dial.

B. Units shall have a 120 volt, single phase, 60 hertz heavy duty synchronous, self-starting, high torque timing motor, and schedule tabs which are captive on the dial. Tabs shall be capable of being set by hand. The dial shall be capable of 1 to 48 ON/OFF operations per day, and shall have a 96 self contained trippers for 15 minute switching changes.

C. Units shall have one SPDT output contact rated 10 amperes minimum at 120 volts AC.

D. Provide time switches inside a hinged steel NEMA 3 indoor/outdoor enclosure suitable for wall or surface mounting.

E. **Acceptable Products: Tork Model 8001 Time Switch with Model 9000A NEMA 3 Enclosure; Intermatic Series 1900 Time Switch; Cutler-Hammer Type D83 Timer;** or equal.

2.13 GENERATOR CONNECTION

A. Provide a generator connection system, complete with power distribution blocks.

1. Use power distribution blocks rated at 800 amps, 600 volts as shown on Contract Drawings. The blocks shall be **Burndy VersiPole No. BDB-22-500-3 (860 amperes),** or equal.

2.14 INTRUSION SWITCHES

A. Limit switches for intrusion alarms shall be **Square D Class 9007, Type C,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Perform work in accordance with the National Electrical Code.

3.2 CONNECTION

A. Rigidly attach wiring devices in accordance with National Electrical Code, and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

3.3 INSTALLATION

A. Mount boxes at the following heights unless otherwise indicated (heights are to the centerline of the box):

Wall Switches	48” above floor
Thermostats, Non-fused Disconnect Enclosed Combination Starters, Wall Mounted Control Panels	54” above floor
Wall Telephone Outlets	15” above floor
Wall-Mounted Telephone Outlets	52” above floor for standard wall telephone
Convenience Receptacles:	
Indoor:	
Interior Office Interior General	15” above floor, unless otherwise indicated
Interior Damp Interior Corrosive	48” above floor
Outdoor:	
All Areas	24” above floor, finished grade, or slab

B. Where above heights do not suit the building construction or finish, locate boxes where directed by the ENGINEER.

C. Locations indicated are approximate. Study the Contract Drawings in relation to spaces and equipment surrounding each outlet. When necessary, with the approval of the ENGINEER, relocate outlets to avoid interference with mechanical equipment or structural features. Locate all light switches on lock side of doors. Locate all light fixture outlets in a symmetrical pattern according to the room layout unless otherwise indicated.

D. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits. Make edges of boxes flush with finished surface. Provide proper type extension rings for this purpose. For flush mounted boxes, make holes in the surrounding surface no larger than required to receive the box.

E. Install boxes in a secure, substantial manner supported independently of conduit by attachment to the building structure or a structural member. Use bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded, threaded studs on steelwork. Threaded studs driven in by a powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields. Boxes embedded in concrete or masonry need not be additionally supported. Utilize galvanized mounting hardware.

F. Provide flush or recessed lighting fixtures with separate junction boxes when required by the fixture terminal temperature. Where boxes support fixtures, provide proper means of attachment with adequate strength.

G. Open on more knockouts in boxes than are actually required. Seal any unused openings in any type box.

3.4 GROUNDING

A. Ground all devices, including switches and receptacles, in accordance with NEC, Article 250, and Section 16450 - Grounding.

B. Ground switches and associated metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and their metal plates through positive ground connections to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw or by grounding jumper, each making positive connection to outlet box and grounding system at all times.

3.5 INDIVIDUAL CIRCUIT BREAKERS, DISCONNECT SWITCHES, AND COMBINATION STARTERS

A. Mount individual circuit breakers, disconnect switches, and combination starters, in a location that is easily accessible, but does not obstruct working areas and walkways and that is in line-of-sight of the equipment for which the switch is used as a disconnect. Attach nameplate to the front of the switch identifying the name and tag number of the equipment.

3.6 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 16950 - Electrical Testing.

B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.

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SECTION 16431 - PROTECTIVE DEVICE STUDIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform short circuit, arc flash, coordination and protective device study for the electrical power system in accordance with the Contract Documents. The study shall cover 3-phase faults and line to ground faults to coordinate over-current settings and ground fault settings for proper coordination and protection.

B. The study shall include all portions of the electrical distribution system for normal and standby power sources down to and including the 240/120V and 208/120V distribution systems.

C. The WORK of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

D. It is the responsibility of the CONTRACTOR to obtain from the electric utility and appropriate vendors the information required to perform all the studies including the 3-phase fault study, the line to ground fault study, arc flash study, coordination and protective device study. The CONTRACTOR shall contact the electric utility and obtain the short circuit contribution and impedance values in writing for this water treatment facility needed for these studies. The CONTRACTOR shall contact the protective device manufacturer's and obtain the ratings and time current curves for all protective devices including fuses, circuit breakers, motor circuit protectors, relays and overload protective elements. Roseville Electric Utility contact is Mr. Norman Lee (916) 774-5618.

E. The SUBCONTRACTOR shall perform all needed field investigation and inspections to properly identify protective devices and their settings and ratings to get the correct information to work with including the correct trip and/or time-current curves.

F. The CONTRACTOR shall perform all needed field investigation and inspections to properly identify equipment including motors, generators and transformers and any appropriate settings and nameplate data to get the correct information to work with including impedance values, voltage ratings, base kVA ratings and/or current ratings.

G. The CONTRACTOR shall perform all needed field investigation and inspections to properly identify all cable and wire size, type, size and material for use in the study. The CONTRACTOR shall also determine the cable and wire lengths and protective conduit type (plastic, steel, aluminum, non-conductive fiber) for use in the study.

H. A preliminary short circuit report shall be prepared and submitted early in the project to verify suitability of new equipment short circuit ratings and allow approval of the distribution and utilization equipment.

I. All the short circuit, arc flash, coordination and protective device studies shall be submitted as part of the normal construction sequencing, input of settings and startup. After the facilities are built and operating all comments on the studies and studied equipment shall be addressed and all corrections made to input data. With the O+M submittal all the studies shall be resubmitted with all calculations rerun and coordination

plots remade, tabulations corrected and reports adjusted reflecting the as-built equipment, as left settings and corrected input data as a separate submittal.

1.2 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, and protective device coordination studies shall be performed by a manufacturer who has been regularly engaged in short circuit and protective device coordination services for a period of at least 15 years.

B. Studies shall utilize proven computer programs for making three-phase fault duty calculations. The studies shall also cover ground faults for coordination of ground fault settings.

C. Studies shall be thoroughly reviewed, stamped and signed by an electrical engineer registered in the State of California having experience performing short circuit and coordination studies who directly supervised the collection of information, the creation of the studies and associated reports.

1.3 CONTRACTOR SUBMITTALS

A. All Reports shall be submitted and approved prior to final project acceptance in accordance with Section 16050 and 01300. Approval from the ENGINEER shall be obtained to ensure that protective device settings are appropriate and equipment withstand and interruption ratings will be adequate.

B. Prior to releasing the distribution equipment for manufacture a preliminary Short Circuit Report shall be approved by the ENGINEER.

C. The complete studies, reports, settings, calculations, plots and tabulations shall be performed and submitted twice in addition to the preliminary study to allow approval of distribution equipment short circuit protective devices. The first time as a part of normal construction, setup and startup of the facilities. The second time with the O+M submittal as a separate submittal after all comments, corrections, updated input data, and as left settings have been inserted into the software programs to produce an as-built set of studies, reports, settings, calculations, plots and tabulations.

D. CD disk of the as-built set of studies, reports, settings, calculations, plots and tabulations.

E. A separate CD disk of the original source format of input data used as direct input to the selected software to perform the calculations, generate the reports, generate the tabulations, plot the curves and graphs, and list the device settings for the as-built facilities.

F. The name and manufacturer of the software utilized to perform the calculations, prepare the reports, make the tabulations, plot the curves, graphs and drawings with the specific version used. This specific reported software shall be able to take the original source format information submitted above and generate associated tabulations, plot the curves and graphs, perform the calculations and list the device settings for the as-built facilities submitted as paper and electronic copies. Submit all setup information for using the solftware used to generate the studies and reports submitted.

1.4 SERVICES OF MANUFACTURERS

A. The low voltage switchgear manufacturer shall furnish 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. This shall include trip values, time delay values and other protective device settings as recommended in the power system coordination study and by the manufacturer.

B. The motor control center manufacturer shall furnish the services of a qualified field engineer to calibrate/adjust/set all over-current protective devices. This shall include circuit breaker trip unit settings, motor solid state starter settings, motor solid state overload settings, protective device settings, motor management relays, time delay settings and MCPs as recommended in the power system study and by the manufacturer.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 GENERAL

A. The study shall include single-line and impedance diagrams of the power system. This diagram shall identify all components considered in the study and the ratings of all power devices, including transformers, circuit breakers, relays, fuses, busses, and cables. The resistances, and reactances of all cables shall be identified in the impedance diagram. The study shall contain all written data from the electric utility company regarding maximum available short circuit current, voltage, and X/R ratio of the utility power system.

B. The study shall include all protective devices and feeders included under this Contract. The study shall include all existing upstream protective devices and feeders supplying the new loads under this Contract. The utility supply overcurrent protective device and ground fault protective device for the utility circuit breaker delivering power to the facility shall be used as a fixed reference and starting point for these studies.

3.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with:

1.	ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
2.	ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
3.	ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4.	ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

B. The CONTRACTOR shall as-built the short circuit study and rerun and adjust all the reports, calculations, device settings and output tabulations for all the protective devices

reflecting the as-built facilities after all corrections have been inserted into the input data and all previous comments have been addressed.

3.3 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, and fuses. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the ENGINEER's attention.

B. Do not utilize series rated circuit breakers to meet short circuit requirements for this project. Devices shall be fully rated to withstand available fault currents.

C. The CONTRACTOR shall as-built the protective device evaluation study and rerun and adjust all the reports, calculations, and plot the final curves for all the protective devices reflecting the as-built facilities after all corrections have been inserted into the input data and all previous comments have been addressed.

3.4 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective device coordination study shall be performed to provide the necessary calculations required to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

B. The CONTRACTOR shall as-built the Protective Device study and rerun and adjust all the reports, calculations, and plot the final curves for all the protective devices reflecting the as-built facilities after all corrections have been inserted into the input data and all previous comments have been addressed.

3.5 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following on 5-cycle log-log graph paper:

1. Time/current curves for each protective relay, circuit breaker, 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 specified. Provide individual curves for each feeder unless identical to others.

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 ENGINEER shall be notified as to the cause. Recommendations shall be included for alternate methods that would improve selectivity.

3. Time/current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

6. Sketch of bus and breaker arrangement.

7. Magnetizing inrush points of transformers.

8. Thermal limits of dry type and liquid insulated transformers. (ANSI damage curve).

9. All restrictions of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.6 ARC FLASH STUDY

A. An arc flash study shall be performed with the aid of a digital computer program to cover the whole power distribution system. The arc flash study shall calculate, determine and report the "Arc Flash Protection Boundary", incident energy at 18 inches expressed in cal/sq-cm, voltage shock hazard, limited shock approach boundary, restricted shock approach boundary, prohibited shock approach boundary and "Personal Protective Equipment" (PPE) level. The arc flash study shall calculate and determine these items for all new and existing electrical equipment in the power distribution system study. The arc flash study shall be performed in conjunction with short circuit calculations and protective device coordination. The arc flash study shall be in accordance with the latest version of:

1. NFPA 70E - Standard for Electrical Safety Requirements for Employee Workplaces

2. IEEE 1584 - IEEE guide for performing Arc Flash Hazard Calculations

3. OSHA (29 CFR PART 1910) - Occupational Safety and Health Standards for General Industry

4. ANSI Z535.1 - Safety Color Code

5. ANSI Z535.3 – Criteria For Safety Symbols

6. ANSI Z535.4 - Product Safety Signs and Labels

All calculation shall be performed in accordance with IEEE 1584. The use of thumbrules is not acceptable in place of a calculated value as shown in IEEE 1584.

B. **The study shall determine and report the following:**[3] The recommended values for the "Arc Flash Protection Boundary", incident energy at 18 inches expressed in cal/sq-cm, voltage shock hazard, limited shock approach boundary, restricted shock approach boundary, prohibited shock approach boundary and PPE levels, based on the arc flash study results. These results shall be tabulated with all identified equipment or short circuit interrupting items in the short circuit and coordination study.

C. The study shall recommend the Personal Protective Equipment (PPE) that the OWNER should maintain on site for standard maintenance and operations expected to be conducted for this electrical system. The study shall recommend the safety label design that should be posted on electrical equipment. The study shall recommend the specific information that should be type written as part of the safety label. These recommendations shall be based on the NEC requirements, OSHA standards, and NFPA recommended practices. The CONTRACTOR shall furnish and install the field markings required by the NEC for Flash Protection on all power distribution equipment. The field marking shall be the approved recommended safety label.

D. The CONTRACTOR shall as-built the arc flash study and rerun and adjust all the reports, calculations, and adjust the PPE recommendation reflecting the as-built facilities after all corrections have been inserted into the input data and all previous comments have been addressed.

3.7 REPORT

A. The results of the power system studies shall be summarized in a final Report. Eight bound copies of the Report shall be submitted. The Report shall include the following:

1. Single-line diagram.

2. Impedance diagram for 3-phase faults.

3. Impedance diagram for line to ground faults.

4. Tabulation of all protective devices for 3-phase faults, which shall be identified on the single line diagram.

5. Tabulation of all protective devices for line to ground faults, which shall be identified on the single line diagram.

6. Time/current coordination curves for 3-phase fault protective settings.

7. Time/current coordination curves for line to ground fault protective settings.

8. Computerized 3-phase fault current calculations.

9. Computerized line to ground fault current calculations.

10. Transformer energization inrush points plotted on the associated time current protective curves

11. Motor starting inrush current plotted on the associated time current protective curves.

12. Sensing instrumentation, condition, and connections, as applicable, for each study.

13. Arc Flash Study report including tabulations, label design and recommendations.

14. Tabulation of all power distribution measuring, control, monitoring, communication and setup device settings

15. Specific recommendations shall include how to potentially reduce the arc-flash incident-energy levels for each location having more than 8 calories per square centimeter present. Include a budgetary estimate for implementing any proposed change

B. The Report shall include information concerning the computer program used for the study and also shall include a general discussion of the procedure, items, and data considered in preparing the study.

C. The CONTRACTOR shall indicate in the Report suggested changes to the protection scheme or equipment selection that will result in improved system reliability, and safety.

D. The final as-built protective device short circuit study, coordination study, arc-flash study shall include an electronic CD disk(s) as well as hard paper copy form of all input data, all calculation reports, all plotted curves, all drawings, all output data, and all device settings in tabulated organized form. Also the CONTRACTOR shall submit all the input data in original source format on a separate CD that can be utilized by the CONTRACTOR selected software to generate all the reports, calculations, drawings, curves and tabulations in the final reports.

3.8 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices other protective device settings as recommended in the power system coordination study.

B. Calibrate all MCPs and motor overload settings as recommended in the power system study.

C. All adjustments shall be made prior to acceptance testing of any electrical equipment.

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SECTION 16450 - GROUNDING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide the electrical grounding system, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 - Electrical Work, General apply to this Section.

C. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with the requirements of Section 01300 - Contractor Submittals and Section 16050 - Electrical Work, General.

B. **Shop Drawings:** Manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

C. **Technical Manuals:** The CONTRACTOR shall submit Technical Manuals for the grounding system in accordance with the requirements of Section 01300 - Contractor Submittals.

D. **Certification:** The CONTRACTOR shall obtain written certification from the grounding system manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the CONTRACTOR for coordination of all equipment, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed system. The CONTRACTOR shall submit all such certificates to the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All components of the grounding electrode system shall be manufactured in accordance with ANSI/UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes. Equipment grounding conductors shall be same manufacturer and style as specified for load circuit conductors. The minimum size shall be as outlined in Table 250-95 of the National Electrical Code. There shall be an equipment grounding conductor in each raceway.

2.2 GROUNDING ELECTRODE SYSTEM

A. Grounding loop conductors shall be bare annealed copper conductors suitable for direct burial. Conductors shall be #4/0 unless indicated otherwise.

B. Ground rods shall be copper-clad steel conforming to ANSI/UL 467.

1. Ground rods shall be 3/4-inch diameter and 10 feet long unless indicated otherwise.

C. Cable-to-cable connections, cable-to-ground rod connections and all concealed connections shall be made using exothermic type welds. Exothermic welds shall be manufactured by **Cadweld, Erico Products,** or equal.

D. Manufacturers of grounding materials shall be **Copperweld, Blackburn, Burndy,** or equal.

2.3 GROUND ROD BOXES

A. Boxes shall be precast, high density, reinforced concrete, approximately 12-3/8" diameter exterior at top, 9" interior diameter at top, 8-1/2" interior at bottom, and 11-3/4" deep. Covers in sidewalks or pedestrian areas shall be reinforced concrete or as shown on Drawings. Covers in traffic areas shall be cast iron or as shown on Drawings. All covers shall be marked "GROUND ROD".

B. Boxes and covers shall be manufactured by **Christy, Brooks,** or equal.

PART 3 -- EXECUTION

3.1 GROUNDING

A. **General:** When sizes are not specifically indicated on the Drawings, grounding cable shall be sized by the CONTRACTOR in accordance with all applicable code requirements. The location of ground rods shall be as indicated. The lengths of rods forming an individual ground array shall be equal and shall be of the quantity required to obtain a ground resistance of no more than 5 ohms. Resistance may be less where specific code or utility requirements apply. The grounding system shall be in strict accordance with Article 250 of the NEC.

B. **Equipment Ground:** Ground continuity throughout the facility shall be maintained by means of a ground conductor run in all conduits. Grounding conductors run in conduit shall be insulated copper conductors, sized in accordance with the NEC and the Drawings. Conductors shall meet the requirements of Section 16120 - Wires and Cables.

1. Metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear or motor control center ground bus. This grounding requirement is in addition to the raceway grounding required in the preceding paragraph. If not indicated otherwise, provide #6 AWG conductor in 3/4-inch conduit.

2. Copper bonding jumpers shall be used to obtain a continuous metallic ground for equipment such as expansion joints, cable trays, switchgear, and motor control centers. Provide an external, visible, ground connection to all Electrical Equipment including switchgear, motor control centers, and transformers.

3. Make connections of any grounding conductors to motors 10 hp and above or circuits 20 amps or above by a solderless terminal and a 5/16-inch minimum bolt tapped to the motor frame or equipment housing. Ground connections to smaller motors or

equipment may be made by fastening the terminal to a connection box. Connect junction boxes to the equipment grounding system with 3/8-inch machine screw.

4. Completely remove all paint, dirt, or other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.

5. Bond all exposed structural members and metallic enclosures of electrical equipment including motor control centers, transformers, panelboards, motor starters, motors, control panels, and generators to the embedded building ground mats by means of bare copper cable or strap. Unless otherwise indicated on the Drawings, the ground connections direct to the ground mats shall be No. 4/0 AWG for equipment rated above 600 volts; No. 2 AWG for equipment rated 480 or 208 volts; and No. 6 for 120-volt equipment.

C. **Grounding Electrode System:** The CONTRACTOR shall install the grounding electrode system with all required components in strict accordance with National Electrical Code Article 250.

1. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed or below grade, and shall be bolted pressure type where exposed and above grade. Bolted connectors shall be assembled wrench tight to manufacturer's requirements. Ground rings shall have a minimum buried depth of 36” below finished grade.

2. Insulated throat grounding bushings shall be employed for all grounding connections to steel conduits. Fasten with double locknuts. Provide solid bare copper wire, tying all insulated throat grounding bushings together to ground grid.

3. Copper bonding jumpers shall be used to obtain a continuous metallic ground across non-conductive structural members.

4. Within buildings, the grounding cable shall, where possible, be embedded in or installed beneath the slabs. Attach and bond grounding electrode system to building’s metal frame, metal roof deck, water pipe systems, concrete encased reinforcement bars, metal handrails, metal ladders, structural columns, and HVAC equipment frames. Bonding jumper shall be sized as shown, if not shown shall be sized per requirements of National Electrical Code Article 250.

5. Install sufficient ground rods in addition to Code required grounding so that resistance to ground as tested by standard methods does not exceed five ohms unless otherwise approved in writing by the ENGINEER. Where more than one rod is required, install rods at least 10 feet apart. Set ground boxes flush with grade or slab.

6. Bond neutrals of transformers within buildings to the system ground network, and to any additional indicated grounding electrodes.

7. In manholes and large handholes, ground all exposed noncurrent-carrying metallic parts, power cable shields, and ground conductor(s) in duct banks to a ground rod installed in the base of each manhole and handhole with No. 4/0 AWG bare copper wire. Connect No. 2 AWG ground wire to each exposed cable rack by drilling and tapping a hole in each rack, and connecting the ground wire to the racks utilizing tin-plated copper alloy split bolt connectors manufactured by **Blackburn**, or equal;

connect ground wire to power cable shields utilizing approved compression type cable-to-cable connections; connect ground wire in manhole and large handholes, and ground wire in concrete duct banks to the ground rod utilizing approved exothermic type cable-to-ground rod connections.

8. In manholes and large handholes, install ground rods with ends 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

9. In ground rod boxes, install ground rods with ends 6 inches above a sand backfill with exothermic connections of grounding conductors fully visible and accessible.

D. Shield Grounding

1. Shields on power cable shall be grounded at each termination in a manner recommended by the cable manufacturer.

2. Shielded instrumentation cable shall be grounded at one end only; this shall typically be at the "receiving" end of the signal carried by the cable.

3. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be jumpered with No. 16 solid tinned bare copper wire; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

3.2 FIELD TESTS

A. Test in the ENGINEER’s presence the ground resistance of the grounding system using the IEEE “Fall of Potential Method.” Test each ground grid per facility and equipment.

B. Test all ground fault interrupter (GFI) receptacles and circuit breakers for proper connection and operation with methods and instruments prescribed by the manufacturer.

C. Provide copies of reports of all grounding system tests for inclusion in Technical Manuals and for review by the ENGINEER.

D. Refer to Specification 16950 - Electrical Testing for further testing requirements.

- END OF SECTION -

SECTION 16460 - ELECTRIC MOTORS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide electric motors, accessories, and appurtenances complete and operable, in conformance with the individual driven equipment specifications and the Contract Documents.

B. The provisions of this Section apply to all low voltage AC squirrel cage induction motors except as indicated otherwise.

C. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:

1. Machine name and specification number of driven machine.

2. Motor manufacturer.

3. Motor type or model and dimension drawing. Include motor weight.

4. Nominal horsepower.

5. NEMA Design.

6. Enclosure.

7. Frame Size.

8. Winding insulation class and temperature rise class.

9. Voltage, phase and frequency ratings.

10. Service factor.

11. Full load current at rated horsepower for application voltage.

12. Full load speed.

13. Guaranteed minimum full load efficiency. Also nominal efficiencies at 1/2 and 3/4 load.

14. Type of thermal protection or overtemperature protection, if included.

15. Wiring diagram for devices such as motor leak detection, space heaters, temperature, zero speed switches, as applicable.

16. Bearing data. Include recommendation for lubricants of relubricatable type bearings.

17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.

18. Power factor at 1/2, 3/4 and full load.

19. Power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load for all motors 20 HP and larger.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

C. **Minimum motor HP:** The CONTRACTOR shall size motors to continuously carry the maximum load imposed through the full range for driven equipment operation; however, power ratings shall not be less than the specified values, when indicated in the specification. If the specified values are less than those required from the first criterion above, then the CONTRACTOR shall provide greater capacity motors at no additional cost to the OWNER. In addition, increases in circuit breaker, magnetic starter, conductor, and conduit size capacities related to increased motor size shall also be provided at no additional cost to the OWNER.

D. **Exempt Motors:** Motors which are for valve actuators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.2 DESIGN REQUIREMENTS

A. **General:** All electric motors shall comply with ANSI/NEMA MG-1 - Motor and Generator. All motors used with adjustable frequency drives shall comply with ANSI/NEMA MG-1, Part 31.

B. **NEMA Design:** Electric motors shall be NEMA Design B, (except motors controlled for variable speed operation and other special motors) and constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value specified in said ANSI/NEMA MG 1. Motors shall be suitable for the indicated starting method.

C. **Motor Voltage Ratings:** Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Motors 1/2-HP and below shall be rated 115 volts, single-phase, 60-Hz. Dual voltage motors rated 115/230-volts, 115/208-volts, or 120-240 volts are acceptable, provided all leads are brought out to the conduit box.

2. Motors larger than 1/2-HP shall be rated 230 volts, 460 volts, or 4160 volts, 3-phase, 60-Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided all loads are brought out to the conduit box.

D. **Insulation:** All 3-phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in ANSI/NEMA MG 1-12.42. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dt as defined in NEMA MG 1-31.

E. All motors 50 HP or smaller located in non-hazardous areas shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated.

F. All motors 50 HP and greater located in non-hazardous areas shall be ODP with a service factor of 1.15. Modify enclosure for outdoor application and low noise service.

G. Motors for use in hazardous locations shall have enclosures suitable for the classification indicated. Such motors shall be U.L. listed and be stamped as such.

H. Motors larger than 50 HP used outdoors shall have 120-volt AC space heaters and temperature sensors.

I. Motors for vertical mixed - flow pumps shall be as specified in Section 11104 – Vertical Mixed - Flow Pumps.

J. Premium Efficiency Motors

1. Motors with a nameplate rating of 1 HP and larger shall be "premium efficiency" units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 -Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.

2. Efficiency Index: Efficiency index, nominal efficiency, and minimum efficiency shall be defined in accordance with ANSI/NEMA MG 1-12.59 - Efficiency Levels of Energy Efficient Polyphase Squirrel-Cage Induction Motors: these three values shall be stated in the Shop Drawing submittal.

3. Premium Efficiency motors shall conform to the following guaranteed minimum efficiency requirements which are full load values:

OPEN DRIP-PROOF (ODP)								
FULL-LOAD EFFICIENCIES OF PREMIUM EFFICIENT MOTORS								
OPEN MOTORS								
	2 POLE		4 POLE		6 POLE		8 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1.0	--	--	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	84.0	81.5	75.5	72.0
2.0	84.0	81.5	84.0	81.5	85.5	82.5	85.5	82.5
3.0	84.0	81.5	86.5	84.0	86.5	84.0	86.5	84.0
5.0	85.5	82.5	87.5	85.5	87.5	85.5	87.5	85.5
7.5	87.5	85.5	88.5	86.5	88.5	86.5	88.5	86.5
10.0	88.5	86.5	89.5	87.5	90.2	88.5	89.5	87.5
15.0	89.5	87.5	91.0	89.5	90.2	88.5	89.5	87.5
20.0	90.2	88.5	91.0	89.5	91.0	89.5	90.2	88.5
25.0	91.0	89.5	91.7	90.2	91.7	90.2	90.2	88.5
30.0	91.0	89.5	92.4	91.0	92.4	91.0	91.0	89.5
40.0	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50.0	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60.0	93.0	91.7	93.6	92.4	93.6	92.4	92.4	91.0
75.0	93.0	91.7	94.1	93.0	93.6	92.4	93.6	92.4
100.0	93.0	91.7	94.1	93.0	94.1	93.0	93.6	92.4
125.0	93.6	92.4	94.5	93.6	94.1	93.0	93.6	92.4
150.0	93.6	92.4	95.0	94.1	94.5	93.6	93.6	92.4
200.0	94.5	93.6	95.0	94.1	94.5	93.6	93.6	92.4
250.0	94.5	93.6	95.4	94.5	95.4	94.5	94.5	93.6
300.0	95.0	94.1	95.4	94.5	95.4	94.5	--	--
350.0	95.0	94.1	95.4	94.5	95.4	94.5	--	--
400.0	95.4	94.5	95.4	94.5	--	--	--	--
450.0	95.8	95.0	95.8	95.0	--	--	--	--
500.0	95.8	95.0	95.8	95.0	--	--	--	--

TOTALLY ENCLOSED - FAN COOLED (TEFC)								
FULL-LOAD EFFICIENCIES OF PREMIUM EFFICIENT MOTORS								
ENCLOSED MOTORS								
	2 POLE		4 POLE		6 POLE		8 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1.0	75.5	72.0	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	85.5	82.5	77.0	74.0
2.0	84.0	81.5	84.0	81.5	86.5	84.0	82.5	80.0
3.0	85.5	82.5	87.5	85.5	87.5	85.5	84.0	81.5
5.0	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10.0	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15.0	90.2	88.5	91.0	89.5	90.2	88.5	88.5	86.5
20.0	90.2	88.5	91.0	89.5	90.2	88.5	89.5	87.5
25.0	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
30.0	91.0	89.5	92.4	91.0	91.7	90.2	91.0	89.5
40.0	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50.0	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60.0	93.0	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75.0	93.0	91.7	94.1	93.0	93.6	92.4	93.0	91.7
100.0	93.6	92.4	94.5	93.6	94.1	93.0	93.0	91.7
125.0	94.5	93.6	94.5	93.6	94.1	93.0	93.6	92.4
150.0	94.5	93.6	95.0	94.1	95.0	94.1	93.6	92.4
200.0	95.0	94.1	95.0	94.1	95.0	94.1	94.1	93.0
250.0	95.4	94.5	95.0	94.1	95.0	94.1	94.5	93.6
300.0	95.4	94.5	95.4	94.5	95.0	94.1	--	--
350.0	95.4	94.5	95.4	94.5	95.0	94.1	--	--
400.0	95.4	94.5	95.4	94.5	--	--	--	--
450.0	95.4	94.5	95.4	94.5	--	--	--	--
500.0	95.4	94.5	95.8	95.0	--	--	--	--

K. All two-speed motors shall be the two-winding type.

2.3 ACCESSORY REQUIREMENTS

A. **General:** Horizontal motors 3 HP and larger, and all vertical motors, shall have split-type cast metal conduit boxes. Motors less than 3 HP shall have the manufacturer's standard conduit boxes. Motors other than open drip-proof shall be gasketed.

B. **Lifting Devices:** All motors weighing 265 lb (120 Kg) or more shall have suitable lifting eyes for installation and removal.

C. **Special Requirements:** The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. **Grounding Lugs:** Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. **Nameplate:** All motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40.

F. The motor manufacturer shall furnish for installation by the Electrical CONTRACTOR power factor correction capacitors for each motor 20 HP and larger that is started with FVNR, FVR, FVNR-AT (auto-transformer) or FVTS (two-speed, high speed winding corrected) starters only. Motors started with solid state starters or VFDs shall locate capacitors per manufacturer’s recommendation. The capacitors shall be fused, with internal resistors, suitably enclosed for mounting adjacent to the starter, MCC, or the motor, and sized to improve power factor to not less than 95 percent at full load. Size shall be as recommended by the motor manufacturer. The capacitors shall be wired to the motor starter output terminals. Dielectric fluid shall be non-PCB type, non-flammable and biodegradable.

G. Where motors are indicated by elementary schematics or specifications to have zero speed switches, the switches shall be factory mounted integral to the motors. Zero speed switch lead wires to be accessible and routed to motor conduit box.

2.4 MOTOR THERMAL PROTECTION

A. **Single Phase Motors:** All single phase 120, 208, or 230 volt motors shall have integral thermal overload protection or shall be inherently current limited.

B. **Thermostats:** Winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be precalibrated by the manufacturer.

C. **RTDs**: Bearing RTDs and/or winding RTDs (two per phase) shall be provided where indicated. RTDs shall be 100 ohm platinum.

2.5 MOTOR BEARINGS

A. **General:** Bearings shall conform to Section 11000 - Equipment General Provisions, except as indicated herein.

B. All motors greater than 2 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

C. **Fractional Horsepower:** Motors with fractional horsepower through 2 HP shall be provided with Lubricated-for-Life ball bearings.

D. **Horizontal Motors Over 2 HP:** Motors larger than 2 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

E. **Vertical Motors Over 2 HP:** Vertical motors larger than 2 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

F. **Water Cooled Motors:** If water cooling is required for the thrust bearings, cooling water lines shall be provided complete with shut-off valve, strainer, solenoid valve, flow indicator, thermometer, throttling valve, and, (where subject to freezing), insulation with heat tracing.

2.6 MANUFACTURERS, OR EQUAL

A. **U.S. Motors;**

B. **Reliance Electric.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment.

B. Related electrical work involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 16.

C. Capacitors shall be connected to the motor branch circuit conductors on the load side of the starter contactor. Motor overload elements shall be adjusted downwards to reflect the reduction in line current resulting from power factor correction.

3.2 FACTORY TESTING

A. Motors rated 100 HP and larger shall be factory tested in conformance with ANSI/IEEE 112, IEEE 43 - Recommended Practice for Testing Resistance of Rotating Machinery, and NEMA MG-2. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and

instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the ENGINEER.

3.3 FIELD TESTING

A. The CONTRACTOR shall perform the following field tests and additional test as outlined in the latest edition of NETA acceptance testing specifications:

1. Inspect each motor installation for any deviation from rated voltage, phase, or frequency, improper installation, physical and mechanical condition, deviations from drawings and specifications from nameplate. Inspect anchorage. Confirm correct application of lubricants.

2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage.

3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

5. Test insulation (megger test) of all new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of the motor.

6. Testing shall be witnessed by ENGINEER and OWNER.

- END OF SECTION -

SECTION 16480 - LOW VOLTAGE MOTOR CONTROL CENTER

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide a motor control center (MCC) and switchboard, complete and operable, in accordance with the Contract Documents. The metering section of the switchboard shall meet Roseville Electric Utility service meter requirements for a single 800 amp service.

B. The requirements of Section 16050 - Electrical Work, General, apply to the WORK of this Section.

C. In the event that motors provided are larger horsepower than motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower according to Section 16460-Electric Motors. Adjustments shall be made at no increase in cost to the OWNER.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Sections 01300 - Contractor Submittals and 16050.

B. Shop Drawings

1. Enclosure NEMA rating and color.

2. Horizontal and vertical bus ampacities, voltage rating and interrupting capacity. Include materials of construction.

3. Ground bus size and material of construction.

4. Conduit entrance provisions.

5. Main incoming line entry provision (top or bottom).

6. Metering cabinet and equipment meeting Roseville Electric Standards, with proof of approval by Roseville Electric.

7. Transformers.

8. Panelboards.

9. Surge suppressors.

10. Control unit nameplate schedule.

11. All circuit breaker types, frames and settings.

12. All starter NEMA sizes, auxiliary contact provisions, coil voltage.

13. Relays, timers, pilot devices, control transformer VA and fuse sizes.

14. Elementary schematic ladder diagrams for each compartment. Custom schematics shall be furnished. Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED - RESUBMIT".

15. Short circuit rating of the complete assembly.

16. Replacement parts lists and operation and maintenance procedures.

17. Seismic design certification of the anchoring system.

18. Time-current curves for all protective devices.

19. Three line diagram for each starter schematic.

20. Verification from serving utility that metering section is approved.

C. **Technical Manuals:** The CONTRACTOR shall submit Technical Manuals for the low voltage motor control center and switchboard in accordance with the requirements of Section 01300 - Contractor Submittals.

D. **Certification:** The CONTRACTOR shall obtain written certification from the manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the CONTRACTOR for coordination of all equipment, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The CONTRACTOR shall submit all such certificates to the ENGINEER.

1.3 SEISMIC CERTIFICATION

A. All equipment to be furnished under this contract shall be designed, constructed, and installed in accordance with the earthquake regulations of the California Building Code, Title 24, and the Uniform Building Code (UBC).

B. The CONTRACTOR shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed structural engineer in the State of California. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of that type if equipment.

C. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in Title 24 and the UBC. Alternatively, the manufacturer’s certification may be based on a detailed computer analysis of the entire assembly structure and its components. The manufacturer's certification shall be submitted with the shop drawing of the MCC in accordance with the requirements of Section 16050 - Electrical Work, General and Section 01300 - Contractor Submittals.

D. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification is achieved when the capability of the equipment, as described by the test response spectra, meets or exceeds the required response spectra as specified in Title 24 and the UBC, for all equipment natural frequencies up to 35 HZ.

1.4 DUTIES OF THE MANUFACTURER'S QUALIFIED FACTORY REPRESENTATIVE

A. A manufacturer's engineering representative for the equipment specified herein shall be present at the jobsite for the frequency and minimum duration (travel time excluded) as specified below to perform the following manufacturer's services:

1. Three 8-hour-day for inspection, assistance during installation and alignment, and certification of proper installation. The certificate of installation shall be submitted in accordance with the requirements of Section 01300 - Contractor Submittals.

2. Three 8-hour-day for assistance and witnessing of system testing by the CONTRACTOR and any required troubleshooting.

3. Two individual 4-hour sessions for operation and maintenance training of Owner's personnel. Each individual training session shall be conducted on a separate work day.

B. The manufacturer's engineering representative may be required at the ENGINEER's direction to provide a minimum of five separate trips to the jobsite to fulfill the above requirements.

C. The OWNER reserves the right to record (audio and/or video) the operation and training sessions conducted by the manufacturer's representative.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Devices of the same type shall be products of the same manufacturer. This requirement applies to all control devices, and insofar as practical, to equipment manufactured on a production basis. It also applies without exception to equipment custom fabricated for this project.

B. Motor control center and switchboard shall conform to the standards for NEMA Class IIS, type B diagrams and wiring.

2.2 DESIGN, CONSTRUCTION, AND MATERIAL REQUIREMENTS

A. The motor control centers shall be 600-volt class suitable for operation on a three-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated.

B. The switchboard shall receive power from a three phase, wye connected 277/480 volt transformer with a grounded neutral. Power distribution from the switchboard shall be 277/480 volt, three-phase, four-wire, however the switchboard shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements for service entrance.

C. MCC and switchboard shall be rated NEMA 12. Compartment doors shall be interlocked with compartment circuit breakers. The interlock shall be fitted with a maintenance override.

D. Size and Arrangement

1. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be nominally 90 inches tall by minimum 20 inches deep.

2. MCC's shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares and future compartments. MCC's shall be subject to rejection for exceeding the lengths shown where allotted space is critical.

3. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space and future provisions indicated.

4. All switches and circuit breakers used as switches shall be located so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6 feet 7 inches above the floor, including the height of the concrete pad.

E. Components

1. Busses:

a. A continuous copper ground bus shall be provided with full width of the motor control center line-up.

b. The main horizontal bus shall be copper or silver-plated copper, located within an isolated compartment. The bus shall be rated as shown on the Contract Drawings.

c. The vertical bus in each section shall consist of a single silver-plated copper conductor per phase with a current capacity of not less than 300 amps. The vertical bus shall be completely isolated and insulated, and shall extend the full height of the section wherever possible.

d. Fully rated continuous copper neutral bus shall be provided through the control center. Lugs of appropriate capacity shall also be provided.

e. All power buses shall be braced to withstand 65,000 amperes, minimum.

2. Wireways: A separate vertical wireway shall be provided adjacent to each vertical unit, and shall be covered by a hinged door. Each individual unit compartment shall be provided with a side barrier to permit pulling wire in the vertical wireway without disturbing adjacent unit components.

F. Cabinet

1. Structural members shall be fabricated of not less than 12 gauge steel and side and top panels and doors shall be not less than 14 gauge steel.

2. Spaces designated as "SPACE" or "BLANK" shall include blank hinged doors and vertical bus bars.

3. Control units inside compartments shall be clearly identified with tags or stencil markings.

4. Each control unit including spares, spaces, and blanks, lights and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.

5. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacturer, and place of manufacture.

6. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.

7. Finish for motor control center shall be light grey, ANSI 61. The panels shall be given two coats of primer inside and out and two coats of enamel finish. External colors other than ANSI 61 will not be acceptable.

2.3 MOTOR STARTERS

A. Motor starters shall be mounted in standard motor control center assemblies, arranged as indicated.

B. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device, mounted in a completely enclosed cubicle. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position. Reset of thermal overload elements shall be possible with unit door closed. Three phase overload trip units shall be furnished to suit the full load current of the equipment installed. Overload trip unit shall be adjusted as required for power factor correction capacitors.

C. Magnetic starters shall have auxiliary contacts as required by electrical motor control diagrams including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact. The combination motor starters shall be drawout-type for size 5 and below. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

D. Each starter unit shall have its own control power transformer. It shall have a 115-volt grounded secondary. One secondary fuse and 2 primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Local control devices shall be mounted independently of the cover door. All starters shall have a local red "running" lamp and a green "off" light to indicate the presence of control power

when the motor is not running. Starters shall be provided with devices as indicated in the Schematic Diagrams. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.

E. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends.

F. Full voltage motor starter units shall be NEMA Size 1 or larger. The combination starters shall be rated for a minimum 65,000 RMS symmetrical amperes.

G. Motor starters shall be designed to NEMA ratings. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be acceptable, either as part of any MCC, as remote starters, or as part of any equipment package.

H. Solid state reduced voltage starters shall be UL listed and consist of an incoming power circuit breaker, a power section, logic board, and a field wiring interface terminal board. Solid state starters shall include adjustments for starting torque, acceleration rate control by voltage ramps, and current limit. Options to be included are pump control to provide smooth motor acceleration and deceleration with adjustable times periods, “Local-Off Remote” switch, “SMC-Off-Bypass Selector” switch, isolation contactor, NEMA bypass contactor, Emergency Stop pushbutton terminals, start and stop pushbuttons, overload relays, SCR fusing, “Run” pilot light, and auxiliary contacts. Output contactors shall be provided where indicated. Solid state starters for the Well Pump may be a free standing unit, in a NEMA 12 enclosure. Provide with protective unit, **Multilin 269 Plus**. Provide programming of protective unit and starter. Program variables shall be provided by pump and motor supplier with approval from manufacturers, for starting protection and number of allowed starts. Solid state reduced voltage starters shall be **Allen-Bradley SMC-Plus,** no substitutions.

I. Two speed starters shall be of the two-winding type.

2.4 MAIN, FEEDER AND MOTOR CIRCUIT PROTECTORS CIRCUIT BREAKERS (480 V)

A. Circuit breakers having a frame size of 225 amperes or less shall be molded case type with thermal magnetic non-interchangeable, trip-free, sealed trip units. Thermal magnetic molded case circuit breakers shall be **Cutler-Hammer Series C F-Frame Type HFD,** or equal. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes at operating voltage.

B. Circuit breakers with a frame size of 250 amperes to 400 amperes shall be molded case with interchangeable thermal magnetic and electronic microprocessor based RMS trip elements. Molded case circuit breakers with interchangeable trip shall be **Cutler-Hammer Series C K-Frame Type HKD with Digitrip OPTIM 550 trip unit,** or equal. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes at operating voltage.

C. Circuit breakers with a frame size of 450 amperes to 1200 amperes shall be molded case with electronic microprocessor based RMS trip elements. Molded case circuit breakers with electronic trip shall be **Cutler-Hammer Series C N-Frame Type HND with Digitrip OPTIM 550 trip unit,** or equal. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes at operating

voltage. Ground fault shall be provided where indicated as “GFP” on Contract Drawings and for all service disconnects rated 1,000 amps or more.

D. Circuit breakers feeding motors shall be molded case instantaneous only motor circuit protectors. Motor circuit protector shall be rated 600VAC. Motor circuit protectors shall be **Cutler-Hammer Series C Type HMCP,** or equal. CONTRACTOR is responsible to provide correct motor circuit protector size and trip rating based on installed equipment. The interrupting capacity of the motor circuit protector breakers shall be 65,000 RMS symmetrical amperes at operating voltage.

2.5 SURGE SUPPRESSORS

A. Motor control centers shall have an UL 845, UL 1449 and UL 1283 listed integrated surge suppressors installed in the main power service compartment, or in a separate removable compartment, and shall be UL labeled for such use.

B. Surge suppressors shall be installed with twelve inches or less of connecting cable from the bus to the surge suppressor electronics. Surge suppressors shall be rated for 480 volt three phase service at 160kA per phase. Surge suppressors shall have a built-in diagnostic package with flashing trouble light, display for the status of each phase, and have a counter and display to indicate the number of surges that have caused the device to operate. Surge suppressors shall be resettable or the sacrificial element shall be replaceable without disrupting the operation of the MCC. The CONTRACTOR shall furnish twenty sets of spare elements for each surge suppressor having sacrificial elements.

C. Surge suppressors shall be **Cutler-Hammer Clipper CPS-S2**, or equal.

2.6 TRANSFORMERS WITHIN MCC

A. General

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. All transformers shall be UL-listed and bear the UL label.

B. Ratings

1. kVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers.

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA; 40 dB
10 to 50 kVA; 45 dB

C. Construction

1. Insulation Systems:

a. Transformers shall be insulated as follows:

(1) 2 kVA and below: 150 degrees C insulation system based upon 80 degree C rise.
(2) 3 to 15 kVA: 185 degrees C insulation system based upon 115 degree C rise.
(3) 15 kVA and above: 220 degrees C insulation system based upon 150 degree C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient.

c. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

d. All transformers shall have copper windings.

D. Manufacturers

1. Transformers shall have four 2-1/2 percent taps, two above and two below 480 volts. Transformers shall be **Cutler-Hammer, General Electric, Square D**, or equal.

2.7 PANELBOARDS WITHIN MCC

A. **General:** Panelboards shall be dead front factory assembled, UL listed. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards.

B. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 10,000 amperes RMS symmetrical or as indicated, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than 25,000 amperes RMS symmetrical or as indicated, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

C. Construction

1. All lighting and power distribution panels shall have copper busbars.

2. Breakers shall be one, two, or three pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse

time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall be inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. All panelboards shall be rated for the intended voltage.

5. All circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. All panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated. Panelboards shall be as manufactured by **Cutler-Hammer, General Electric**, or equal.

D. Surge Suppressers

1. All lighting and power distribution panels shall have surge suppressors installed as part of the panelboard or close-coupled to the panelboard. Surge suppressors shall be rated for the voltage and phase service of the panel at 120kA per phase. Surge suppressors shall have a built-in diagnostic package with flashing trouble light, display for the status of each phase, and have a counter and display to indicate the number of surges that have caused the device to operate. Surge suppressors shall be resettable, or the sacrificial element shall be replaceable without disrupting the operation of the panel. The CONTRACTOR shall furnish twenty sets of spare elements for each surge suppressor having sacrificial elements.

2. Surge suppressors shall be **Cutler-Hammer Clipper CPS-S**, or equal.

2.8 CONTROL DEVICES

A. All control devices shall conform to the requirements of Section 16485 - Local Control Stations. Provide LED type lamps for all indicating controls.

B. Provide solid state type metering where indicated. Include CT's and PT's of ratios as indicated, or as required. Solid state metering shall be **GE PQM, Cutler-Hammer DP-4000, Square D Power Logic,** or equal.

C. Provide Elapsed Time Meters (ETMs) for all motor starters connected to motors larger than 2 horsepower, even if not shown on electrical schematics.

D. Provide yellow disconnecting type terminal blocks for all terminal blocks connected to foreign voltage sources. Refer to electrical schematics for foreign voltage sources. In addition to foreign voltage sources, provide disconnecting type terminal blocks to all terminals connected with wiring to/from PLC equipment.

E. Provide the following color schemes as part of the MCC equipment.

Device Description	Color and Equipment
Foreign voltage wiring	Yellow wires
Motor “Run”	Red indicating lens
Motor “Off and Ready”	Green indicating lens
Motor “Alarm” or “Fault”	Yellow indicating lens

2.9 FACTORY TESTS

A. All motor control centers and their components shall be given Manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices. Testing shall be witnessed by ENGINEER and OWNER.

2.10 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC:

1. One unit control transformer of each size furnished in magnetic starters installed

2. Three bezels of each color installed for pilot indicators

3. One dozen panel lamps

4. One dozen control fuses of each size installed

B. Spare parts shall be identified by type, size, and manufacturer.

2.11 MANUFACTURERS

A. Motor control centers shall be **Cutler-Hammer Freedom 2100** or **General Electric 8000 Line**, or equal.

2.12 MCC RUBBER MATTING

A. Furnish and install high voltage switchgear rubber matting in front of motor control center and switchboard. Matting shall conform to ASTM D178-93 Type 1 Class 2, proof tested at 20,000 volts AC. The matting shall be black, 1/4-inch thick and 36-inches wide, run the entire length of MCC plus 12-inches on both ends, manufactured by **Bilrite Matting and Mats,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall install motor control center and switchboard in accordance with Manufacturer's published instructions. Conduit installation shall be coordinated with

Manufacturer's as-fabricated drawings so that all conduit stub-ups are within the area allotted for conduit. Conduit shall be stubbed up in the section that contains the devices to which conductors are terminated.

B. If stored at the site, motor control center and switchboard shall be stored in a clean, dry space. Factory wrapping shall be maintained or an additional heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic. Storage space shall be heated or space heaters shall be energized.

C. Motor control center and switchboard shall be handled carefully to avoid damage to components, enclosure, and finish. Damage shall be repaired before installation.

3.2 INSTALLATION

A. Motor control center and switchboard shall be installed on 4-inch concrete pad. After leveling and shimming, the CONTRACTOR shall anchor equipment to concrete pad, and shall grout so that no space exists between the pad and equipment.

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 Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. 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.

4. Furnish and install high voltage switchboard matting in front of the MCC and switchboard. Install mat after testing yet prior to start-up.

3.3 FIELD TESTS

A. Visual and mechanical inspection after installation shall include:

1. Inspect for physical damage, proper anchorage and grounding.

2. Verify that the ratings of the thermal overload heaters match the motor full-load current nameplate data.

3. Check tightness of bolted connections.

B. Electrical Tests

1. Insulation tests:

a. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute. Test voltage and minimum acceptable resistance shall be in accordance with Manufacturer's recommendations.

b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable resistance shall be in accordance with the Manufacturer's recommendations.

c. Measure insulation resistance of each control circuit with respect to ground.

2. Verify proper operation of control logic in all modes of control.

C. Provide additional testing as outlined in Specification 16950 - Electrical Testing.

3.4 TRAINING

A. Separate classes shall be conducted for the OWNER’s maintenance and operating personnel. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects. Operator classes shall stress operational theory. Training shall provide detailed information on the reduced voltage solid state starter.

B. The training classes shall be scheduled a minimum of 3 weeks in advance of when they are to be given. Proposed training material, including a resume for the proposed instructor(s) (indicating previous instructional experience), and a detailed outline of each lesson shall be submitted to the ENGINEER at least 30 days in advance of when the lesson is to be given. The ENGINEER shall review the submitted data for suitability and provide comments that shall be incorporated into the course.

C. Within 10 days after the completion of each class the CONTRACTOR shall present to the ENGINEER the following:

1. A list of OWNER personnel that attended the class.

2. A copy of the hard copy text utilized during the class with all notes, diagrams, and comments.

- END OF SECTION -

SECTION 16485 - LOCAL CONTROL STATIONS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide complete local control stations as shown and as specified herein or in other Sections of the Specification. The stations shall be designed to provide the sequence of operation specified in Division 17000, and as shown on the P&ID Drawings and the Schematic Drawings.

B. The requirements of Section 17200 - PLC Control Panel, apply to just the PLC Control Panel.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Local control stations shall comply with the requirements of NEC, NEMA, and UL. Stations shall be built by UL listed panel shop, and contain shop sticker displaying such.

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit shop drawings in accordance with the requirements specified in Sections 01300 - Contractor Submittals, and 16050 - Electrical Work, General.

B. Ladder diagrams and written descriptions explaining ladder diagrams operation and system operation shall be provided with shop drawings. Provide sizes on all protective devices.

C. Provide catalog cuts of all control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

D. Provide scaled layout drawings showing panel front and internal layout. Include nameplate nomenclature, tagging and terminal labels.

E. **Technical Manuals:** The CONTRACTOR shall submit Technical Manuals for the Local Control Stations in accordance with the requirements of Section 01300 - Contractor Submittals.

F. **Certification:** The CONTRACTOR shall obtain written certification from the manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the CONTRACTOR for coordination of all equipment, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The CONTRACTOR shall submit all such certificates to the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide the local control stations to satisfy the functional requirements specified in the relevant mechanical equipment, and Instrumentation & Control specification sections and as shown on the Electrical Schematics. Each station shall be fabricated with UL labeled components. Stations not specifically specified as being provided in other Sections of the Specification shall be furnished and installed under this Section. All stations shall be wired under this Section.

B. The controls shall be 120 volt maximum. Where the electrical power supply is 240 volt single phase, or 480 volt, 3-phase, as shown on the electrical drawings, the local control station shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with the requirements specified in Section 16120 - Wires and Cables.

C. Each local control station shall be provided with identified terminal strips for the connection of all external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 20 percent additional conductors for future use. Termination points shall be identified in accordance with accepted shop drawings. The stations shall be the source of power for all 120 VAC solenoid valves interconnected with the stations. All equipment associated with the stations shall be ready for service after connection of conductors to equipment, controls, and stations.

D. All internal wiring shall be factory-installed and shall be contained in plastic raceways or troughs having 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.

E. Enclosures

1. In Interior General and Interior Office Areas (see Section 16050 - Electrical Work, General), enclosures shall be NEMA 12 and NEMA 1 painted steel enclosures, respectively, with ANSI 61 light gray exterior and white interior.

2. In damp locations enclosures shall be NEMA 3R with ASNI 61 light gray exterior and white interior.

3. In non-hazardous, corrosive areas enclosures shall be NEMA 4X stainless steel (prior to modifications) with brushed finish or as specified, unless specified otherwise. Where possible, penetrations shall be made in such a manner as to maintain the NEMA 4X rating. If this is not possible, the penetrations shall be made in such a manner as to minimize entry of foreign materials into the enclosure.

4. In hazardous areas, enclosures shall be cast aluminum NEMA 7 and shall be U.L. Listed for use in hazardous or classified locations.

5. Provide fast operating clamps assemblies; screw clamps are not acceptable.

6. Enclosures shall be either freestanding, wall-mounted, pedestal-mounted, or equipment skid-mounted, as specified or shown. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white. All enclosures shall be hinged, except for pushbutton stations.

F. The main feeder disconnect shall have a door-mounted handle unless otherwise specified or shown.

G. Identification of panel-mounted devices, conductors, and electrical components shall meet the requirements specified in Section 16050 - Electrical Work, General.

2.2 STATION COMPONENTS

A. Relays

1. General purposes relays shall be enclosed octal plug-in units. Two- and 3-pole relays shall be **IDEC Series RR**, or equal. Four-pole relays shall be **IDEC Series RH**, or equal. Relay contacts for control circuits shall be rated not less than 7.5 amperes at 120 VAC and at 30 Vdc. Relays shall be UL listed, indicating type, push to test.

2. Where shown, time delay functions shall be accomplished with time delay relays. Units shall be adjustable time delay relays with the number of contacts and contract arrangements as shown. A neon status-indicating light shall be provided with each relay. Contacts shall be rated for 7.5 A at 120 VAC. Integral knob with calibrated scale shall be provided for adjustment of time delay. Initial setting shall be as shown with time delay range approximately 3 times the initial setting. Delay rangeability shall be at least 10:1. Timing relays shall be solid state pulse-count type utilizing a high frequency resistance-capacitance (RC) oscillator and integrated circuit counter for timing. Time delay relays shall be **IDEC Series GT3,** or equal.

3. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

4. Latching relays shall be two-pole, 10A, 120 VAC din rail mounted. Relay shall be industrial type, dual coil. Manufacturer to be **IDEC Series RR2KP**, or equal.

B. Illuminated control indicating lights (including MCC indication):

1. Shall be heavy duty, NEMA 4X, with round, plastic lens, and jumbo legend plate. Each shall be push-to-test indicating light, LED lamp, transformer type.

2. Acceptable products: **Allen-Bradley Bulletin 800H-PRTL**, or equal

C. Non-illuminated control pushbuttons:

1. Shall be heavy duty, NEMA 4X, bootless, flush head pushbutton, momentary contact, with jumbo legend plate.

2. Acceptable products: **Allen-Bradley Bulletin 800H-AR**, or equal.

D. 2-, 3-, and 4-position, selector switches:

1. Position switches shall be maintained contact type, rated 20 A minimum at 120 VAC. Control knob shall be black, NEMA 4X, and shall show clearly the control switch position.

2. Selector switch shall be complete with jumbo legend plate, and with contact blocks.

3. Acceptable products: **Allen-Bradley Bulletin 800H**, or equal.

E. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **G.E., Cutler-Hammer,** or equal. Elapsed time meters are required on all motor starter cubicles for motors greater than 2 horsepower.

F. Circuit breakers shall be din rail mounted, thermal magnetic, tease-free, trip-free, snap action mechanism with two button operation. Circuit breakers shall be din rail mounted. Breakers shall be **Phoenix Contact Model No. TMC 42-01,** or equal.

G. Magnetic starters shall meet the following requirements:

1. NEMA rated: IEC or dual NEMA/IEC rated type are not acceptable.

2. FVNR type unless specified otherwise.

3. Combination starters with magnetic only instantaneous trip circuit breakers such a **Cutler-Hammer "MCP," G.E., "Mag-Break,"** or equal.

4. Control transformers shall be provided, with primary and secondary fuses, 120 VAC maximum control voltage.

H. **Signal Isolator/Converter**: Signal isolator and or converter shall have complete isolation of input, output, and power input. Signal isolator/converter shall be universal type, UL listed, dip switch configurable with low temperature drift. Span and zero shall be adjustable $\pm$2%; accuracy shall be plus and minus 0.1 percent of span. Units shall be din rail mounted. Signal isolator/converters shall be **Phoenix Contact Model No. MCR Series**, or equal.

I. Process alarm relays shall have a 4-20 mA input and two (2) independent SPST contact outputs as manufactured by **A.G.M.,** or equal. Power input shall be 120 VAC.

J. **Indicators, Digital Process:** Digital process 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 a 3-1/2 digit LED display of no less than 0.5-inch height. The input signal to the digital process indicator shall be 4-20 mA DC or 1-5 VDC as indicated. 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/or offset. Accuracy shall be plus and minus 1 least significant digit. Input power to the digital indicator shall be 120 VAC, 60 Hz. Digital process indicators shall be as manufactured by **Kessler-Ellis Products INT 69,** or equal.

K. **DC Power Supplies:** Furnish DC power supplies to convert 120 AC input power to 24V DC regulated voltage output. Power supplies to be equipped for din rail mounting or back panel mounting. Power supplies shall be auto resetting, adjustable output voltage, LED

status, 200 mV peak to peak maximum ripple, UL listed with overload protection. Power supplies to be wired in parallel with auxiliary relay for “loop power lost” status. No more than four loops on each paralleled power supply system. Power supplies shall be **Phoenix Contact Model No. CM 50-PS-120AC/24DC/2.5/F,** or equal.

2.3 CONTROL STATION ELECTRICAL

A. Interior Panel Wiring

1. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V-1. Wiring channel fill shall not exceed 40 percent of cross section area. Only one wire per terminal block with exception of a comb jumper in addition to the single wire.

2. Power and control wiring shall be single conductor. Stranded copper, NFPA No. 70 Type MTW, No. 16 AWG minimum.

3. Wiring shall comply with the requirements of NEC as a minimum. Plug strips with grounding type receptacles shall be provided for 120 VAC power supply connections. Each piece of equipment requiring ac power shall be provided with an NEC Type SJ cord with molded-on grounding type plug for ac power connection. Panelwork shall contain no exposed connections, and adjustments to equipment shall be made without exposing these terminals. Power and control wiring operating above 80 VAC or dc shall be carried in covered channels or EMT raceways separate from low voltage signal circuits.

4. Analog signal cables shall be No. 18 AWG, 7 x 28 stranded copper, twisted shielded pairs, rated 60 degrees C, 600 V. Cable to be **Belden,** or equal.

5. Terminal blocks: Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:

   a. Provide sufficient terminations to accommodate both present and future needs. Wire all spare or unused panel mounted elements to their panels’ terminal blocks. Provide the greater of 20 percent of all connected terminals or four unused spare terminals.

   b. Provide 600-volt spring type terminal blocks. Use yoke that guides all stands of wire into the terminal. All terminal blocks shall be the knife switch, disconnect type isolation terminal blocks. Supply terminals that allow connection of wire without any preparation other than stripping. Rail mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

   c. Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number of each terminal. Numbers shall be machine printed and 1/8-inch high. Terminal strip codes and terminal numbers shall comply with numbers listed on the wiring diagram.

d. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Provide terminal blocks manufactured by **Wago, Weidmuller,** or equal.

6. Field connections shall be to separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.

7. Circuits shall be fused where shown. Fuses shall be 1/4 by 1-1/4 inch. Fuses on 120 VAC circuits shall be ceramic tube type with 25,000 amperes interrupting capacity at 125 volts and neon blown fuse indicator lamps. Fuses for 24 V DC shall be fast-acting glass tube type rated 1/8 or 1/10 amp for 4-20 and 10-50 mA loops and 3 amps for the power supply to individual instruments. Fuse holders for 120 VAC shall be drawout type and molded from melamine plastic.

8. Two 1/4-inch wide by 3-inch long copper buses shall be provided: one for signal and shield grounding and one for equipment and cabinet grounding. The signal ground bus shall be mounted on insulated stand-offs and the entire signal ground system bonded to the cabinet ground system at a single point.

B. Signal distribution within panels:

1. 4 to 20 mA signals shall be distributed within panels as 4 to 20 mA signals.

2. Signals distributed outside panels shall be isolated 4 to 20 mA signals.

3. Instrument loop field wires shall terminate on panel terminal strips in the control panel. Instruments in the same loop shall be wired to panel terminal strips with spare terminal enough for one additional instrument. No looping from instrument to instrument will be allowed.

4. In the event of a conflict between instrumentation manufacturer's cable specifications and this specification, the instrumentation manufacturer's specifications shall take precedence.

5. RTD and thermocouple extension cable shall be continuous field to panel with no intermediate junction boxes or terminations and in addition shall meet the following specifications. RTDs in motor windings shall be considered a 600-volt circuit. Thermocouple extension wire shall be terminated directly to the loop instrument.

2.4 HVAC CONTROL STATIONS

A. **General:** HVAC control stations shall be provided by the Electrical Contractor. The Electrical Contractor shall install and terminate. The HVAC Contractor shall test and start-up.

B. **Construction:** Control stations shall be NEMA 3R for pedestal or wall mounting. Design shall be in accordance with the Contract Drawings. The enclosure shall have screw on cover, with stainless steel captivated screws. Cover gasket shall be oil resistant with tongue and groove construction. Acceptable products: **Hoffman Bulletin CF-1,** or equal.

C. Exhaust and supply fan control station electrical:

1. Refer to Parts 2.2 and 2.3.

2. For combination starters and disconnects, refer to Section 16140 - Wiring Devices.

2.5 SPARE PARTS

A. Provide a minimum of 10% spare lamps (minimum 2) and one spare lens for each color pilot lamp in each Local Control Station.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Local Control Stations shall be installed in accordance with the requirements specified in Section 16050 - Electrical Work, General and in accordance with the Manufacturer's recommendations. Panel mounting height shall be 5’-6” to top of enclosure unless shown otherwise.

B. Local Control Stations shall be protected at the jobsite from loss, damage, and the effects of weather. Local Control Stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Local Control Stations interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the work.

D. Conduit, conductors, and terminations shall be installed in accordance with the requirements specified in Section 16050 - Electrical Work, General.

3.2 FACTORY TESTING

A. Each Local Control Station shall be factory assembled and tested for sequence of operation prior to jobsite delivery. Factory testing to be witnessed by ENGINEER and OWNER with approved, submitted Factory Test Sheets, describing test procedure.

3.3 FIELD TESTING

A. Each Local Control Station shall be field tested and witnessed by the ENGINEER and OWNER for functional operation after the connection of external conductors yet prior to equipment startup.

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SECTION 16500 - LIGHTING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide lighting fixtures, and accessories for all lighting systems, complete and operable, in accordance with the Contract Documents.

B. CONTRACTOR is responsible for lighting sensor design, layout, equipment, conduit and wiring, panels and controls for a complete operable system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

National Electric Code

Underwriters Laboratories

ANSI C82.1	Specifications for Fluorescent Lamp Ballasts
ANSI C84.4	Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)

Standards of the Certified Ballast Manufacturer's Association

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit the following in accordance with the requirements of Section 01300 - Contractor Submittals.

1. Shop drawings and catalog data.

2. Catalog literature for each fixture.

a. Materials of construction, type of diffusers, hardware, gasketing, reflector and chassis, finish, and ballast.

b. Interior Luminaries: Submit complete photometric data for each submitted luminaries, including candle power distribution curves in two or more planes, candle power chart 0 to 90 degrees, lumen output chart, average maximum brightness data, and coefficients of utilization for zonal cavity calculations, luminaries finish, metal gauge, lens material, pattern, and thickness.

c. Exterior Luminaries: Submit technical photometric data for each luminaries, including IES lighting classification and isolux diagram. Submit fastening

details of luminaries to pole or structure, ballast type, ballast location, and method of fastening.

3. Pole-mounted fixtures, including complete data on the pole material, finish, handholes, anchoring, and fixture attachment.

4. Support method shall be submitted for interior fixtures weighing more than 50 pounds.

5. Lamps: Submit manufacturer's catalog data, including voltages, colors, approximate hours, life, approximate initial lumens, lumen maintenance curve, lamp type, and base.

6. Ballasts: Submit manufacturer's catalog data, including type, wiring diagram, nominal watts, input voltage, starting current, line current, input watts, sound rating, power factor, and low temperature characteristics.

7. Photocell data submittal shall indicate switching capacity, the means of adjusting the lighting pickup level, and enclosure.

B. Substitutions for specified fixtures: CONTRACTOR shall provide a sample of the specified luminaries and the proposed substituted luminaries for each proposed substitution. Substitutions will be accepted only if judged equal or better in performance characteristics, construction quality, ease of maintenance, and aesthetic appearance.

C. Provide seismic conformance computations carried out by a professional structural engineer registered in the State of California. Submit calculations that verify that the lighting fixtures greater than 50 pounds and all emergency lighting fixtures have been designed and construction to withstand the specified seismic requirements.

1.4 QUALITY ASSURANCE

A. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixture poles shall be stored on blocks above grade until the time of installation.

1.5 CLEANUP

A. Fixture lenses, diffusers, and reflectors shall be cleaned just prior to the time specified for the system demonstrations.

B. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished to level acceptable to ENGINEER.

PART 2 -- PRODUCTS

2.1 FIXTURES - GENERAL

A. Fixtures are designated on drawings by means of letters and numbers. See drawings for fixture description and type of lamp required.

B. Where only one fixture designation appears in a room or area, that designation applies to all fixtures in that room or area.

C. Provide luminaires as shown in Luminaries Schedule, with proper hangers, mounting stems, canopies, energy efficient electronic ballasts and T-8 fluorescent lamps, etc., necessary for complete installation. Provide luminaires having "feed thru", or separate junction boxes. Provide two-lamp ballasts wherever possible. Provide luminaires with wire leads not smaller than 18 AWG and with all electrical components easily accessible and replaceable without removing the luminaries from the ceiling.

D. Special Requirements

1. CONTRACTOR shall install appropriate fittings provided by the luminaries' manufacturer to make the assembly complete.

2. Provide luminaires installed in building soffits with SUITABLE FOR DAMP LOCATIONS label. Provide luminaires installed outdoors with SUITABLE FOR WET LOCATIONS label and a removable prewired ballast.

3. For photocells mounted within exterior luminaires provide the luminaries manufacturer's standard design. Provide photocells designed to switch ON at dusk and OFF at dawn.

4. Provide pendant mounted or suspended luminaires with a safety cable attached to the structure and the luminaries at each support; safety cable shall be capable of supporting four times the vertical load.

5. Mount all luminaires in accordance with specified seismic requirements.

E. **Manufacturer:** See types listed in the Luminaries Schedules as part of the Contract Drawings. Substitutions are allowed only if agreed to by the ENGINEER after a product review. To propose substitutes, supplier shall provide both specified model and proposed substitute model for review, as part of the submittal process. The ENGINEER shall review the fixture based on photometrics, luminaries construction, material of construction, finish quality, ease of maintenance, quality of luminaries and installed track record.

2.2 EXTERIOR FIXTURES

A. Exterior fixtures in combination with their mounting pole and bracket shall be capable of withstanding 90 MPH winds without damage. Exterior street light poles shall have fuses installed in the bases of the pole. Manufacturer of luminaries to recommend fuse type and size. Exterior fixtures shall have corrosion-resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo-electrical control shall be of the fixture manufacturer's standard design.

2.3 LAMPS

A. **General:** Provide energy efficient lamps of the types and sizes indicated on the drawings for each luminaries. Provide at least 10% spare lamps for each lamp type, with a minimum of two lamps per type, at project close out. Label spare lamp boxes with fixture type and fixture installed location. All fixtures shall be fully operating at project

close out. Any relamping required prior to close out shall be done by the CONTRACTOR, and not utilizing spare lamps supplied.

B. Incandescent lamps shall be rated 130 volts, inside frosted, 2500 hours rated average life, 1400 initial lumens for 100 watt bulbs.

C. Fluorescent lamps shall be energy saving, long life rapid-start type, 4100 degree K color temperature, minimum color rendering index (CRI) of 85, or as shown on the drawings. Lamps shall be T8 where applicable. 32 watt, 48" lamps shall have 24,000 average life hours and initial lumens of 2950. 17 watt, 24" lamps shall have 20,000 average life hours and 1400 initial lumens.

D. High pressure sodium lamps shall be color corrected, medium base, ANSI Specification S54, 24000 hours rated average life, clear, 2100 degree K color temperature, and minimum CRI of 20.

E. Metal halide lamps shall be medium base, 10,000 hour rated average life minimum, ANSI Specification grade, and 4000 degree K color temperature. Provide a minimum CRI of 85 for all lamps less than 150 watts. 100 watt lamps shall have initial lumens of 9,000, 250 watt lamps shall have initial lumens of 23,000. Lamps and ballasts to be pulse start type.

F. Acceptable Manufacturers

1. All Lamps: **Sylvania, Philips, or General Electric**, no other accepted.

2.4 PHOTO-ELECTRIC CELLS

A. Photoelectric cells for control of multiple fixtures shall be self-contained, weatherproof type and shall be provided with time-delay features.

2.5 LIGHT FIXTURE CONTROL RELAYS

A. Relays for light fixture control shall be mechanically held. Such relays shall be based-mounted, single-purpose units, i.e., not attachments to a multi-purpose solenoid operator.

B. If not indicated otherwise, coil voltage shall be 115 volts ac with contacts rated at 20 amps, 280 VAC. Relays shall be **ASCO Series 166, Zenith Series MSC,** or equal.

2.6 BALLASTS

A. **General:** Provide energy efficient ballasts conforming to ANSI and UL standards for light output, reliable starting, radio interference, and dielectric rating. Provide only ballasts that are UL listed. Replace all noisy and defective ballasts. Provide ballasts for use in exterior luminaires to produce reliable starting of the lamps at -20°F at 90 percent of nominal line voltage.

B. Fluorescent

1. Provide high power factor, electronic rapid start ballasts for lamps of the rating indicated, for operation at voltage shown, and compatible with the lamps specified. Provide ballasts certified by Electrical Testing Laboratories to conform to Certified

Ballast Manufacturers, specifications, except where such specifications are not available.

2. Provide fluorescent ballasts with “A” sound ratings. Where an “A” rating is not available, use the next highest rating. The noise level, 2 feet from the installed fixture, shall not exceed 30 decibels.

3. Provide Class P fluorescent ballast furnished with minimum of one automatic resetting, thermostatic protector to prevent the case temperature from exceeding 110°C in the event of a short circuit in the ballast.

C. **High Pressure Sodium:** Provide auto-regulator type for operation of voltages shown.

D. **Metal Halide:** Prove high power factor, normal ambient, constant wattage ballasts for the various voltages and wattage as specified in the Luminaries Schedule shown on the drawings. Ballasts to limit lamp wattage variation to 5 percent for a line voltage change of 10 percent. Line current during starting and during lamp warm-up time not to exceed normal operation current. Ballasts to have separate capacitor protection.

E. Acceptable Manufacturers

1. All ballasts: **Osram Sylvania, Advance, or MagneTek,** or equal.

2.7 EMERGENCY LIGHTING FIXTURES

A. Emergency battery-operated lighting fixtures shall be provided as shown on the drawings and shall provide emergency illumination automatically and instantaneously upon failure or interruption of normal electric power. Fixtures shall be complete with 12-volt rechargeable battery, lamps integrally mounted, charger and control, wall mounting brackets, and other accessories as herein specified.

B. The fixtures shall be connected to and rated for use on an unswitched 120-volt AC, 60-Hertz, single-phase circuit, and the connection shall be made permanent.

C. The enclosures shall be NEMA 4X in corrosive areas, otherwise NEMA 1. The enclosures shall be compartmented so that the charger and controls are separate from the battery.

D. Directionally adjustable lamp assemblies shall be mounted on the enclosures where indicated on the drawings. The lamps shall be both horizontally and vertically adjustable.

E. The illumination time in hours of light for a two-lamp load shall be 1-1/2 hour’s minimum. In addition to lamps shown, provide two lamps of each size and type for spares.

F. Each fixture shall contain a 12-volt, 150-watt lead calcium battery. The battery shall be encased in a high-impact, heat-resistant, translucent plastic container with permanently sealed cover to prevent leakage of electrolyte. The battery shall operate entirely unattended and require no additional maintenance for a period of 10 years or longer under normal operating conditions. Battery shall be unconditionally guaranteed for 5 years with an additional 7 years prorated. Life expectancy shall be 15 years.

G. Each fixture shall contain a hermetically sealed load relay, which automatically and instantaneously connects the lamp load to the battery upon failure of the ac supply and disconnects the lamp when normal power is restored. Each fixture shall incorporate a completely automatic, solid-state, two-rate charger of sufficient capacity to restore the battery to full charge within 12 hours following a discharge of not more than 2 hours minimum with 150 percent of a two-lamp load connected. The charger shall also continuously monitor the battery voltage and return to hi-rate as required by the battery. Solid-state components shall operate at less than 50 percent of rating. Entire unit shall also meet UL 924.

H. Each fixture shall have a push-to-test switch for quick testing of lamps and battery, an amber light, which glows when the unit is in the ready state, and a red light to indicate that the unit is on the high rate of charge.

I. Provide fixtures with an automatic low voltage disconnect to protect the battery from deep discharge.

J. **Acceptable Products:** See types listed in Luminaire Schedule on the Contract Drawings.

2.8 LIGHTING SENSORS

A. Daylight sensors shall be located per manufacturer's recommendation, shall control lights within influence of skylight, as noted on the Drawings, reducing light by 50 percent.

B. Occupancy sensors shall be located per manufacturer's recommendation. Snesor shall have override switch to keep lights on for 2 hours maximum, unless motion is detected.

C. CONTRACTOR is responsible for all work associated with lighting sensors, including design, layout, power packs, control panels, wiring and conduit.

D. Lighting sensors and controls shall be **Lutron,** or equal.

PART 3 -- EXECUTION

3.1 LUMINAIRES

A. General

1. Install each luminaire in a manner recommended by the luminaire manufacturer and accepted by the ENGINEER.

2. Furnish and install all additional ceiling or wall bracing, hanger supports, and other structural reinforcements to the building to properly and safely mount luminaires to meet the seismic requirements of Section 16050 - Electrical Work, General, all acceptable to the Engineer.

3. Be responsible for handling the luminaires, installing plumb and level, and keeping luminaires clean.

4. Where luminaires are wall mounted and a mounting height is indicated in the Luminaries Schedule or on the Contract Drawings, the height is from the bottom of the luminaries to finished floor or finished grade, whichever is applicable.

5. Where luminaires are pendant-mounted and a mounting height is indicated in the Luminaries Schedule or on the Contract Drawings, the height is from the bottom of the luminaries to finished floor.

6. Provide each luminaries outlet box with a galvanized luminaries stud to fit the luminaries selected.

7. Provide pendant-mounted luminaires with swivel type hangers and canopies as accepted by the Engineer. Finish hangers and canopies to match luminaires, unless otherwise noted. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart. Use twin stem hangers on single luminaires.

8. After construction of total project is completed, remove all labels and other markings, wash dirty luminaires inside and out with a nonabrasive mild soap or cleaner. Clean luminaries' plastic lenses with antistatic cleaners only. Touch up all painted surfaces of luminaires with high-grade exterior enamel, and poles with paint supplied by manufacturer.

9. All stored equipment shall be protected in accordance with the manufacturer's recommendations and as specified. All equipment shall be covered with heavy-gauge polyethylene sheeting or canvas while stored and during construction to protect the equipment from dust and moisture until accepted, or as directed by the ENGINEER.

10. Provide and install all fixtures complete, including lamps, and ready for service. Deliver all warranty paperwork to ENGINEER.

11. Verify ceiling type and conditions and order fixtures for proper application required by the type of ceiling installed.

12. Install fixtures in such a manner as to avoid obstructions and to give proper illumination result. Verify layouts with the ENGINEER.

13. Secondary seismic restraint for pendant mounted light fixtures shall be in accordance with the SMACNA Seismic Restraint Manual and Section 16050 - Electrical Work, General of these Specifications. CONTRACTOR shall submit details showing how these supports are to be installed.

B. Finished Areas

1. Locate luminaires where optimum light spread is obtained, and as approved by ENGINEER.

2. Install all luminaires straight and true with reference to adjacent walls and where mounted on tiled ceilings; locate luminaires symmetrically with the tile pattern as shown on the drawings. In all cases, locate centerlines of luminaires either on centerline of tile or on joint between adjacent tile runs, as best suits luminaries spacing shown.

3. Provide surface-mounted luminaires, not accepted for installation on combustible low-density cellulose fiberboard, with accepted spacers to mount luminaires 1-1/2 inches from the ceiling surface.

4. All surface mounted fixtures shall be supported from the building structural members or from bridging attached to the structural members. Provide all necessary blocking and hardware so fixtures hang true, square, plumb, and in proper alignment. Fixtures installed suspended below grid type ceilings shall be supported independently of the grid system at a minimum of four points per four foot long fixture.

5. Provide flush and recessed luminaires installed in ceilings with junction boxes located at least one foot from luminaires. Provide wiring from junction box to luminaries of temperature rating as required by the luminaries in not less than four feet, but no more than six feet of flexible steel conduit. In concealed locations, install junction boxes to be accessible by removing luminaries.

6. Install all recessed luminaires tight with the finished surface so that no spill light will show between the ceilings and the sealing rings, and furnish plaster frames when required by ceiling construction.

C. Unfinished Areas

1. Install all luminaires straight and true with reference to adjacent walls and structural members. Locate luminaires symmetrically in the pattern used for the computerized lighting layout performed as described above. If no lighting layout was done on an area, locate as shown on Contract Drawings and as approved by ENGINEER.

2. Coordinate luminaries' locations with other utility systems (e.g., Plumbing, HVAC). After obtaining the ENGINEER's approval, relocate luminaires to avoid conflict with these other systems and to avoid blockage of luminaries' light output.

3.2 BALLASTS

A. Install in strict accordance with manufacturer's recommendations. Utilize all ballast mounting holes to fasten the ballast securely within the luminaire.

3.3 EMERGENCY LIGHTING UNITS

A. Install in strict accordance with manufacturer's recommendations.

B. Provide separate circuit wiring to luminaire as required by NEC and make all circuit connections permanent with conduit and wire.

C. CONTRACTOR shall not install or connect batteries to emergency lighting units until the units are ready for testing.

3.4 OUTLET BOXES

A. Outlet boxes for surface or stem mounted fixtures shall be provided with fixture stud as well as tapped and drilled canopy covers.

B. Flush outlet boxes shall be provided with fixture stud and plaster ring.

3.5 TESTS

A. Test all lighting systems for proper operation and conformity to these specifications and as shown on the Contract Drawings.

3.6 FIXTURE POLES

A. Fixture poles shall be set on anchor bolts and secured with double nuts on each bolt. After fixture has been leveled and plumbed, the fixture base shall be dry-packed with grout.

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SECTION 16950 - ELECTRICAL TESTING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. This section specifies the work necessary to test, commission and demonstrate that the electrical work satisfies the criteria of this specification and functions as required by the Contract Documents.

1.2 GENERAL

A. The work of this Section includes furnishing the labor, equipment, and power required to support the testing specified in this and other sections of the Specification. Electrical testing specified in Division 16 and functional testing of all power and controls not tested under Division 17 shall be completed before commencement of start-up testing specified in Section 01660 - Equipment Testing and Plant Startup. This scope of work may require the CONTRACTOR to activate circuits, shutdown circuits, run equipment, take electrical measurements, replace blown fuses, install temporary jumpers, etc.

B. The CONTRACTOR shall provide support to disconnect and reconnect cables, rack in and out breakers, handle testing equipment and perform any other functions required to test electrical equipment at no extra cost to the OWNER. CONTRACTOR is responsible for all work, equipment damage, power interruptions and schedule delays caused by the testing agency.

1.3 SUBMITTALS

A. Results of all testing shall be submitted to the ENGINEER prior to final project acceptance. Six copies are required to be included as part of final Technical Manuals. Submittal shall describe test conditions, weather (including temperature and humidity), test date, duration of test, test equipment, tested equipment, testing technician, “as found” and “as-left” results, expected results, actual results, pass/fail status based on listed testing standards and a registered Professional Engineers stamp and signature; registered in Electrical Engineering in the State of California.

B. Specific data relative to insulation resistance, voltage levels, load currents, relay settings, dial settings, etc., shall be provided for all equipment and material required to be tested.

C. Test result submittals shall be per Specification Section, provide one submittal per Specification Section (ie. 16120 - WIRES AND CABLES).

D. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.4 TESTING ORGANIZATION'S QUALIFICATION

A. Field testing shall be performed by a separate and independent Subcontractor, who has been regularly engaged in the testing of equipment for a period of at least 10 years. All

testing shall be conducted under the direct supervision of an electrical engineer, registered in the State of California. This registered electrical engineer will prepare and sign test reports with values, recommendations, pass/fail status, and comments.

B. Testing equipment required to conduct the specified tests shall be furnished by the testing organization. Testing equipment shall be in good working condition and comply with the requirements of this Specification and applicable industry standards.

C. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards. All testing shall be done in the presence of the ENGINEER, and forms shall include space for ENGINEER sign off at time of test.

D. The testing organization shall cooperate with any manufacturer's representative that may be retained by the CONTRACTOR. Testing organization shall be **Cutler-Hammer; Electro-test; Power Systems; General Electric;** or equal.

E. The testing organization shall be responsible for testing of equipment listed below:

1. Motor Control Centers - low voltage.

2. Panelboards.

3. Cables.

4. Electric Motors (50 hp and up).

5. System Ground.

6. Miscellaneous Testing.

1.5 TESTING

A. The following test requirements are intended to supplement test and acceptance criteria that may be stated elsewhere:

1. Motor Control Center - Low Voltage:

a. Clean equipment prior to testing.

b. Inspect for nameplate compliance, physical damage, and proper operation of alarm and control devices. Inspect and verify anchorage, area clearance, and proper connections. Verify correct mounting of circuit breakers.

c. Functional test of all devices, such as contactors, relays, switches, solid state overloads, protective relays, breakers, indicating lights and meters. Perform adjustments for final settings in accordance with coordination study.

d. Test insulation of the bus phase-to-phase and phase-to-ground for power buses and phase-to-ground for all control circuits with a suitable megohmmeter.

e. Test operation of each switch or breaker in each starter assembly. Test door interlocking. Test Circuit Breakers according to Miscellaneous Testing this specification.

f. Energize space heaters and check operation.

g. Check for proper torquing of all bolted connections.

h. Verify grounding of lugs, conduit hubs and MCC.

i. CONTRACTOR shall tabulate the following data for all three-phase motors. Tabulation shall be submitted to the ENGINEER at least two weeks prior to performing the testing specified in this section.

(1) Motor identification including tag number.

(2) Motor nameplate full load amps, horsepower, voltages and phase.

(3) Solid state overload relay catalog data.

(4) Recommended MCP setting.

j. The work of this section requires that the CONTRACTOR record the following data to the tabulation specified in paragraph i above.

(1) Measurable amperes when motor is drawing normal process load.

(2) Changes required to MCP setting.

(3) Date of test.

(4) Remarks (i.e. difficulty in motor attaining full speed, abnormal process conditions, and abnormal line voltage).

2. Panelboards:

a. Clean equipment prior to testing.

b. Inspect for physical damage, grounding, proper connections, and anchorage.

c. Test insulation of the bus phase to phase and phase to ground. Record data.

d. Test operation of each circuit breaker.

e. Verify nameplate data, panelboard schedule information.

f. Check for proper torquing of all bolted connections.

g. Verify proper grounding of lugs, conduit hubs, and panelboard.

3. Cables:

    a. Refer to Section 16120 - Wires and Cables, for the testing requirements.

    b. Perform a shield continuity test by ohmmeter method for instrumentation cables. Ohmic value shall be recorded.

    c. Check for proper termination of cables.

4. Electric Motors (50 hp and up):

    a. Inspect each motor installation for any deviation from rated voltage and/or frequency and improper installation. Inspect for physical damage, anchorage, and proper connection. Verify nameplate data with drawings and specifications. Confirm correct application of manufacturer's recommended lubrication.

    b. Visually check frame for proper ground connection.

    c. Check winding temperature detectors, surge and lightning protection equipment and space heaters for functional operation and proper grounding.

    d. Test each motor for proper connection, rotation, and automatic operation.

    e. Perform resistance measurements through all bolted connections. Test insulation (high potential test) of all motors in accordance with NEMA MG 1. The test voltage shall be 1000 volts AC plus twice the rated voltage of the motor. Test surge protection devices. Verify the motor space heater is functional. Test motor starter. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

    f. Refer to Sections 16460 - Electric Motors for additional testing details. Motor control circuits shall also be tested: Inspect motor starters. Inspect all bolted connections for high resistance. Perform insulation resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Test the motor overload relay by injecting primary current through the overload circuit and monitoring trip time. Test circuit breakers, including motor circuit protectors. Perform operational tests by initiating control devices.

5. System Ground:

    a. Verify each ground system per facility, is in compliance with Drawings and Specifications.

    b. Provide ground-resistance tests with a ground-resistance megger at each facility, transformer, switchgear and motor control center. Use appropriate method (fall of potential, three-terminal method) to measure ohmic value of ground system to earth (maximum 5 ohms). Verify all equipment ground terminations with respect to prime point used to establish ohmic value stated in Item a, above.

c. Ground Fault Protection Systems: Visually inspect the components for damage and errors in polarity or conductor routing. Inspect all bolted connections for high resistance. Verify correct operation of all functions of the self-test panel. Set pickup and time-delay settings based on coordination study. Verify pickup settings by using primary injection, that the relay does not operate at 90 percent of the setting, and that pickup is less than 125 percent of setting and or 1200 amperes, whichever is smaller. Measure time delay of the relay at 150 percent or greater of pickup. Verify reduced control voltage tripping capability: 55 percent for ac systems and 80 percent for dc systems.

6. Miscellaneous Testing:

a. Circuit Breaker Tests (Molded Case and Power): Perform contact resistance test. Make adjustments for final settings in accordance with the coordination study. Determine minimum pick-up current on power breakers. Perform long time delay time characteristic test by passing 300 percent rated primary current through each pole separately. Determine short-time pickup and delay by primary current injection. Determine ground fault pickup and time delay by primary current injection. Determine instantaneous pickup current by primary injection using run-up or pulse method. Activate auxiliary protective devices, such as ground fault or undervoltage relays, to insure operation of shunt trip devices. Verify operation of charging mechanism for power circuit breakers.

b. Demonstrate that light fixture outlets are switched as indicated on the Contract Drawings. Test photocell and lighting timer switch. Demonstrate that circuitry is in accordance with panel schedules. Test Ground Fault Interrupter (GFI) receptacles.

c. Perform overall system function tests upon completion of equipment tests. Verify correct operation of all interlock devices, alarms, sensing devices and indicating devices.

1.6 TESTING SEQUENCE

A. Setting the breakers and protective relays is required prior to functional testing and checking of the electrical components specified in this section.

B. A functional test and check of all electrical components is required prior to performing subsystem testing and plant startup. Compartments and equipment shall be cleaned as required by other provisions of this specification before commencement of functional testing.

C. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the ENGINEER and after process control devices have been adjusted as accurately as possible. It is required that the CONTRACTOR adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches and timing relays as dictated by operating results.

D. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

E. Subsystems, in the context discussed here, shall mean individual and groups of pumps, unit heaters, ventilation fans, air compressors, etc.

F. General: Carry out tests specified herein for individual items of materials and equipment specified in other sections.

1.7 COMMISSIONING

A. Commissioning during testing in accordance with Division 1 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.

B. The motor current tabulation shall reflect the values occurring during commissioning. The indications of all ammeters, voltmeters, and kilowattmeters shall be recorded every one-half hour during commissioning.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 TESTING

A. All testing shall be witnessed and signed-off by the OWNER and ENGINEER. Each test sheet must be signed-off prior to submittal.

- END OF SECTION -

SECTION 17100 - PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all Process Control and Instrumentation Systems (PCIS) complete and operable, in accordance with the Contract Documents. The CONTRACTOR shall provide software programming for the PLC and the operator interface.

B. The requirements of this Section apply to all components of the PCIS unless indicated otherwise.

C. Responsibilities

1. The CONTRACTOR, through the use of a Instrumentation Supplier and qualified electrical and mechanical installers, shall be responsible to the OWNER for the implementation of the PCIS and the integration of the PCIS with other required instrumentation and control devices.

2. The Instrumentation Supplier shall be responsible to the CONTRACTOR for the integration of the PCIS with devices provided under other sections with the objective of providing a completely integrated control system free of signal incompatibilities.

3. As a minimum, the Instrumentation Supplier shall perform the following work:

a. Implementation of the PCIS.

(1) prepare analog hardware submittals.

(2) design, develop, and electronically draft loop drawings, interconnection diagrams, and control panel layouts suitable for construction based on Contract Drawings. Prepare same as submittals and as-built record drawings. All drawings shall be done in Autocad 2004.

(3) prepare the test plan, the training plan, and the spare parts submittals.

(4) procure hardware.

(5) fabricate panels.

(6) perform factory tests on panels.

(7) perform calibration and verify calibration after installation.

(8) oversee and certify installation.

(9) oversee, document, and certify loop testing.

(10) oversee, document, and certify system commissioning.

(11) conduct the performance test.

(12) prepare Technical Manuals, including as-built drawings and completed test sheets.

(13) conduct training classes.

(14) prepare record drawings.

b. Integration of the PCIS with instrumentation and control devices being provided under other sections;

(1) Design, develop and electronically draft loop drawings, and interconnection diagrams associated with equipment provided under other Divisions of these Specifications and Owner existing equipment. Prepare same as submittals and as-built record drawings.

(2) Resolve signal, power, or functional incompatibilities between the PCIS and interfacing devices.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals and the following:

1. The CONTRACTOR shall coordinate the instrumentation work so that the complete instrumentation and control system will be provided and will be supported by accurate shop drawings and record drawings.

2. Symbology and Nomenclature: In these Contract Documents, all systems, all meters, all instruments, and all other elements are represented schematically, and are designated by symbology as derived from Instrument Society of America Standard ANSI/ISA S5.1 - Instrumentation Symbols and Identification. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout shop drawings, and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the Drawings.

B. Shop Drawings

1. General:

a. All shop drawings shall include the letter head or title block of the Instrumentation Supplier. The title block shall include, as a minimum, the Instrumentation Supplier's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing. The quantity of submittal sets shall be as indicated in Section 01300 - Contractor Submittals.

b. Organization of the shop drawing submittals shall be compatible with eventual submittals for later inclusion in the Technical Manual. Submittals not so organized and incomplete submittals for a given loop will not be accepted.

c. Shop drawing information shall be bound in standard size, 3 ring, looseleaf, vinyl plastic, hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 3 inches.

d. Interfaces between instruments, motor starters, control valves, variable speed drives, flow meters, chemical feeders and other equipment related to the PCIS shall be included in the shop drawing submittal.

2. Analog Hardware Submittal: The CONTRACTOR shall submit an analog hardware submittal as a complete bound package at one time, including:

a. A complete index which lists each device by tag number as shown on the drawings, type, and Manufacturer. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that instrument in that system. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.

b. Fully executed data sheets according to ISA-S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, for each component, together with a technical product brochure or bulletin. The technical product brochures shall be complete enough to verify conformance to all Contract Document requirements. The data sheets, as a minimum, shall show:

(1) Component functional description used in the Contract Documents.

(2) Manufacturer's model number or other product designation.

(3) Project tag number used in the Contract Documents.

(4) Project system or loop of which the component is a part.

(5) Project location or assembly at which the component is to be installed.

(6) Input and output characteristics.

(7) Scale, range, units, and multiplier (if any).

(8) Requirements for electric supply (if any).

(9) Requirements for air supply (if any).

(10) Materials of component parts to be in contact with or otherwise exposed to process media and corrosive ambient air.

(11) Special requirements or features.

(12) Local supplier including contact name, phone number, and address.

c. Priced list of all spare parts for all devices.

d. Instrument installation, mounting, and anchoring details shall be submitted in an electronic AUTOCAD version 2004 and hard copy format. Each instrument shall have a dedicated 8 1/2" X 11" detail which only pertains to the specific instrument by tag number. Each detail shall be certified by the instrument manufacturer that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.

3. Project-Wide Loop Drawing Submittal: The CONTRACTOR shall furnish a Project-wide Loop Drawing Submittal (PLDS) which completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under Division 17 sections, equipment provided under sections in other Divisions, and OWNER furnished equipment which is to be incorporated into the PCIS. The PLDS shall be a singular complete bound package electronically drafted in AUTOCAD, and shall include the following:

a. A complete index in the front of each bound volume. The loop drawings shall be indexed by systems or process areas. All loops shall be tagged in a manner consistent with the Contract Documents. Loop drawings shall be submitted for every analog and discrete monitoring and control loop.

b. Drawings showing definitive diagrams for every instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ANSI/ISA S5.4 - Instrument Loop Drawings, extending the format as shown on Drawing GI-1 and as defined by the most recent revision in ISA. Each system or loop diagram shall be drawn with no more than four loops per drawing. Separate loop drawings shall be developed for loops in equipment vendor supplied packages, equipment provided under Division 17, and OWNER furnished equipment. The loop drawings shall also show all software modules and linkages. In addition to the expanded ISA S5.4 requirements the loop diagrams shall also show the following details:

(1) Functional name of each loop.

(2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.

(3) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.

(4) Designation, and if appropriate, terminal assignments associated with every manhole, pullbox, junction box, conduit, and panel through which the loop circuits pass.

(5) Vendor panel, instrument panel, conduit, junction boxes, equipment and PLC terminations, termination identification wire numbers and colors, power circuits, and ground identifications.

c. Itemized instrument summary. The summary shall be prepared with Microsoft Excel software and shall be submitted on hard copy. The instrument summary shall list all of the key attributes of each instrument provided under this Contract. As a minimum, attributes shall include:

(1) Tag number per Contract Documents.

(2) Manufacturer

(3) Model number.

(4) Service.

(5) Area location.

(6) Calibrated range.

(7) Loop drawing number.

(8) PLC input/output address.

(9) Setpoint of any discrete alarm, contact closure, etc.

4. Test Procedure Submittals:

a. The CONTRACTOR shall submit the proposed testing procedures to be followed during tests of the PCIS and its components. This includes procedures for the Factory Acceptance Test and Field Test (Loop Test).

b. Preliminary Submittal: Outlines of the specific proposed tests and examples of proposed test forms.

c. Detailed Submittal: After approval of the Preliminary Submittal, the CONTRACTOR shall submit the proposed detailed test procedures, forms, and checklists. This submittal shall include a statement of test objectives with the test procedures.

5. Training Submittals: The CONTRACTOR shall submit a training plan which includes:

a. Schedule of training courses including dates, durations, and locations of each class.

b. Resumes of the instructors who will actually implement the plan.

C. Technical Manual

1. General: Information in the Technical Manual shall be based upon the approved shop drawing submittals as modified for conditions encountered in the field during the work.

2. The Technical Manual shall have the following organization for each process:

   a. Section A - Process and Instrumentation Diagrams.

   b. Section B - Loop Descriptions.

   c. Section C - Loop Drawings.

   d. Section D - Interconnection Drawings.

   e. Section E - Instrument Summary.

   f. Section F - Instrument Data Sheets.

   g. Section G - Sizing Calculations.

   h. Section H - Control Panel Elevation and Layout Drawings.

   i. Section I - Instrument Installation Details, Operation and Maintenance Manuals.

   j. Section J - Test Results.

3. Signed results from Loop Testing, Precommissioning, and Performance Testing shall be included in Section J.

4. Initially, 3 sets of draft Technical Manuals shall be submitted for review after return of favorably reviewed shop drawings and data required herein. Following the ENGINEER's review, one set will be returned to the CONTRACTOR with comments. The Manuals shall be revised and amended as required and the final Manuals shall be submitted 10 days prior to start-up of systems.

D. Record Drawings

1. The CONTRACTOR shall keep current a set of complete loop, diagrams schematic diagrams and interconnection drawings which shall include all field and panel wiring, piping and tubing runs, routing, mounting details, with cable, wire, tube and termination numbers. These drawings shall include all instruments and instrument elements. One set of drawings electronically formatted in AUTOCAD 2004 and 2 hard copies shall be submitted after completion of all Precommissioning tasks but prior to Performance Testing. All such drawings shall be submitted for review prior to acceptance of the completed work by the OWNER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Code and Regulatory Compliance:** All PCIS WORK shall conform to or exceed the applicable requirements of the National Electrical Code. Conflicts between the requirements of the Contract Documents and any codes or referenced standards or specifications shall be resolved according to Section 01090 - Reference Standards.

B. **Hardware Commonality:** All instruments which utilize a common measurement principle (for example, d/p cells, pressure transmitters, level transmitters which monitor hydrostatic head) shall be furnished by a single Manufacturer. All panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

C. **Instrument and Loop Power:** Power requirements and input/output connections for all components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. The use of "2-wire" transmitters is preferred, and use of "4-wire" transmitters shall be minimized. Redundant power supplies shall be provided. All power supplies shall be mounted within control panels.

D. **Loop Isolators and Convertors:** Signal isolators shall be provided as required to ensure adjacent component impedance match where feedback paths may be generated, or to maintain loop integrity during the removal of a loop component. Dropping precision wirewound resistors shall be installed at all field side terminations in the control panels to ensure loop integrity. Signal conditioners and converters shall be provided where required to resolve any signal level incompatibilities or provide required functions.

E. **Environmental Suitability:** All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices 20% within the minimums and maximums of their rated environmental operating ranges. The CONTRACTOR shall provide all power wiring for these devices. Enclosures suitable for the environment shall be furnished. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

F. **Signal Levels:** Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals outside control panels shall be 4 to 20 mA dc except as indicated. Signals within enclosures shall be 4 to 20 mA dc unless shown otherwise.

G. **Control Panel Power Supplies:** All control panels shall be provided with redundant power supplies which are configured in a fault-tolerant manner to prevent interruption of service upon failure and interruption of service necessitated by the replacement of a power supply. Each redundant power supply shall be wired in parallel along with an auxiliary relay for “loop power lost” status. All power supplies shall power no more than four loops. The failure of a power supply shall be indicated at the control panel and repeated to the PLC.

H. **Block and Bleed:** All pressure gauges, pressure transmitters, and pressure switches shall be furnished with valves such that the device may be blocked off from the process stream and the trapped fluid and/or air bled off.

2.2 OPERATING CONDITIONS

A. The PCIS shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:

1.	Environment	-	water pump station
2.	Temperature Range	-	32 through 115 degrees F
3.	Thermal Shock	-	1 degree F per minute, max
4.	Relative Humidity	-	20 through 90 percent, non-condensing

2.3 SPARE PARTS AND SPECIAL TOOLS

A. The CONTRACTOR shall furnish the spare parts selected by the ENGINEER from the priced list of spare parts in the Analog Hardware Submittal CPES.

B. All spare parts and special tools shall be submitted before startup commences, suitably wrapped and identified.

2.4 FACTORY TESTING

A. The CONTRACTOR shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the ENGINEER and OWNER to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the local control panels, PLC enclosures, and other pertinent systems and devices. A minimum of 10 working days notification shall be provided to the ENGINEER prior to testing. No shipments shall be made without the ENGINEER'S approval.

PART 3 -- EXECUTION

3.1 PRODUCT HANDLING

A. **Shipping Precautions**: After completion of shop assembly, factory test, and approval, all equipment, cabinets, and panels shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. **Special Instructions:** Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. **Tagging:** Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel tag firmly attached, with solid #20 AWG stainless steel wire ties, and permanently and indelibly marked with the instrument tag number, as given in the Contract Documents. Tag shall be located on the conduit serving the instrument. This stainless steel tag is an addition to any tagging on the instrument label as provided by the manufacturer.

D. **Storage:** Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR at no additional cost to the OWNER. If any apparatus has been subject to possible injury by water, it shall be replaced, at no cost to the OWNER, even if stored on Technical premise with approval.

3.2 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall furnish the following Manufacturer's services for the instrumentation listed below:

1. Perform bench calibration.

2. Provide critical installation criteria prior to installation which shall effect operation such as: minimum and maximum sample stream flow for analyzers, upstream/downstream straight pipe lengths for flow meters, dead space for level transmitters, and minimum back pressure on metering pumps discharge.

3. Oversee installation.

4. Verify installation of installed instrument.

5. Certify installation and reconfirm Manufacturer's accuracy statement.

6. Oversee loop testing, prepare loop validation sheets, and certify loop testing.

7. Oversee precommissioning, prepare precommissioning validation sheets, and certify precommissioning.

8. Train the Technical personnel.

B. Manufacturer's services shall be furnished for the following equipment:

1. All process analyzers, Specification 17112.

2. All in line flow measuring devices, Specification 17102

3. All level measuring systems, Specification 17106.

3.3 INSTALLATION

A. General

1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed under Division 17 and the manufacturers' instructions.

2. **Equipment Locations:** The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the OWNER exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the CONTRACTOR shall make such changes without additional cost to the OWNER.

B. Conduit, Cables, and Field Wiring

1. All conduit shall be provided under Division 16 without delay to the WORK of Division 17.

2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, PLC input and output wiring and other field wiring and cables including the antenna cable shall be provided under Division 16.

C. **Instrumentation Tie-Downs:** All instruments, control panels, and equipment shall be anchored by methods which comply with seismic requirements applicable to the site.

D. **Ancillary Devices:** The CONTRACTOR shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the OWNER to provide a complete and operational system. All such additions and all such changes, including the proposed method of installation, shall be submitted to the ENGINEER for approval prior to commencing the work. Such changes shall not be a basis of claims for extra work or delay.

E. **Installation Criteria and Validation:** All field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have at least one copy of the approved shop drawings and data.

2. Instrument process sensing lines shall be installed similar to conduit specified under Section 16050 - Electrical General Provisions. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

3. All differential pressure elements shall have 316 stainless steel, 3 valve manifolds.

4. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.

5. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. The CONTRACTOR shall certify in writing that for each loop or system checked out, all discrepancies have been corrected.

3.4 CALIBRATION

A. **General:** All devices provided under Division 17 shall be calibrated and ranges set, according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. **Calibration Points:** Each instrument shall be calibrated at 0, 10, 50, 90 and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.

C. **Field Calibration:** Instruments shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

D. **Analyzer Calibration:** Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.

E. **Calibration Sheets:** Calibration sheets to be submitted prior to start up of any system or subsystem. Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name.

2. Loop number.

3. Tag number.

4. Manufacturer.

5. Model number.

6. Serial number.

7. Calibration range.

8. Calibration data: Input, output, and error at 10 percent, 50 percent and 90 percent of span.

9. Switch setting, contact action, and deadband for discrete elements.

10. Space for comments.

11. Space for approval sign-off by Instrumentation Supplier and date.

3.5 LOOP TESTING

A. **General:** Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the ENGINEER for review prior to the loop tests. The CONTRACTOR shall notify the ENGINEER of scheduled tests a minimum of 10 calendar days prior to the estimated completion date of installation and wiring of the PCIS. After the ENGINEER'S review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the ENGINEER.

B. **Control Valve Tests:** All control valves, shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place.

C. **Interlocks:** All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

D. **Loop Validation:** Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks which incorporate analog elements, simulated sensor inputs corresponding to 0, 10, 50, 90 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to accuracy tolerance. Provisional settings shall be made on controllers and alarms during analog loop tests.

E. **Loop Validation Sheets:** The CONTRACTOR shall prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights based on example attached at the end of this section. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the Instrumentation Supplier:

1. Project name.

2. Loop number.

3. Tag number, description, manufacturer and model number for each element.

4. Range check.

5. Space for comments.

6. Space for loop acceptance sign-off by Instrumentation Supplier and date.

7. Space for ENGINEER approval signature and date.

3.6 PRECOMMISSIONING

A. **General:** Precommissioning shall commence after acceptance of all wire test, point to point validation, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements. Precommissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. **Precommissioning Procedures and Documentation:** All precommissioning and test activities shall follow detailed test procedures and check lists accepted by the ENGINEER. Completion of all system precommissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the ENGINEER with a clear and unequivocal statement that all system precommissioning and test requirements have been satisfied.

C. **Operational Validation:** Where feasible, system precommissioning activities shall include the use of water 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.

D. **Precommissioning Validation Sheets:** Precommissioning shall be documented on one of two types of test forms as follows:

1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:

a. Project name.

b. Loop number.

c. Loop description.

d. Tag number, description, manufacturer and data sheet number for each component.

e. Space for sign-off and date by both the Instrumentation Supplier and ENGINEER.

2. For functions which cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

a. Specification page and paragraph of function demonstrated.

b. Description of function.

c. Space for sign-off and date by both the Instrumentation Supplier and ENGINEER.

E. **Precommissioning Certification:** The CONTRACTOR shall submit an instrumentation and control system precommissioning completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the precommissioning testing. Acceptance of the instrumentation and control system precommissioning testing must be provided in writing by the ENGINEER before the performance testing may begin. Final acceptance of the control system shall be based upon project completion as stated in the General Conditions.

3.7 ON-SITE SUPERVISION

A. The CONTRACTOR shall furnish the services of an on-site resident engineer to supervise and coordinate installation, adjustment, testing, and start-up of the PCIS. The resident engineer shall be present during the total period required to effect a complete operating system.

3.8 PERFORMANCE TEST

A. The entire PCIS shall operate for 30 calendar days without failure as described in Section 17520.

B. The CONTRACTOR shall furnish all necessary support staff as required to operate the system and to satisfy the repair or replacement requirements. Staff to be “on-call” during entire 30-day performance test with maximum 4 hours response time.

3.9 TRAINING

A. **General:** The CONTRACTOR shall train the TECHNICAL personnel on the maintenance, calibration and repair of all instruments provided under this Contract.

B. **Instructions:** The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

C. **Duration:** Each training class shall be a minimum of 4 hours in duration and shall cover, as a minimum, operational theory, maintenance, trouble shooting/repair, and calibration of the instrument.

D. **Schedule:** Training shall be performed during the precommissioning phase of the project. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The ENGINEER will review the course outline for suitability and provide comments that shall be incorporated.

E. **Agenda:** The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.

F. **Documentation:** Within 10 days after the completion of each session the contractor shall submit the following:

1. A list of all OWNER personnel that attended the session.

2. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

3.10 ACCEPTANCE

A. For the purpose of this Section, the following conditions shall be fulfilled before the WORK is considered complete:

1. All submittals have been completed and approved.

2. The PCIS has been calibrated, loop tested and precommissioned.

3. The OWNER training has been performed.

4. All required spare parts have been delivered to the ENGINEER.

5. The performance test has been successfully completed.

6. All punch-list items have been corrected.

7. All record drawings in both hard copy and electronic format have been submitted.

8. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.

9. All debris associated with installation of instrumentation has been removed.

10. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition. Cleaning to include vacuum of enclosure interiors, wipe down of exteriors, and paint touch up as required by ENGINEER.

Manufacturer: _____ **Loop Number:** _____
Model Number: _____ **Device Description:** _____
Serial Number: _____ **Tag Number:** _____

Initials for Sign-off

	Date:	Contr.	Engr	Manu.	SCADA
Installation					
1. Installed per Contract Drawings					
2. Installed per Manufacturer's recommendation					
Labeling	Date:				
1. Wires labeled with correct number and tag type.					
2. Conduits labeled with correct number and tag type, at device and PLC.					
3. Device Instrument Tag installed with correct number and tag type.					
4. Device Calibration Tag installed and signed by Manufacturer (see *note below)					
Loop Drawing Verification	Date:				
1. Drawing matches field at device, terminal numbers and wire labels.					
2. Drawing matches field at PLC, terminal numbers and wire labels.					
3. Drawing matches field at JTB, terminal numbers and wire labels.					
4. ISA Sheet data fields verified, check model and serial numbers.					
Calibration - Analog	Date:				
1. Range: _____ units: _____					
2. Tested under actual condition or simulation (describe): _____					
3. PLC Input Address: _____					
4. PLC Output Address: _____					
5. Analog Loop Resistance: _____ ohms					

6. Measurements	milliamps	@ PLC	@ HMI	@ SCADA	Contr.	Engr	Manu.	SCADA
0% (4.0 mA)								
25% (8.0 mA)								
50% (12.0 mA)								
75% (16.0 mA)								
100% (20.0 mA)								

Calibration - Digital	Date:	Contr.	Engr	Manu.	SCADA
1. Setpoint _____	units: _____				
2. Contact position at normal condition, (circle one)	NO or NC				
3. PLC Input Address _____					
4. PLC Output Address _____					
5. Actual trip measurement: _____	units: _____				
6. Reset Function _____					
Operational	Date:				
1. Verify status, interlocks based on Schematics	PLC Address				
Lock-Out-Stop	n/a				
Local Mode	n/a				
Remote Mode	_____				
Auto Mode	_____				
Ready Status	_____				
Run Status	_____				
Alarm Status 1	_____				
Alarm Status 2	_____				
Interlock 1, describe _____					
Interlock 2, describe _____					
Other _____					

Comments: _____

Acceptance and Completion Signatures: Date: _____

Contractor Testing Representative: _____ Owner or Engineer Representative: _____

*Note: Upon successful completion of Loop Validation Test, Engineer to sign off on Instrument Calibration Tag.

- END OF SECTION -

SECTION 17102 - FLOW MEASURING SYSTEMS AND DETECTION DEVICES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all meters and flow measurement systems and detection devices with associated instrumentation and controls as shown and specified herein, complete and operable, for functions including flow measurement, and flow detection in accordance with the requirements of the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Codes:** All codes, as referenced herein, are specified in Section 01090 - Reference Standards.

B. Commercial Standards

ISA - S 5.1	Instrumentation Symbols and Identification

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit complete shop drawings of all meters for review in accordance with the Section 01300 - Contractor Submittals. Each meter shall be identified with its equipment number, as shown or specified.

B. **Technical Manuals:** The CONTRACTOR shall furnish to the ENGINEER 5 identical copies of complete operation and maintenance instructions of all the metering systems including instrumentation and controls, as specified under paragraph "Technical Manuals" of the Section 01300 - Contractor Submittals.

C. **Spare Parts:** The CONTRACTOR shall provide a list of manufacturer's recommended spare parts and after the ENGINEER'S approval, shall furnish all spare parts suitably packaged and labeled for each meter device.

D. **Special Tools:** A list of special tools required shall be submitted to the ENGINEER for approval. After approval the CONTRACTOR shall supply these tools suitably wrapped and identified for application.

1.4 QUALITY ASSURANCE

A. **Inspection and Testing Requirements:** After installation, the CONTRACTOR shall obtain the services of a factory service representative to inspect and test all meters for proper performance and installation.

B. **Accuracy Requirements:** Unless otherwise specified herein, the flow meters shall be guaranteed to register flow to an accuracy of $\pm$0.5 percent of actual flow throughout the range specified.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. **Installation Assistance:** During installation of the equipment the CONTRACTOR shall obtain all necessary assistance from an experienced factory service representative to ensure a correct and first class installation, in accordance with the manufacturer's instructions.

B. **Instruction of OWNER's Personnel:** After completion of the installation and during startup of the plant, the CONTRACTOR shall instruct the OWNER's personnel in the proper operation, maintenance and repair of all metering equipment. For this purpose, the CONTRACTOR shall obtain the services of an experienced factory service representative, who shall spend four hours minimum on the site to fully instruct the OWNER's operating personnel on all phases of its equipment.

1.6 GUARANTEES, WARRANTIES

A. After completion the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the metering systems will operate within the published accuracies and flow ranges and meet these Specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

PART 2 -- PRODUCTS

2.1 MAGNETIC FLOW MEASURING SYSTEMS (FOR MEASURING SENSOR DIAMETER OVER 1 INCH)

A. **General:** Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Meter shall measure flow in either direction. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, transmitter and flowmeter grounding rings.

B. Metering Tube

1. Flange Type Magnetic Flowmeter Element: In-line flow element with no constrictions in flow of fluid through meter consisting of metallic tube with ANSI B16.5, Class 150, flanged ends for diameter and bolt drilling pattern. Flange material shall be compatible with the piping material and corrosion resistant.

2. Electrode and Liner Materials: Fully compatible with process fluid, complying with requirements of application. Refer to the chart below for electrode and liner material compatibility.

Process Fluid	Size	Liner	Electrode
Water	12”	Polyurethane	Stainless Steel

3. Ground Rings: Manufacturer's standard.

C. Microprocessor-Based Transmitter

1. Direct current, pulsed bipolar, with signal stability at zero flows.

2. Micro-processor type with local flow rate indication and local flow totalization indicator, scaled in engineering units. Transmitter to be bidirectional.

3. Zero Flow Stability: By power driven electrode shielding or automatic zero adjustment of direct current excited metering circuit.

4. Power Supply: 120 VAC.

D. **System Accuracy, Including Magnetic Flowmeter Transmitter:** Within 0.5 percent of actual flow rate for 10-100 percent full scale where velocity is between 0.3 and 30 feet per second.

E. **Housing:** NEMA 4X, corrosion-resistant, weatherproof, operable in ambient minus 20 to plus 140 degrees Fahrenheit temperature and 10 to 100 percent relative humidity.

F. Transmitter Output

1. Normal Flow Direction: Analog output isolated 4-20 milliamperes direct current, HART protocol.

2. Reverse Flow Direction: Analog output isolated 4-20 milliamperes direct current.

3. Flow Direction: Contact output that is closed for reverse flow.

4. Flow Total: Frequency output.

G. Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Standards and Technologies. The calibrations procedure shall conform to the requirements of MIL-STD-45662A. A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 0, 20, 50, 80 and 100 percent of the calibrated range shall be submitted to the ENGINEER at least thirty (30) days prior to shipment of the meters to the project site.

H. Manufacturer, No Equal

1. **Endress & Hauser, PROMAG 53W3H-UL0BIRA0BAA2.**

2.2 FLOW SWITCHES (SEAL WATER AND SAFETY SHOWER)

A. Application is for any fluid. Operating fluid temperature 32 to 140 degrees F. Temperature compensation shall be provided to maintain correct setpoint trip.

B. Sensors

1. Operating Principle: Heat generated in an RTD element installed in the sensor is carried away by a flowing fluid. When the flow stops or changes, the RTD circuit senses the change in the temperature as an electronic signal proportional to flow.

2. Sensor Size: 1.125 inches in dia.; 2.0 inches long.

3. Mounting: Mounted in a pipeline. Provide necessary mounting accessories.

4. Process Connection: 1.0 inch male NPT.

5. Material: 316 stainless steel.

6. Pressure Rating: 150 psig minimum.

C. Controller

1. Energize or de-energize a control relay when the preset flow is reached.

2. Enclosure: NEMA Type 4X 316 stainless steel or other noncorrosive material.

3. Output Contacts: DPDT, 5 Amps, 115 Volts inductive.

4. Power Requirements: 24 VDC.

5. Response Time: 10 to 120 seconds adjustable.

6. Setpoint Adjustment: 0 through 10 percent of full scale flow.

7. Accuracy: +/- 1 percent of flow.

D. **Manufacturer:** The thermal flow switch shall be **FCI Model 12-64B**.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall assemble and install all equipment specified herein, in strict accordance with the manufacturer's published instructions, under the supervision of the manufacturer's representative, under the general review of the ENGINEER. All installations shall be accomplished by competent craftsmen in a workmanlike manner.

B. The meters shall be installed in easily accessible locations for ease of reading and maintenance. Wherever possible, all meters shall be installed in such a way to provide the manufacturer's recommended straight piping approach and straight piping downstream. All meters shall be firmly supported from the structure or from the floor with approved supports. In-line meters shall be installed to provide full-line flow and not less than the manufacturer's recommended head at all times.

C. **Magnetic Flowmeter Elements:** Provide and install ground rings as recommended by manufacturer of flow meter, including grounding materials and grounding method.

D. Installation of Thermal Flow Switch

1. Isolate flow sensor from vibration and possible physical damage. Provide for easy removal of probe for maintenance or cleaning as required.

2. Install union(s) to allow removal of the sensor without dismantling the entire process line installation. Insertion tee shall be of appropriate depth to ensure that the flow switch will function in accordance with manufacturer’s installation recommendation.

3. Wire probe using a manufacturer’s recommended flexible cable with plug and receptacle at a junction box close to the probe. Wire from junction box to controller using manufacturer’s recommended wires and rigid conduit.

3.2 TESTING

A. Each item shall be subjected to an operating test over the total range of the equipment. The CONTRACTOR shall obtain copies of factory test certifications and shall notify the ENGINEER one week in advance of all tests to be conducted on site.

3.3 TRAINING

A. Manufacturer shall provide training to OWNER as specified in Sections 17100 and 17520.

3.4 ACCEPTANCE BY OWNER

A. Final acceptance of the equipment is contingent on satisfactory operation after installation.

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SECTION 17106 - LEVEL MEASURING SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The requirements of Section 17100 - Process Control and Instrumentation Systems, apply to this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All devices specified herein shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

2.2 WELL LEVEL TRANSMITTER - HYDROSTATIC PRESSURE

A. The continuous level transmitter shall be of the hydrostatic pressure type. Unit shall have a ceramic measuring cell, rugged housing hermetically sealed to cable.

B. Probe

1. The probe diameter shall be 0.87 inches maximum.

2. Cable length to be field measured by CONTRACTOR at least 225 feet for bid.

3. Mounting: Include mounting clamp and guide pipe. Provide protective cap.

4. Output: Standard 4-20 mA with imposed HART protocol.

C. Capacitive level probe and electronic insert shall be a **Endress + Hauser Waterpilot FMX 167-F2DPK1G7 with additional weight,** or equal.

D. The following level transmitter shall be provided and installed:

Tag No.	Service
WD35-LITx26100	Well Level

2.3 TANK LEVEL SWITCH

A. Tank level switch shall be **ball float type, USFilters Model 100-B**.

PART 3 -- EXECUTION

3.1 GENERAL

A. Level measuring systems shall be executed according to the requirements of Section 17100.

B. Installation of level transmitters to be approved by manufacturer such that rated accuracy and repeatability is met.

C. Training by manufacturer to be per Sections 17100 and 17520.

- END OF SECTION -

SECTION 17108 - PRESSURE MEASURING SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide pressure measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Shop Drawings, Owner's Manual, and Records Drawings shall be submitted in conformance with the requirements of Section 17100 and Section 01300 - Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 17100.

2.2 PRESSURE GAUGES

A. Pressure gauges shall be 4-1/2 inches in diameter, bottom connected, with white laminated dials and black graduations. Gauges shall have a blowout disc and safety glass. Measuring element shall be a helically wound Inconel X-750 bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared, all stainless steel material. All pressure gauges shall be provided with a pulsation snubber constructed of 316 stainless steel and an isolation valve. Gauge for sodium hypochlorite shall have compatible materials and equipped with diaphragm seal. Accuracy shall be plus and minus 1/2 percent range. Instrument shall be provided with 6-year warranty, to cover all defects on material and workmanship. The pressure gauge shall be **3D Instruments,** or equal.

B. The following pressure gauges shall be provided and installed:

Tag No.	Service	Range	Process Connections
WD34-GAGE26111	Distribution Water	0-100 psig	¼" NPT Male
WD34-GAGE26112	Seal Water	0-100 psig	¼" NPT Male
WD39-GAGE26211	Sodium Hypochlorite	0-100 psig	¼" NPT Male with diaphragm seal

2.3 ELECTRONIC GAUGE PRESSURE TRANSMITTERS

A. **Components:** Electronic gauge pressure transmitters shall consist of a capsule assembly, bottom works, vent plug, drain plug, cover flange, process connector and

connection, amplifier unit, integral indicator, terminal box with cover, and conduit connections.

B. **Operating Principles:** Pressure applied to the unit shall be transmitted by a sealed fill fluid to a sensing diaphragm using a dry cell ceramic sensor.

C. Performance Requirements

1. The amplifier unit shall convert the change in capacitance to a 4-20 mA DC signal with superimposed HART protocol with an allowable loop load of no less than 600 ohms.

2. Static pressure rating shall be a minimum of 500 psig.

3. The maximum overrange pressure limit shall be a minimum of 150 percent of the minimum range.

4. Span shall be adjustable over a minimum of 10:1 range.

5. External adjustment shall include zero and span.

6. Damping shall be provided as an internal adjustment.

7. All equipment shall be suitable for an ambient operating range of minus 40 degrees F to plus 212 degrees F.

8. The integral indicator shall be calibrated in process units, (PSI).

9. Power supply shall be 24 VDC.

10. Accuracy, including linearity and repeatability, shall be a plus or minus 0.2 percent of span or less.

D. **Materials:** All wetted parts including block and bleed valves parts shall be constructed of 316 stainless steel. Transmitter to be rated NEMA 4. Process lines to be 3/8" I.D., 316 stainless steel.

E. **Manufacturers, No Equal**: **Endress + Hauser Cerabar M PMC 41-RC11P6J21N1.** Valve manifold to be **Rosemont No. 0306RT22AA11 with ¼" – 18 NPT threadson test/bleed ports**.

F. The following electronic gauge pressure transmitter shall be provided and installed:

Tag No.	Range	Process Seal	Process Connection	Mounting
WD34-PITx26103	0-100 psig	Viton	1/2" NPT, 316 SS	2" pipe bracket

2.4 DIAPHRAGM SEALS FOR PRESSURE MEASURING SYSTEMS

A. **Components:** Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing.

B. **Operating Principles:** The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch or other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing and refilling.

C. **Materials:** All exposed surfaces, housings, and diaphragm shall be constructed PVC.

D. **Manufacturers: 3D Instruments, Inc.,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Pressure measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested according to Section 17100. The Manufacturer shall furnish the manufacturer's service, supervision, and training indicated by Section 17100 and 17520.

B. All pressure switches and pressure gauges to be installed with block and bleed valves per Contract Drawings.

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SECTION 17109 - PRESSURE DETECTION SWITCHES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide pressure detection switches, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Shop Drawings, Owner's Manual, and Records Drawings shall be submitted in conformance with the requirements of Section 17100 and Section 01300 - Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 17100.

2.2 PRESSURE SWITCHES

A. Pressure switches shall be UL listed and diaphragm operated, where shown, with fully adjustable setpoint. Switch shall have visible setpoint indicator and adjustable deadband protected by clear polycarbonate window. Electrical terminals shall be isolated from setpoint adjustment. Housing shall be NEMA 4X. Switches shall be in accordance with the data sheet listed below with instrument tag numbers and specified service. Pressure switches shall be **Mercoid Series SA1100,** or equal.

B. The following pressure switches shall be provided and installed:

Tag No.	Range	Trip Settings	Actuator Seal And Material	Connection Material	Comments
WD34-PSHx26102	0-150 psi	100 psi	¼" NPTF, Buna-N	316 SS	

PART 3 -- EXECUTION

3.1 GENERAL

A. Pressure measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested according to Section 17100. The Manufacturer shall furnish the manufacturer's service, supervision, and training indicated by Section 17100.

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SECTION 17112 - PROCESS ANALYSIS MEASURING SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide process analysis measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Shop Drawings, Owner's Manual, and Records Drawings shall be submitted in conformance with the requirements of Section 17100 and Section 01300 - Contractor Submittals. Provide start-up calibration methods as part of submittal.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 17100.

2.2 CHLORINE RESIDUAL ANALYZERS

A. Two electrode amperometric cell type, for continuous on-line duty.

B. Measures free chlorine residual after mixing pH/buffer with the sample.

C. **Control Unit:** Operator panel with visible numeric display showing by menu selection.

1. mg/L residual.

2. On screen instruction.

3. Self-diagnostics.

4. High- and low-alarm setpoints, to open when in alarm state.

D. Panel mounting.

E. **Power Source:** 120 VAC, 60 Hz. Unit to be equipped with 6-foot power and plug.

F. Other Requirements

1. Range: 0 to 2.0 mg/L.

2. Accuracy: 0.01 mg/L or 2 percent of full scale, whichever is greater.

3. Sample temperature range: 40 degree F to 80 degree F.

4. Residual type: Free.

5. Two month supply of reagents.

6. Stainless steel equipment tag.

G. **Acceptable Products: Capital Controls Aztec CL500.** No substitutions.

PART 3 -- EXECUTION

3.1 GENERAL

A. Process analysis measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested according to Section 17100. The Manufacturer shall furnish the manufacturer's service, supervision, and training indicated by Section 17100.

B. After installation, manufacturer representative to verify calibration of all analyzers and make necessary adjustments so that specified accuracies are met. Calibration techniques to be approved method of OWNER. Manufacturer representative to certify installation and provide written certification of such to OWNER prior to system startup and performance testing.

C. CONTRACTOR is responsible to plumb chlorine analyzer sensor element such that the probe electronics are always wet. Install probe in low spot of saddle, configured with sample line piping.

- END OF SECTION -

SECTION 17200 - PLC CONTROL PANEL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide control panels, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16485 - Local Control Stations, apply to this Section.

C. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to this Section.

D. The provisions of this Section apply to Section 17201 - PLC Control Panel Instrumentation except where indicated otherwise.

E. Panels shall be built by a UL listed shop. Provide shop nameplate within panel.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. **Control Panel Engineering Submittal:** The CONTRACTOR shall submit a control panel engineering submittal (CPES) for the PLC Control Panel. The CPES shall completely define and document the construction, finish, layout, power circuits, signal and safety grounding circuits, fuses, circuit breakers, signal circuits, internally mounted instrumentation and SCADA system components, face plate mounted instrumentation components, internal panel arrangements, and external panel arrangements. All panel drawings shall, as a minimum, be "B" size with all data sheets and manufacturer specification sheets being "A" size. The submittal shall be in conformance with ISA-S20, Standard Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, shall be submitted as a singular complete bound volume or multi-volume package within 120 calendar days after Notice to Proceed and shall have the following contents.

1. A complete index shall appear in the front of each bound volume. All drawings and data sheets associated with a panel shall be grouped together. All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.

2. Front of panel layouts for all control panels. CONTRACTOR to include in bid price costs associated with revisions of control panel layouts during CPES review. A minimum of two revisions by ENGINEER/OWNER for a total of three submittals shall be allowed at no additional costs or project delays.

3. Schematic/elementary diagrams shall depict all control devices and circuits and their functions.

4. Wiring/connection diagrams shall locate and identify electrical devices, terminals, and interconnecting wiring. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

5. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

6. Control sequence diagrams to portray the contact positions or connections required to be made for each successive step of the control action. Written descriptions explaining the control sequence diagrams and system operation shall be furnished.

7. Completed ISA-S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify conformance to the requirements of the Contract Documents.

8. A bill of material which enumerates all devices associated with the control panel.

1.3 EXTENDED PERIOD FOR CORRECTION OF DEFECTS

A. The CONTRACTOR shall correct all defects in accordance with Section 17100.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Environmental Suitability:** All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The CONTRACTOR shall provide all power wiring for these devices. Enclosures suitable for the environment shall be provided. All instrumentation and enclosures in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

B. The control panel controls shall be 120 VAC.

C. The control panel shall be the source of power for any 120 VAC solenoid valves interconnected with the control panel. All equipment associated with the control panel shall be ready for service after connection of conductors to equipment, controls, and control panel. All power to 120 VAC solenoids shall be done through interposing relays.

D. PLC Control Panel shall be wall mounted, NEMA 3R.

E. Each source of foreign voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front. Each control panel shall be provided with identified terminal strips for the connection of all external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 20 percent additional conductors for future use.

F. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 amps at 120 VAC. Analog inputs and outputs shall be isolated 4-20 mA, 2-wire signals with power supply.

G. All control panel mounted devices shall be mounted a minimum of 3 feet above finished floor elevation.

H. **Painting:** Control panels shall be thoroughly cleaned and sand blasted per Steel Structures Painting Council Specification SSPC-SP-6 (Commercial Blast) after which surfaces shall receive a prime coat **Amercoat 185,** or equal, 3-mils DFT, for a total thickness of the prime plus finish system of 6 mils. The finished color of the outside surfaces shall be ANSI 61, unless otherwise indicated. Interior of the control panel, back-panel, and side-panels shall have a white enamel finish coat.

2.2 CONTROL PANELS

A. Materials

1. Panel section faces shall be No. 10 gauge minimum thickness steel for free standing panels and No. 14 gauge minimum thickness steel for wall mounted or pedestal mounted panels. All materials shall be selected for levelness and smoothness.

2. Construction: Dimensions shall be in accordance with vendor's requirements. Elevations and horizontal spacing shall be subject to ENGINEER'S approval.

3. Provide fast operating clamp assemblies. Screw clamps are not acceptable.

B. Electrical Requirements

1. The CONTRACTOR shall provide conduit, wireways, switches, wire, and electrical fittings for all 115 VAC/24V DC circuits to instruments and other electrical devices as required for a complete and operable installation.

2. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. All wiring shall be identified with stamped tubular wire end markers.

3. Wall mounted or pedestal mounted panels shall be so sized as to adequately dissipate heat generated by equipment mounted in or on the panel. Provide further environmental conditioning if required.

4. Provide a door activated switch controlled light and a breaker protected 120-volt, 15-amp duplex receptacle within the PLC Control Panel.

5. Wiring Methods: Wiring methods and materials for all panels shall be in accordance with the N.E.C. requirements for General Purpose (no open wiring) unless otherwise indicated.

6. Signal and Control Circuit Wiring:

a. Wire Type and Sizes: Conductor shall be flexible stranded copper machine tool wire, UL listed Type MTW, and shall be rated 600-volts. Wires for instrument signal circuits and alarm input circuits shall be No. 14 AWG. All

other wires, including shielded cables, shall be No. 16 AWG minimum, unless shown otherwise.

b. Wire Insulation Colors: Conductors supplying 120 VAC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120V AC control circuit conductors shall be violet. All wires energized by a voltage source external to the control panels shall have yellow insulation. Insulation for all DC control wires shall be violet with white tracer. DC power supply wires shall be red.

c. Wire Marking: Wire numbers shall be marked using white numbered wire markers made from plastic, **Brady Label-Lite,** or equal.

d. For grounding, panels shall be provided with a 1/4-inch by 1-inch copper ground bus complete with solderless connector for one No. 4 AWG bare stranded copper cable. The copper cable shall be provided by the CONTRACTOR and be connected to a system ground loop.

7. Power Supply Wiring:

a. Unless otherwise indicated, all instruments, alarm systems, and motor controls shall operate on 115 volt, 60 Hz circuits.

b. When instruments do not come equipped with integral fuses, provide fuses as required for the protection of individual instruments against fault currents. Fuses shall be mounted on the back of the panel in a fuse holder, and each fuse shall be identified by a service name tag. Fuses shall be as manufactured by **Bussmann Manufacturing Division, Type KAW TRON,** or equal.

8. Signal Wiring:

a. Signal Wire:

(1) Signal cable shall be rated at 600 volts.

(2) Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded PVC with nylon overcoat: black-red for two-conductor cable and black-red-white for three-conductor cable.

(3) Signal cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 AWG stranded tinned copper drain wire, and a PVC outer jacket.

(4) Two conductor shielded cable shall be UL 1277 NEC Type TC.

(5) Three conductor shielded cable shall be UL 1277 NEC Type TC.

(6) Color code for instrument signal wiring shall be as follows:

Positive (+) - Red
Negative (-) - Black

C. **Labor and Workmanship:** All panels shall be fabricated, piped, and wired by fully qualified workmen who are properly trained, experienced, and supervised.

2.3 PLC ENCLOSURE

A. Each PLC and corresponding housing, I/O modules, power supply modules, communication interface devices, and peripheral equipment shall be mounted inside an enclosure. All I/O wiring from the field to the I/O system shall be terminated on terminal blocks in the lower portion of the enclosure. A nameplate shall be mounted on the outside of the door of the enclosure and be engraved with "WOODCREEK NORTH PUMP STATION PLC CONTROL PANEL WELL NO. 7". Enclosures shall be as manufactured by **Hoffman**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Preparation for Shipment and Shipping

1. All panels are to be crated for shipment using a heavy framework and skids. The panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. All instruments which are shipped with the panel shall further have suitable shipping stops and cushioning material installed to protect parts which could be damaged due to mechanical shock. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.

2. All shipments shall be by air ride van, unless otherwise indicated.

3. All control panel factory testing and inspection shall be performed prior to shipping.

B. Control panel shall be installed in accordance with Section 17100.

3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

A. **Wiring Installation:** All wires shall be run in plastic wireways except field wiring and wiring to panel-mounted components. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied 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 run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be 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. Shop drawings shall show conformance to the above wiring installation requirements.

E. **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.

3.3 CALIBRATION, TESTING, AND INSTRUCTION

A. **General:** Calibration, testing, and instruction shall be performed in accordance with Section 17100.

B. Inspection and Approval

1. Panel fabricator shall conduct the following tests prior to arrival of the ENGINEER for factory testing and before shipment.

   a. All alarm circuits rung out to determine their operability.

   b. All electrical circuits checked for continuity and where applicable, operability.

   c. All nameplates checked for correct spelling and size of letters.

   d. Any other test required to place the panel in an operating condition.

2. It shall be the responsibility of the CONTRACTOR to furnish all necessary testing devices and sufficient manpower to perform the tests required by the ENGINEER.

3. If the above tests have not been performed prior to the arrival of the ENGINEER, the CONTRACTOR shall be liable to the OWNER for costs of the ENGINEER for the extra time required for inspection services.

4. Field testing: Each control panel shall be tested again for functional operation in the field after the connection of external conductors, and prior to equipment startup.

- END OF SECTION -

SECTION 17201 - PLC CONTROL PANEL INSTRUMENTATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall provide PLC Control Panel instrumentation, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to the WORK of this Section.

C. The requirements of Section 17200 - PLC Control Panel apply to the WORK of this Section.

D. The requirements of Section 16485 - Local Control Stations apply to the WORK of this section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be included within the submittals of Section 17200 - Control Panels.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Quality Assurance

1. The panel construction and all interior wiring shall be in strict accordance with the National Electric Code (NEC), state and local codes, and in conformance with applicable specifications of NEMA, ANSI, UL, and ICECA.

2. All panels shall be completely fabricated, instruments installed, wired, and plumbed at the Contractor's factory.

3. All panels shall bear a UL label stating "suitable for use as an industrial control panel", or built by an UL listed shop and shop label is included within panel.

4. All electrical work shall be in accordance with the applicable requirements of Division 16, ELECTRICAL.

B. Control Panel Electrical

1. Interior panel wiring:

a. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V-1. Wiring channel fill shall not exceed 40 percent of cross section area. Only one wire per terminal block with exception of a comb jumper in addition to the single wire.

b. Wiring shall comply with the requirements of NEC as a minimum.

c. Terminal blocks: Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:

(1) Provide sufficient terminations to accommodate both present and future needs. Wire all spare or unused panel mounted elements to their panels' terminal blocks. Provide the greater of 20 percent of all connected terminals or four unused spare terminals.

(2) Provide 600-volt terminal blocks. Rail mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

(3) Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number of each terminal. Numbers shall be machine printed and 1/8-inch high. Terminal strip codes and terminal numbers shall comply with numbers listed on the wiring diagram.

(4) Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Provide listed terminal blocks manufactured by **Wago**, no substitutions.

Type of Terminal	**Wago Part Number**
120 vac Indicating fuse block	281-611/281-418
24 vdc Indicating fuse block	810-281/282
Indicating fuse block end cover	281-309
Terminal block	280-681
Terminal blocks end cover	280-326
Disconnect Terminal block	280-683
Disconnect Terminal blocks end cover	280-326
Ground block	280-687
Ground block end cover	280-326
Terminal block end stops	249-116

Note: Use appropriate Wago jumpers for terminal busing.

d. Field connections shall be to separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.

e. Circuits shall be fused where shown.

f. Two 1/4-inch by 1-inch copper buses shall be provided in the panels: one for signal and shield grounding and one for equipment and cabinet grounding. The

signal ground bus shall be mounted on insulated stand-offs and the entire signal ground system bonded to the cabinet ground system at a single point.

2. Signal distribution within panels:

   a. 4 to 20 mA signals shall be distributed within panels as 4 to 20 mA signals.

   b. Signals distributed outside panels shall be isolated 4 to 20 mA signals.

   c. Instrument loop field wires shall terminate on panel terminal strips in the control panel. Instruments in the same loop shall be wired to panel terminal strips with spare terminal enough for one additional instrument.

   d. In the event of a conflict between instrumentation manufacturer's cable specifications and this specification, the instrumentation manufacturer's specifications shall take precedence.

3. All unused I/O must be prewired through isolators/isolation relays to field terminal blocks.

2.2 INDICATORS

A. **Indicators, Digital Process:** Digital process 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 a 3-1/2 digit LED display of no less than 0.5-inch height. The input signal to the digital process indicator shall be 4-20 mA DC or 1-5 VDC as indicated. 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/or offset. Accuracy shall be plus and minus 1 least significant digit. Input power to the digital indicator shall be 120 VAC, 60 Hz. Digital process indicators shall be as manufactured by **Kessler-Ellis Products INT-69,** or equal.

2.3 CONVERTERS

A. **Signal Inverter**: Signal inverters shall have complete isolation of input, output, and power input. Signal input shall be 4-20 mA into 50 ohms maximum. Signal output shall be 20-4 mA, linearly inverse to the input signal into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable; accuracy shall be plus and minus 0.1 percent of span. Units shall be surface or rack mounted. Signal inverters shall be **AGM Electronics Series 5000, Moore Industries Model SCT, Rochester Instrument Systems Model SC-1302 LZ**, or equal.

2.4 DC POWER SUPPLIES

A. Furnish DC power supplies to convert 120 AC input power to 24V DC regulated voltage output. Power supplies to be equipped for back panel mounting. Power supplies to be auto-resetting, adjustable output voltage, LED status, 200 mV peak to peak maximum ripple, UL listed for overload protection. No more than four loops on each paralleled power supply system.

B. Power supplies to be **Phoenix Contact Model No. CM 50-PS-120AC/24DC/2.5/F,** or equal.

2.5 CONTROL DEVICES

A. Relays

1. General purposes relays shall be enclosed octal plug-in units. Two- and 3-pole relays shall be **IDEC Series RR**, or equal. Four-pole relays shall be **IDEC Series RH**, or equal. Relay contacts for control circuits shall be rated not less than 7.5 amperes at 120 VAC and at 30 VDC. Relays shall be UL listed, indicating type, push to test.

2. Where shown, time delay functions shall be accomplished with time delay relays. Units shall be adjustable time delay relays with the number of contacts and contract arrangements as shown. A neon status-indicating light shall be provided with each relay. Contacts shall be rated for 7.5 A at 120 VAC. Integral knob with calibrated scale shall be provided for adjustment of time delay. Initial setting shall be as shown with time delay range approximately 3 times the initial setting. Delay rangeability shall be at least 10:1. Timing relays shall be solid state pulse-count type utilizing a high frequency resistance-capacitance (RC) oscillator and integrated circuit counter for timing. Time delay relays shall be **IDEC Series GT3,** or equal.

3. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

4. Latching relays shall be two-pole, 10A, 120 VAC din rail mounted. Relay shall be industrial type, dual coil. Manufacturer to be **IDEC Series RR2KP,** or equal.

B. Illuminated Control Indicating Lights

1. Shall be heavy duty, NEMA 4X, with round, plastic lens, and jumbo legend plate. Each shall be push-to-test indicating light, transformer type, with LED lamps.

2. Acceptable products: **Allen-Bradley Bulletin 800H-PRTL,** or equal.

3. Indicating lamp colors shall be in accordance with the following schedule:

Color	Function	Example
Red	Run, valve status	Equipment operating, motor running, valve open
Green	Normal condition, ready, valve status	Status OK, equipment ready, valve closed
White	Control power	Control power on
Amber	Abnormal condition	Failure of equipment or status abnormal, fault condition

C. Non-illuminated Control Pushbuttons

1. Shall be heavy duty, NEMA 4X, bootless, flush head pushbutton, momentary contact, with jumbo legend plate.

2. Acceptable products: **Allen-Bradley Bulletin 800H-AR**, or equal.

D. 2-, 3-, and 4-position, Selector Switches

1. Position switches shall be maintained contact type, rated 20 A minimum at 120 VAC. Control knob shall be black, NEMA 4X, and shall show clearly the control switch position.

2. Selector switch shall be complete with jumbo legend plate, and with contact blocks.

3. Acceptable products: **Allen-Bradley Bulletin 800H**, or equal.

2.6 INTRUSION TIMER

A. Spring wound timers shall be industrial grade, 0-12 hours, with 10 amp switch ratings. Timers shall be compact design to fit within 2-1/2-inch deep junction box. Spring wound timer to be **Intermatic FF312H,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Control panel instrumentation shall be executed in accordance with Section 17100.

3.2 ASSEMBLY

A. The installation of instrumentation and associated components shall following manufacturer's instructions.

B. Equipment shall be installed in a neat and workmanlike manner, and firmly secured to the surface on which it is mounted.

C. Inspection and Testing

1. Prior to shipment, all local control panels shall be checked for compliance with specification and drawings and functionally tested by the CONTRACTOR and witnessed by the ENGINEER at the factory. The intent is to thoroughly test the completed system so that any faults may be corrected, before the local panels are installed.

2. Prior to testing the panels, fabricator shall have performed the needed wiring continuity check, operation of relay and control switches in accordance with control schematics.

3. Notify the ENGINEER not less than seven working days prior to desired inspection and test.

3.3 INSTALLATION

A. Each control panel shall be set level and plumb, and shall be secured by not less than four 3/8-inch diameter stainless steel epoxy anchor bolts. Doors shall swing freely and close tightly. Wall mounted panels shall have top of panel mounted at 6' - 0" above finished floor unless shown otherwise or directed by the ENGINEER.

B. Any damage to the structure, components or finish shall be carefully repaired to the satisfaction of the ENGINEER.

- END OF SECTION -

SECTION 17520 - PLC-BASED CONTROL SYSTEM HARDWARE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR, through the use of an Instrumentation Supplier and electrical installers, shall furnish, supervise installation, assemble, configure, tests and start-up the PLC-based Control System specified under this Section, and in Section 17530 - PLC-Based Control System-Software, all in accordance with the requirements of the Contract Documents. The PLC programming and required software shall be provided by the CONTRACTOR.

B. **Instrumentation Supplier:** The Instrumentation Supplier shall be responsible for verifying the selection, purchasing, installing, programming and testing compatible hardware and software to provide a functional Control System.

C. **Scope of Work:** The CONTRACTOR through his Instrumentation Supplier shall furnish, install, program, test and start-up the Control System as specified within these Contract Documents. The CONTRACTOR shall be responsible for all equipment selection and supply hardware and software material, submittal preparation, total system integration, communication system configuration, supervision of installation, testing, training, start-up and implementation activities for the entire Control System being furnished under this Contract. The CONTRACTOR shall provide the programming effort for the PLC, and also will provide assistance for control system testing and start-up. The Control System hardware and software being furnished under this Contract shall be a standardized system which utilizes off-the-shelf commercially available configurations of hardware and software modules.

The CONTRACTOR shall be responsible for the following work, equipment and services but not be limited to:

1. Prepare and submit for approval Control System hardware shop drawings.

2. Furnish and install a complete and operational Control System, including all peripherals and other equipment specified herein.

3. Perform all required Control System tests, including adjustments and calibrations to ensure a fully functional system.

4. Furnish labor to perform Control System programming, installation and start-up.

5. Furnish qualified instructors to provide Control System instruction and training.

6. Furnish all required Control System tools, test equipment, spare parts, supplies, operations and maintenance manuals, and reproducible "as-built" drawings as specified herein.

D. **System Responsibility:** All Control System hardware and software furnished in accordance with the Contract Documents shall be done so by the CONTRACTOR. The CONTRACTOR shall have responsibility for providing a fully integrated Control System. The CONTRACTOR shall coordinate the WORK of his personnel and the Instrumentation Supplier's personnel for the installation, interconnection, testing, calibration, and operation of all Control System equipment and coordinate the scheduling along with the programming work of the OWNER representative at the

remote SCADA facility. The CONTRACTOR shall be responsible for providing equipment that properly meets the functional intent of the Contract Documents. Substitutions for Control System functions specified are not permitted.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS.

A. PLC-based control system hardware reference specifications, codes, and standards shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems.

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** Control System submittals shall be in accordance with the applicable requirements of Section 17100 - Process Control and Instrumentation Systems.

B. **Hardware Submittals:** The Control System hardware submittal shall include hardware specified under this Section and shall be a singular all inclusive submittal which shall include but not be limited to:

1. A complete index appearing in the front of each bound submittal volume.

2. Complete grounding requirements for the entire Control System including any requirements for PLC's, shall be indicated on catalog cut sheets or drawings.

3. Requirements for physical separation between Control System components and 120 volt power cables shall be indicated in layout drawings and/or installation detail drawings. A minimum separation of 4 inches shall be enforced between Control System 24V wiring and any control wiring carrying 120V or higher.

4. UPS and battery load calculations for the units specified to show that the backup capacity and time meet the specified requirements.

5. All unused I/O shall be prewired through isolators/isolation relays to field terminal blocks.

6. A complete set of Control System diagrams which depict:

a. All PLC’s, communication devices, and communication links. All PLC’s shall be shown with their current I/O allocation, future I/O allocation (current plus spares provided under this project), maximum potential I/O based on available slots, and all I/O addresses.

b. All cables required to support the communication requirements.

7. Data sheets shall be included for each Control System component together with a technical product brochure or bulletin. These data sheets shall show: the component name as used within the Contract Documents, the manufacturer's model number or other identifying product designation, the project tag number, the input and output characteristics, the requirements for electric power, the specifications for ambient operating conditions, and details on materials of construction.

8. **Complete and detailed bills of materials:** A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the Control System. Bills of material shall include all items within the control panel.

9. Site-specific arrangement and construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates, and the like. All drawings shall be scaled, as noted above, and show the position of the equipment on its intended installation location. All drawings must show a scaled representation of the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas. All acquired access and clearances associated with the equipment must be shown with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes. Panel layout drawings shall be submitted on 11” x 17” paper and AutoCAD 2004 electronic format.

10. Calibration, adjustment, and test details for all Control System components.

C. **Technical Manuals:** General requirements for Technical Manuals are as described in Section 17100 - Process Control and Instrumentation Systems. The following items shall also be included in the Technical Manuals:

1. A documented PLC I/O list and housing configuration for each PLC. Each element and each ring must be documented. Provide cross references for all register bits.

2. Operation and maintenance manuals for the PLC’s, and all other Control System hardware.

1.4 STORAGE AND HANDLING

A. All equipment and materials delivered to the jobsite shall be stored in a location which shall not interfere with construction. Storage and handling shall be performed in manners which shall afford maximum protection to the equipment and materials. It is the CONTRACTOR’S responsibility to assure proper handling and on-site storage.

1.5 WARRANTY

A. The complete Control System (and associated software) included therein shall be guaranteed to meet or exceed the design requirements set forth in the Contract Documents.

B. Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the CONTRACTOR to attain compliance, at no additional cost to the OWNER. Following replacement or modification, the CONTRACTOR shall retest the system and perform any additional procedures needed to place the complete Control System in satisfactory operation and attain design compliance approval from the ENGINEER.

C. The CONTRACTOR warrants the materials and workmanship used for the Control System equipment and materials furnished under the Contract and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the work of this Contract to be as herein specified and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

D. The CONTRACTOR shall warrant/guarantee the satisfactory performance of the equipment and materials under operating conditions for a period of one year after date of final acceptance of the **entire** Control System (i.e., completion of all contractual items including a successful full system-wide 30 day performance test as specified in Part 3). In the event that tests and inspections disclose latent defects of failure to meet the specified requirements, the Instrumentation Supplier upon notification by the ENGINEER

shall proceed at once to correct or repair any such defects or non-conformance or to furnish, at the delivery point named in the Contract, such new equipment or parts as may be necessary for conformity to the specified requirements, and shall receive no additional compensation therefore. In case of any required repairs or other corrective or remedial work covered under warranty, the warranties on all such corrections, repairs, new equipment, or parts shall be extended for an additional 12 months from the date of final acceptance or 12 months from the date of completion of any such corrections, repairs, new equipment, or parts, whichever date is later. The CONTRACTOR shall reimburse the OWNER for all costs incurred in the removal of the defective material and installation of the replacement.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All materials and all Control System equipment furnished under this Contract shall be new, free from defects, of first quality, and produced by manufacturers regularly engaged in the manufacture of these products.

B. Where there is more than one item of similar equipment being furnished under this Contract, all such similar equipment shall be the product of a singular manufacturer.

2.2 PLC ENCLOSURES

A. PLC-Based Control System - Hardware PLC enclosures shall be provided in accordance with Section 17200 - PLC Control Panel.

2.3 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. The UPS shall receive a 120 VAC, 60 Hz power input, and generate a 120 VAC, 60 Hz output signal which is protected from incoming spikes, sags, noise, brownouts, and power outages.

Each UPS shall have, a battery pack, a battery charger, an inverter, and a microprocessor based controller to provide continuous, on-line, computer grade uninterruptible power.

Each UPS shall maintain power to all of its loads, including non-constant loads, for a minimum of thirty minutes at a loading of 50 percent of UPS capacity. The equipment submittal shall include sizing calculations which support the unit selected. The UPS shall be supplied with a low output voltage cutoff to prevent damage to loads when the battery power is exhausted.

The uninterruptible power supply shall **Powerware 5115-750 or larger**. No substitutions. Provide two year warranty.

2.4 PLC HARDWARE

A. **Programmable Logic Controller:** The programmable logic controllers shall be **Automation Direct, Direct Logic 250, #D2-250-1**. No substitutions.

B. **PLC Power Supply:** Each PLC power supply shall be mounted in the PLC housing and be sized to power all modules mounted in that housing and an "average module load" for any empty housing slots plus 25 percent above that total. Power Supplies shall be **Automation Direct**. No substitutions.

C. **PLC Input/Output (I/O) Modules:** All I/O housings and modules shall be suitable for industrial environments as described in Section 17100 - Process Control and Instrumentation Systems. The I/Os shall be 4-20 mA DC for all analog inputs and outputs, and shall be 120 VAC for discrete inputs and dry relay contacts for safe discrete outputs. Modules shall be removable without having to disconnect wiring from the module's terminals by means of plug-in wiring connectors.

1. **Discrete Input Modules:** AC input modules shall be **Automation Direct, Direct Logic 205 #D2-16ND3-2**. No substitutions.

2. **Contact Modules:** Contact output modules shall be **Automation Direct, Direct Logic 205 #F2-08TRS**. No substitutions.

3. **Analog Input Modules:** Analog input modules shall be **Automation Direct, Direct Logic 205 #F2-08AD-1**.

4. **Analog Output Modules:** Analog output modules shall be **Automation Direct, Direct Logic 205 #F2-08DA-1**. No substitutions.

5. **Communication Modules:** Communication modules shall be **Automation Direct, Direct Logic D2-DCM**. No substitutions.

D. **PLC Chassis:** The PLC, power supply, and I/O modules shall be mounted in a suitable standard chassis. Chassis shall be **Automation Direct #D2-09BDC1-1**. No substitutions.

E. **PLC Operator Interface:** The Operator Interface shall be **Red Lion Model G303, Part No. G303S000, indoor/outdoor glossy finish with UV rated overlay**. No substitutions. Provide custom cable between Red Lion operator interface and PLC communication module.

F. **Miscellaneous Components:** The following items will be required to provide a fully functional PLC system. Additional components may be required which are not listed here. These components shall be **Automation Direct** parts:

1. PLC Programming Cable: **D2-DSCBL**.

2. PLC to Radio Cable: **D2-DSCBL-1**.

3. Communication Module to Operator Interface Cable: **Custom Cable**.

4. Operator Interface Programming Cable: As required.

2.5 RADIO SYSTEM

A. **Radio:** Radio shall be **Microwave Data Systems** Packaged Radio with 4800 baud modem and remote maintenance options, **MDS4710B with separate 12 VDC power supply**. No substitutions. Provide the following frequencies; transmit 456.0875 MHz and receive 451.0875 MHz. DC power supply to be **Power One Model No. HC15-3-A**, or equal

B. **Antenna:** Antenna shall be yagi directional antenna manufactured by **Telewave Model No. ANT450Y10WR**. No substitutions.

C. **Cable:** Antenna cable shall be 3/8” coaxial transmission line manufactured by **Times Microwave Systems LMR400**. No substitutions. Cable connectors shall be provided by

Times Microwave Systems, as required. Cold shrink connector weatherproofing shall be **Andrews 241548-4**.

D. **Lightning Arrestor:** Lightning arrestor shall be **Polyphaser Model No. IS-50NX-C2**. No substitutions.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it furnishes. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it furnishes.

B. All components of the Control System shall be the installation responsibility CONTRACTOR unless specifically noted otherwise. The installation of the communication networks including antenna cable, shall be the complete installation responsibility of the CONTRACTOR including all cables, connectors, and any required electrical grounds. Grounding shall be shown on submittal drawings.

3.2 CALIBRATION, TESTING, AND INSTRUCTION

A. **Analog Signal Testing:** All analog inputs and outputs of the Control System shall have their calibration checked at a minimum of 5 points to verify consistency with the balance of the analog loop. This calibration check shall be done in conjunction with the analog loop tests specified in Section 17100 - Process Control and Instrumentation Systems. PLC registers shall be verified for correctness.

B. **Discrete Signal Testing:** After the analog points have been calibrated, the Control System shall be tested to verify that all discrete inputs and outputs of PLC's are correct. As much as possible, points shall be checked "end-to-end". An I/O checklist shall be used to record test results and a copy provided to the ENGINEER upon completion.

C. **System Testing:** When analog loop calibration and discrete I/O testing have been completed, system testing shall be performed. System testing shall operate the PLC's to verify compliance with all functional requirements specified, including the automatic control modes and Control System interlocks. Tests which fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the ENGINEER.

Following completion of the System testing and delivery of the System Testing Report, the CONTRACTOR may commence with the Start-Up Test as specified in Section 01660 - Equipment Testing and Start-Up.

D. **Start-Up Test:** The CONTRACTOR shall provide start-up support to include the CONTRACTOR's personnel, electrical personnel, and the Control System manufacturer's representative as required during the Start-Up Testing period to produce a fully operational system. This support shall be provided at no additional cost to the OWNER. The start-up test shall be conducted in accordance with the requirements of Section 01660 - Equipment Testing and Start-Up.

E. Performance Test

1. General: Subsequent to the system and startup testing, the CONTRACTOR, in conjunction with the ENGINEER and OWNER, shall conduct a successful 30 day final acceptance test. Each shall be responsible for the portion of the Control System which they were responsible for providing under this contract. In general the OWNER representative shall be responsible for the remote programming of the SCADA system and the CONTRACTOR shall be responsible for all other components. In the test, the entire Control System shall be continuously operated and maintained (i.e., 7 days per week, 24 hours per day) during the test period with zero downtime resulting from system failures or as directed by ENGINEER. If a major system failure on CONTRACTOR provided components occurs causing disruption in operation for more than 1 hour or as described below, the 30 day test shall be considered a failure and not acceptable. The CONTRACTOR shall repeat the 30 day test. The Control System shall be acceptable only after all equipment and software has satisfied the performance test requirements.

2. Failures: Failures shall be classified as either major or minor. A minor failure would be a small and noncritical component failure which can be corrected by the OWNER's operators. This occurrence shall be logged but shall not be reason enough for stopping the test and shall not be grounds for non-acceptance. However, should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance. A major failure shall be considered to have occurred when a component fault causes a halt in operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system. A major failure shall cause termination of the acceptance test. When the causes of a major failure have been corrected, a new acceptance test shall be started.

3. Report: The CONTRACTOR shall submit a final acceptance test completion report which shall state that all contract requirements have been met and which shall include (1) a listing of all Control System equipment maintenance/repair activities conducted during testing and (2) a listing of all components which were unable to operate successfully. Final acceptance, in writing, of the Control System shall be provided by the ENGINEER if the results of all of the performance tests are acceptable.

F. Radio Test

1. The CONTRACTOR shall provide the services of a “bucket truck” and a technician trained in testing and startup of this radio system for a minimum of 4 hours to make adjustments to the alignment of the antenna as required to optimize the signal strength and to conduct the following radio site tests. To assist the CONTRACTOR, the City O&M will provide trained staff and test equipment to field evaluate the antenna system for proper alignment and signal strength.

2. The CONTRACTOR shall deliver a request in writing to the RESIDENT ENGINEER requesting this service a minimum of two (2) weeks in advance. The CONTRACTOR shall make adjustments as required for either vertical or horizontal polarization of antenna and set the alignment to the CITY’s Master SCADA Radio Station based on the instruction of O&M personnel.

3. Radio Site Tests:

    a. Verify adjustable set points of DC-DC power supply for radio transceiver to verify that output voltage is within tolerances of radio transceiver.

b. Test radio transceiver with all field wiring connected and confirm that the radio status LED indications are normal.

c. Test and record Return Loss and VSWR.

d. Test and record Cable Loss.

e. Test and record Radio Output Power.

G. **Instruction:** The CONTRACTOR shall provide training for the purpose of familiarizing the OWNER's maintenance and operating personnel with the use, maintenance, calibration, and repair of all components of the Control System.

The training shall be scheduled concurrent with the calibration, equipment testing, and process system testing phases of the project.

The training shall be performed by qualified representatives of the CONTRACTOR or the Manufacturer as noted in the table below. Training shall be specifically tailored to this project and reflect the Control System installation and configuration. The table below summarizes training hours required, which shall be provided at no additional cost to the OWNER. All training shall be conducted at the jobsite unless another location is approved by the ENGINEER and OWNER.

	Training Classes Required	**Maintenance Class (Hrs.)**	**Operator's Class (Hrs.)**	**Conducted By**
1.	Flow, Level, Pressure Measuring	4	2	Manufacturer
2.	Process Analyzers (Chlorine Residual)	4	2	Manufacturer

Separate classes shall be conducted for the OWNER's maintenance and operating personnel. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the Control System. Operator classes shall stress operational theory. Each of the training classes listed above for operators shall be conducted twice during separate weeks to allow for scheduling of OWNER personnel. A total of 8 hours of training for maintenance personnel and 8 hours of training for operators shall be provided.

The training classes shall be scheduled a minimum of 3 weeks in advance of when they are to be given. Proposed training material, including a resume for the proposed instructor(s) (indicating previous instructional experience), and a detailed outline of each lesson shall be submitted to the ENGINEER at least 30 days in advance of when the lesson is to be given. The ENGINEER shall review the submitted data for suitability and provide comments that shall be incorporated into the course.

Within 10 days after the completion of each class the CONTRACTOR shall present to the ENGINEER the following:

1. A list of all OWNER personnel that attended the class.

2. A copy of the hard copy text utilized during the class with all notes, diagrams, and comments.

- END OF SECTION -

SECTION 17521 - INPUT/OUTPUT POINT LIST

PART 1 -- GENERAL

1.1 SUMMARY

A. **Section Includes:**

1. PLC I/O Point List to be completed by CONTRACTOR.

2. An electronic version of this I/O Point List is available upon request to ENGINEER.

1.2 SUBMITTALS

A. CONTRACTOR to submit completed I/O Point List in hardcopy and electronic (Excel) version along with the PLC program and Operator Interface program, at least 30 days prior to Factory Acceptance Testing.

1.3 SYSTEM TESTING

A. See Section 17100 - System Testing.

PART 2 -- PRODUCTS

2.1 **General:**

A. This schedule describes the minimum I/O required by the control system.

B. These schedules shall not be interpreted as a set of complete data sheets, but only as a listing of the estimated I/O described. Additional I/O may be in order to provide a complete and operational installation. All required points shall be provided even though they are not included in this list.

C. CONTRACTOR to fill out all fields except those in columns with “Dynac” reference, Excel spreadsheet columns L through P. CONTRACTOR to verify existing data in spreadsheet and assumes complete responsibility for all data included in submitted PLC I/O Point List.

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

Field Tag	PLC	PLC / SCADA Tag	Type	Description	Discrete On State/ Analog Range	Discrete Off State/ Analog Eng Units	Slot	Point	PLC Address	Additional PLC Address	DYNAC RTU Name	DYNAC Address	Dynac DB Group	Dynac DB Point	Dynac Dig Dev Assign	Device Termination-Origination	Device Termination-Destination	Panel Termination-Origination	Panel Termination-Destination	Loop Drawing	Local Readout	Local HMI Address	Elementary Drawing	PID	PID Description
HS-101A	DW07	HC-101A	DI 24VDC	WELL #7 Pump Emergency Stop	No Command	Stop	1	A0	X0	C100															
HS-101B	DW07	ZI-101B	DI 24VDC	WELL #7 Pump Control in Local	Local	No Command	1	A1	X1	C101															
HS-101C	DW07	ZI-101C	DI 24VDC	WELL #7 Pump Control in Remote	SCADA	No Command	1	A2	X2	C102															
HS-101D	DW07	HC-101D	DI 24VDC	WELL #7 Pump Start Button	Start	No Command	1	A3	X3	C103															
HS-101E	DW07	HC-101E	DI 24VDC	WELL #7 Pump Stop Button	Stop	No Command	1	A4	X4	C104															
YS-101	DW07	YI-101	DI 24VDC	WELL #7 Pump Running	Running	Stopped	1	A5	X5	C105															
FS-113	DW07	FSH-113	DI 24VDC	WELL #7 Flush Water Flow Switch	Flow	Low Flow	1	A6	X6	C106															
HS-108A	DW07	ZI-108A	DI 24VDC	WELL #7 Waste Valve Control in Hand	Hand	No Command	1	A7	X7	C107															
HS-108B	DW07	ZI-108B	DI 24VDC	WELL #7 Waste Valve Control in Remote	Remote	No Command	1	B0	X10	C110															
HS-108C	DW07	HC-108C	DI 24VDC	WELL #7 Open Waste Valve Button	Open	No Command	1	B1	X11	C111															
HS-108D	DW07	HC-108D	DI 24VDC	WELL #7 Close Waste Valve Button	Close	No Command	1	B2	X12	C112															
ZSH-108	DW07	YIH-108	DI 24VDC	WELL #7 Waste Valve Open Position	Open	Not Open	1	B3	X13	C113															
ZSL-108	DW07	YIL-108	DI 24VDC	WELL #7 Waste Valve Closed Position	Closed	Not Closed	1	B4	X14	C114															
FS-104	DW07	YS-104	DI 24VDC	WELL #7 Injection Flow Direction Relay	Injection	Production	1	B5	X15	C115															
FQ-104	DW07	FIQ-104	DI 24VDC	WELL #7 Flowmeter Totalizer Pulse	1000 gal	No Command	1	B6	X16	C116															
	DW07		DI 24VDC	SPARE			1	B7	X17	C117															
ESL-100	DW07	EA-100	DI 24VDC	WELL #7 PLC Control Panel AC Power OK	Normal	Alarm	2	A0	X20	C120															
ESL-100A	DW07	EA-100A	DI 24VDC	WELL #7 PLC 24VDC PS #1 OK	Normal	Alarm	2	A1	X21	C121															
ESL-100B	DW07	EA-100B	DI 24VDC	WELL #7 PLC 24VDC PS #2 OK	Normal	Alarm	2	A2	X22	C122															
JS-101	DW07	JA-101	DI 24VDC	WELL #7 Motor Mgmt. Failure	Normal	Alarm	2	A3	X23	C123															
PSH-102	DW07	PAH-102	DI 24VDC	WELL #7 Discharge Pressure Switch	Normal	High	2	A4	X24	C124															
LSL-204	DW07	LAL-204	DI 24VDC	WELL #7 Hypo Tank Float Switch	Normal	Alarm	2	A5	X25	C125															
ZS-1 to 5	DW07	ZA-001	DI 24VDC	WELL #7 Intrusion Switch	Normal	Alarm	2	A6	X26	C126															
FS-220	DW07	FA-220	DI 24VDC	WELL #7 Eyewash Flow Switch	Normal	Alarm	2	A7	X27	C127															
TS-1 to 3	DW07	TA-001	DI 24VDC	WELL #7 Smoke Alarm	Alarm	Normal	2	B0	X30																
HS-100	DW07	HC-100	DI 24VDC	WELL #7 PLC Panel Alarm Reset Button	Reset	No Command	2	B1	X31																
	DW07		DI 24VDC	SPARE			2	B2	X32																
	DW07		DI 24VDC	SPARE			2	B3	X33																
	DW07		DI 24VDC	SPARE			2	B4	X34																
	DW07		DI 24VDC	SPARE			2	B5	X35																
	DW07		DI 24VDC	SPARE			2	B6	X36																
	DW07		DI 24VDC	SPARE			2	B7	X37																
YL-100	DW07	YA-100	DO 24VDC	WELL #7 Station Alarm Light	On	Off	3	C0	Y0																
	DW07	XCH-115	DO 24VDC	WELL #7 Baski Valve Call to Open	On	Off	3	C1	Y1																
	DW07	XCL-115	DO 24VDC	WELL #7 Baski Valve Call to Close	On	Off	3	C2	Y2																
	DW07	XCL-108	DO 24VDC	WELL #7 Waste Valve Call to Close	On	Off	3	C3	Y3																
	DW07	XCH-116	DO 24VDC	WELL #7 Flush Water Solenoid Open	On	Off	3	C4	Y4																
	DW07	XC-101	DO 24VDC	WELL #7 Pump Call to Start	On	Off	3	C5	Y5																
YL-101	DW07	YI-101A	DO 24VDC	WELL #7 Pump Run Light	On	Off	3	C6	Y6																
	DW07		DO 24VDC	SPARE			3	C7	Y7																
	DW07			BLANK FILLER MODULE			4																		
LIT-100	DW07	LI-100	AI 4-20mA	WELL #7 Level	0-693	FEET	5	1	V1400																
FIT-104A	DW07	FI-104A	AI 4-20mA	WELL #7 Flowmeter Production	0-3000	GPM	5	2	V1401																
FIT-104B	DW07	FI-104B	AI 4-20mA	WELL #7 Flowmeter Recharge	0-3000	GPM	5	3	V1402																
PIT-103	DW07	PI-103	AI 4-20mA	WELL #7 Discharge Pressure	0-150	PSI	5	4	V1403																
AIT-231	DW07	AI-231	AI 4-20mA	WELL #7 CL2 Residual	0-2	PPM	6	1	V1404																

Field Tag	PLC	PLC / SCADA Tag	Type	Description	Discrete On State/ Analog Range	Discrete Off State/ Analog Eng Units	Slot	Point	PLC Address	Additional PLC Address	DYNAC RTU Name	DYNAC Address	Dynac DB Group	Dynac DB Point	Dynac Dig Dev Assign	Device Termination-Origination	Device Termination-Destination	Panel Termination-Origination	Panel Termination-Destination	Loop Drawing	Local Readout	Local HMI Address	Elementary Drawing	PID	PID Description
PIT-115	DW07	PI-115	AI 4-20mA	WELL #7 Baski Valve Pressure	0-800	PSI	6	2	V1405																
	DW07		AI 4-20mA	SPARE			6	3	V1406																
	DW07		AI 4-20mA	SPARE			6	4	V1407																
	DW07																								
	DW07	SC-201	AO 4-20ma	WELL #7 CL2 Pump #1 Speed Command	0-100	%	7	1	V7010																
	DW07	SC-202	AO 4-20ma	WELL #7 CL2 Pump #2 Speed Command	0-100	%	7	2	V7020																
	DW07		Virtual AI	WELL #7 Level	0-693	FEET			V2000		DW07	1024	1	1											
	DW07		Virtual AI	WELL #7 Flowmeter Production	0-3000	GPM			V2001		DW07	1025	1	2											
	DW07		Virtual AI	WELL #7 Flowmeter Recharge	0-3000	GPM			V2002		DW07	1026	1	3											
	DW07		Virtual AI	WELL #7 Discharge Pressure	0-150	PSI			V2003		DW07	1027	1	4											
	DW07		Virtual AI	WELL #7 CL2 Residual	0-2	PPM			V2004		DW07	1028	1	5											
	DW07		Virtual AI	WELL #7 Baski Valve Pressure	0-800	PSI			V2005		DW07	1029	1	6											
	DW07		Virtual AI	SPARE					V2006		DW07	1030	1	7											
	DW07		Virtual AI	SPARE					V2007		DW07	1031	1	8											
	DW07		Virtual AO	WELL #7 CL2 Feed Rate	0-100	%			V2010		DW07	1032	1	9											
	DW07		Virtual AO	WELL #7 CL2 Bias	0-100	%			V2011		DW07	1033	1	10											
	DW07		Virtual AO	WELL #7 CL2 Ratio	0-1	n/a			V2012		DW07	1034	1	11											
	DW07		Virtual DI	WELL #7 Pump E-Stop Alarm	Normal	Alarm			V2013-0	C100	DW07	1035-0	2	1											
	DW07		Virtual DI	WELL #7 Pump Control in Local	Local	SCADA			V2013-1	C101	DW07	1035-1	2	2											
	DW07		Virtual DI	WELL #7 Pump Control in Remote	SCADA	Local			V2013-2	C102	DW07	1035-2	2	3											
	DW07		Virtual DI	WELL #7 Pump Start Button	Start	No Command			V2013-3	C103	DW07	1035-3	2	4											
	DW07		Virtual DI	WELL #7 Pump Stop Button	Stop	No Command			V2013-4	C104	DW07	1035-4	2	5											
	DW07		Virtual DI	WELL #7 Pump Running	Running	Stopped			V2013-5	C105	DW07	1035-5	2	6											
	DW07		Virtual DI	WELL #7 Flush Water Flow Alarm	Normal	Alarm			V2013-6	C106	DW07	1035-6	2	7											
	DW07		Virtual DI	WELL #7 Waste Valve in Hand	Local	SCADA			V2013-7	C107	DW07	1035-7	2	8											
	DW07		Virtual DI	WELL #7 Waste Valve in Remote	SCADA	Local			V2013-8	C110	DW07	1035-8	2	9											
	DW07		Virtual DI	WELL #7 Waste Valve Open	Open	No Command			V2013-9	C111	DW07	1035-9	2	10											
	DW07		Virtual DI	WELL #7 Waste Valve Close	Close	No Command			V2013-10	C112	DW07	1035-10	2	11											
	DW07		Virtual DI	WELL #7 Waste Valve Position	Open	Not Open			V2013-11	C113	DW07	1035-11	2	12											
	DW07		Virtual DI	WELL #7 Waste Valve Position	Closed	Not Closed			V2013-12	C114	DW07	1035-12	2	13											
	DW07		Virtual DI	WELL #7 Flow Direction	Injection	Production			V2013-13	C115	DW07	1035-13	2	14											
	DW07		Virtual DI	Well #7 Totalizer Pulse	Count	No Count			V2013-14	C116	DW07	1035-14	2	15											
	DW07		Virtual DI	SPARE					V2013-15	C117	DW07	1035-15	2	16											
	DW07		Virtual DI	WELL #7 PLC Control Panel AC OK	Normal	Alarm			V2014-0	C120	DW07	1036-0	3	1											
	DW07		Virtual DI	WELL #7 PLC 24VDC PS #1 Alarm	Normal	Alarm			V2014-1	C121	DW07	1036-1	3	2											
	DW07		Virtual DI	WELL #7 PLC 24VDC PS #2 Alarm	Normal	Alarm			V2014-2	C122	DW07	1036-2	3	3											
	DW07		Virtual DI	WELL #7 Motor Mgmt. Failure Alarm	Normal	Alarm			V2014-3	C123	DW07	1036-3	3	4											
	DW07		Virtual DI	WELL #7 Discharge Pressure Switch	Normal	Alarm			V2014-4	C124	DW07	1036-4	3	5											
	DW07		Virtual DI	WELL #7 Hypo Tank Low Level Alarm	Normal	Alarm			V2014-5	C125	DW07	1036-5	3	6											
	DW07		Virtual DI	WELL #7 Intrusion Alarm	Normal	Alarm			V2014-6	C126	DW07	1036-6	3	7											
	DW07		Virtual DI	WELL #7 Eyewash Alarm	Normal	Alarm			V2014-7	C127	DW07	1036-7	3	8											
	DW07		Virtual DI	WELL #7 Smoke Alarm	Normal	Alarm			V2014-8	C130	DW07	1036-8	3	9											
	DW07		Virtual DI	WELL #7 PLC Alarm Reset/Ack	Acknowledged	No Command			V2014-9	C131	DW07	1036-9	3	10											
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-10	C132	DW07	1036-10	3	11											
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-11	C133	DW07	1036-11	3	12											

Field Tag	PLC	PLC / SCADA Tag	Type	Description	Discrete On State/ Analog Range	Discrete Off State/ Analog Eng Units	Slot	Point	PLC Address	Additional PLC Address	DYNAC RTU Name	DYNAC Address	Dynac DB Group	Dynac DB Point	Dynac Dig Dev Assign	Device Termination-Origination	Device Termination-Destination	Panel Termination-Origination	Panel Termination-Destination	Loop Drawing	Local Readout	Local HMI Address	Elementary Drawing	PID	PID Description
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-12	C134	DW07	1036-12	3	13											
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-13	C135	DW07	1036-13	3	14											
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-14	C136	DW07	1036-14	3	15											
	DW07		Virtual DI	RESERVE FOR PLC SCADA POINTS					V2014-15	C137	DW07	1036-15	3	16											
	DW07		Virtual DO	WELL #7 SCADA Start	Start	No Command			V2015-0	C140	DW07	1037-0	4	1											
	DW07		Virtual DO	WELL #7 SCADA Stop	Stop	No Command			V2015-1	C141	DW07	1037-1	4	2											
	DW07		Virtual DO	WELL #7 SCADA Reset	Reset	No Command			V2015-2	C142	DW07	1037-2	4	3											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-3	C143	DW07	1037-3	4	4											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-4	C144	DW07	1037-4	4	5											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-5	C145	DW07	1037-5	4	6											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-6	C146	DW07	1037-6	4	7											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-7	C147	DW07	1037-7	4	8											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-8	C150	DW07	1037-8	4	9											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-9	C151	DW07	1037-9	4	10											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-10	C152	DW07	1037-10	4	11											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-11	C153	DW07	1037-11	4	12											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-12	C154	DW07	1037-12	4	13											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-13	C155	DW07	1037-13	4	14											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-14	C156	DW07	1037-14	4	15											
	DW07		Virtual DO	RESERVE FOR PLC SCADA POINTS					V2015-15	C157	DW07	1037-15	4	16											
	DW07		Vitual AI	WELL #7 Waste Valve Timer	0-9999	Seconds			V2016		DW07	1038	5	1											
	DW07		Vitual AI	WELL #7 Production Total	0-9999	1000 GALS			V2017		DW07	1039	5	2											
	DW07		Vitual AI	WELL #7 Injection Total	0-9999	1000 GALS			V2020		DW07	1040	5	3											
	DW07		Vitual AI	WELL #7 Injection Flowrate	0-3000	GPM			V2021		DW07	1041	5	4											
	DW07		Vitual AI	WELL #7 Production Flowrate	0-3000	GPM			V2022		DW07	1042	5	5											

SECTION 17530 - PLC-BASED CONTROL SYSTEM SOFTWARE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR, through the use of an Instrumentation Supplier and electrical installers, shall furnish, supervise installation, assemble, program and place into service the PLC-based Control System specified under this Section and in Section 17520 - PLC-Based Control System Hardware, all in accordance with the requirements of the Contract Documents. The PLC programmer shall coordinate at least two meetings with the OWNER and ENGINEER to discuss program registers, I/O bundling for remote monitoring, and control strategies.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. PLC-Based Control System software reference specifications, codes, and standards shall be provided in accordance with Section 17100 - Process Control and Instrumentation Systems.

1.3 CONTRACTOR SUBMITTALS

A. **Coordination Meetings:** CONTRACTOR to schedule and facilitate Control System Coordination meetings with the OWNER and ENGINEER prior to Control System Submittal. Meeting agenda to be submitted and approved by OWNER two weeks prior to meeting. Meetings to be at City Facility or project construction trailer at job site.

B. **Software Submittals:** The PLC program submittal shall be included in a single submittal. Submit PLC program ladder logic and completed PLC I/O Point List 30 days prior to Factory Testing of PLC Control Panel.

C. **Additional Requirements:** The following items shall be submitted with the final sets of Technical Manuals required 15 days prior to the performance test.

1. All program software, both software and ladder logic, including any program revisions made during the construction period. Provide two copies of each.

2. Provide hard copy print out, in spiral bound binding, two copies, of final PLC program.

PART 2 -- PRODUCTS

2.1 PLC SOFTWARE

A. **PLC Programming Software:** All PLC programming shall be accomplished using a standard software package developed for this purpose from Automation Direct. The PLC programming software is not required to be submitted, but must be compatible with the current version of OWNER programming software.

The PLC programming software shall have the capability to generate a PLC program printout which is fully documented. Fully documented program listings shall have appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes. A fully documented listing shall also include a cross reference report of program addresses. The PLC programming software shall

be suitable for the PLC's furnished under Section 17520 - PLC-Based Control System Hardware. Each rung to have a minimum of two full lines of comments. Each address or coil shall have three lines of description including tag number and I/O description as a minimum.

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 17550 - CONTROL LOOP DESCRIPTIONS

PART 1 -- GENERAL

1.1 SUMMARY

A. PLC programming will be by the CONTRACTOR based on the provided program template these control loop descriptions and the Contract Documents. The OWNER will perform all remote SCADA database configurations.

1.2 SUBMITTALS

A. Submittals for this Section are not required. Control Logic Understanding will be discussed in Control System Coordination meetings.

1.3 SYSTEM TESTING

A. CONTRACTOR shall perform field-testing. These Control Loop Descriptions are provided as an aide to the CONTRACTOR in understanding the overall objective of each subsystem. The CONTRACTOR is responsible from the antenna and within, including all the control actions of the PLC. CONTRACTOR to coordinate with OWNER to allow witnessing of site acceptance testing. Provide 72 hour notice of field-testing, in writing, to the ENGINEER.

B. CONTRACTOR shall include work to test all shared data from PLC to OWNER SCADA system. Bid to include 8 hours to assist in testing of these points as provided in completed PLC I/O Point List.

1.4 DEFINITIONS

A. **Operator Settings:** Operator entered values will be constants that are adjustable locally from the Operator Interface display or remotely from the City's SCADA system.

B. **SCADA:** For the purposes of this specification section, SCADA refers to the portions of the software system executing remotely from the City's SCADA system.

C. **Shared Variables:** This term has been used for database points located in both the PLC and the SCADA database. All real input and output points (i.e. physical analog and discrete points connected to the PLCs, such as run status and commands, flow, chlorine residual, pressure, etc.) in the I/O database are also shared variables since they can be viewed by the SCADA system.

1.5 SOFTWARE DESCRIPTION

A. **Coordination:** CONTRACTOR shall initiate and host two (2) coordination meetings between the CONTRACTOR's integrator and the OWNER to ensure the PLC database is set-up in a manner compatible with the City's existing SCADA system. Each meeting shall last 4 hours.

B. Control Strategy 00-00 summarizes the implementation of commonly executed functions such as Motor Control and Valve Control, and is therefore not repeated in the detailed control strategies. Implement the control code using the Control Strategy 00-00 control

descriptions unless directed otherwise in the control strategy descriptions later in this specification section.

C. Program PLC control code for (work by CONTRACTOR):

1. As described in Paragraph E, entitled “PLC Controls”, for each control strategy description in Part 3 of this Section.

2. All points part of the I/O database and as shown on the P&IDs.

3. All points described in the Shared Variables sections of this specification.

4. Include points described in Control Strategy 00-00.

5. Code to follow PLC template program provided by OWNER. This program serves as a guideline only and will have to be modified.

6. Code to include at least three lines of purpose and action descriptions for each ladder rung and two lines of description for each PLC ladder logic device shown.

D. Configure database points PLC registers for the SCADA (work by CONTRACTOR):

1. All points part of the I/O database and as shown on the P&IDs.

2. All points described in the Shared Variables sections of this specification.

3. All alarms generated by the PLC.

4. Include points described in Control Strategy 00-00.

1.6 CONTROL STRATEGIES

Control Strategy Number	Control Strategy Description
00	General Control Strategy Requirements
01	Well Pump
02	Hypochlorite Storage and Metering Pumps

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

3.1 COMMON CONTROL STRATEGY REQUIREMENTS

A. **Title:** Control Strategy 00 - General Requirements.

B. **Description:** The following strategies are general descriptions to be used in each of the detailed process description when developing the control system code.

C. **Motor Control Logic:** Provide a motor control logic function or functions to execute the following in response to a motor start/stop request from the Local Control Panel or remotely from SCADA:

1. PLC Logic Description:

    a. Verify that the equipment is in the remote operating mode and that all fault conditions, pertaining to that equipment, have been cleared.

    b. When the start request is received, initiate a 'Fail to Start' Timer.

    c. Issue a start command by activating the start PLC output.

    d. When the start confirmation is received, reset the timer started in step 2 and hold the reset as long as the run confirmation signal is present.

    e. If the 'Fail to Start' timer exceeds its set point value prior to receiving the run confirmation signal, issue an 'Fail to Start' alarm and reset the run output.

2. SCADA Requirements:

    a. Provide I/O database points for start/stop requests.

    b. Provide I/O database points for "Failed to Start" and alarm so that this alarm can be displayed at the SCADA.

3. Hardwired Interlocks:

    a. Monitored Interlocks: Provide logic to monitor interlocks that cause equipment shutdowns and clear the run output for this equipment. Prevent the activation of these outputs until the fault has been cleared.

D. **Run Time Totalizers:** Provide a run time totalizer for each motor load, xxxx.x hours.

1. PLC Logic Descriptions:

    a. Use a double precision integer counter to accumulate run time.

    b. Increment the counter for every six minutes the equipment is running.

E. Each discrete alarm input shall be configured with an Engineer tunable de-bounce timer. The de-bounce timer shall initially be set to values shown in template PLC program.

3.2 WELL PUMP

A. **Title:** Control Strategy 01
P&ID: I-01

B. **Description:** With the Woodcreek North Well Pump in-service, the pump will provide up to 2700 GPM into the City's distribution system. The well pump is controlled with a reduced voltage solid-state starter and started manually at the Local Control Panel or remotely from the City SCADA system. This well site shall also serve as an injection site where water from the distribution system can be stored below ground. When in injection or recharge mode an Operator must manually open the recharge valve to allow distribution water to enter the well. The Baski valve can automatically adjust to regulate recharge flow.

Main Equipment	Description
WD34-PUMP26101	Well Pump
WD34-VALV26100	Baski Valve

C. Local Controls and Instrumentation

1. The pump includes the following Local Control Devices:

   a. Local/Remote Selector Switch.

   b. Start/Stop Pushbuttons.

   c. Emergency Stop Pushbutton.

2. Local interlocks for each pump include the following:

   a. A motor temperature switch is hardwired into the starter to shutdown the pump and prevent operation of the pump. The motor temperature switch is not wired to the PLC.

   b. A phase loss device is hardwired into the starter to shutdown the pump and prevents operation of the pump.

   c. Provide a Common Fail Alarm to the PLC from either a phase loss, power failure, or high motor temperature.

   d. A seal flush water flow switch is hardwired into the starter to shutdown the pump.

   e. Emergency Stop Pushbutton. Provide additional contact off Emergency Stop Pushbotton to alarm at the PLC.

3. Process Alarms: None.

4. Process Instruments:

   a. The pump station well water level is measured using a pressure transducer type level transmitter, or bubbler system depending on depth of well. Refer to the Contract Drawings.

   b. A bi-directional magnetic flowmeter measures well pump discharge or recharge flows depending on process flow direction.

D. SCADA Controls and Monitoring

1. Calculations: None.

2. Process Variables: Recharge mode flow rate.

3. Process Alarms: None.

4. Equipment Status, Alarms, and Controls:

SCADA Status	SCADA Alarms	SCADA Control
Well Pump Local	Well Pump Fail to Start	Well Pump Start
Well Pump Remote	Power Fail/ Phase Loss	Well Pump Stop
Well Pump Run	Seal Water Flow Switch Low	Baski Valve Open
Emergency Stop	Injection Valve Pressure Low	Baski Valve Close
Waste Valve Open	Waste Valve Fail to Open	
Waste Valve Closed	Waste Valve Fail to Close	
Recharge Flow Rate		
Baski Valve Pressure		

5. Shared Variables: Provide additional shared variables as follows:

Type (SCADA Viewpoint)	Description	Range	Units
DO	Well Pump Start		
DO	Well Pump Stop		
DO	Baski Valve Open		
DO	Baski Valve Close		

E. PLC Control

1. Local SCADA Manual: Local SCADA Manual control allows the Operator to enter a Start/Stop command from the PLC Control Panel for the Well Pump. When in Local mode, the Operator initiates a start by depressing the Pump Start pushbutton on the Control Panel. If the injection valve pressure switch is OK the Flush Water Solenoid opens and initiates a timer. The timer preset delays the start of the Well Pump to allow the Flush Water Solenoid to open and adequately flush the pump seal. Also, the Waste Valve will open. After a typical preset of two minutes, and the Waste Valve is open, the Well Pump will start. Upon start the Flush Water Solenoid will close after a second delay timer expires. If the Waste Valve fails to open, the Well Pump shall not start. The Waste Valve shall stay open for a preset time that is configurable from the Operator Interface panel or if in manual mode, will stay open for as long as desired (typically five minutes). Once the Waste Valve is closed the hypochlorite metering pump system will start. For information on the hypochlorite feed system see Control Logic below. Once started, the Well Pump will run continuously until a stop command is entered or an alarm condition occurs. When the Well Pump is called to stop, a spin down timer is initiated in the PLC, which prohibits a restart of the pump. The timer preset is adjustable from the Operator Interface panel. Alarms that shutdown the Well Pump include the hardwire interlocks listed above and injection valve pressure switch, waste valve fail to open, waste valve fail to close, and hypochlorite feed system failure. In recharge mode the PLC shall modulate the flow rate to meet an operator input setpoint, by adjusting the Baski valve pressure via the solenoids at the Baski Automatic Control Panel.

2. Remote SCADA Manual: The control strategy shall be the same as Local SCADA Manual above, except the start command and the recharge mode flow rate shall come from the City SCADA system.

3.3 HYPOCHLORITE STORAGE TANK AND METERING PUMP

A. **Title:** Control Strategy 02
P&ID: I-02

B. **Description:** There is one hypochlorite storage tank, which will be used to supply hypochlorite to the metering pump.

There are two metering pumps, which transports hypochlorite to the well pump discharge line. The control strategy will flow pace hypochlorite addition to the plant's water flow rate when in Flow Pace Mode or will pace hypochlorite addition based on chlorine residual and plant's water flow when in Residual Pace Mode.

Main Equipment	Description
WD39-TANK26203	Hypochlorite Storage Tank
WD39-PUMP26201 & 202	Hypochlorite Feed Pump

C. Local Controls and Instrumentation

1. Hypochlorite Feed Pump includes the following Local Control Devices incorporated into the pump's faceplate panel:

   a. Manual/Auto Selector Switch.

   b. Start/Stop Pushbuttons.

   c. Speed Control Knob.

2. Local Interlocks: None.

3. Process Alarm Devices: None.

4. Process Instruments: A low level switch measures the hypochlorite level in the storage tank.

D. SCADA Controls and Monitoring

1. Calculations: None.

2. Process Variables:

   a. Hypochlorite Storage Tank Low Level.

   b. Chlorine Residual.

3. Process Alarms: Residual alarm points.

4. Equipment Status, Alarms, and Controls:

SCADA Status	SCADA Alarms	SCADA Control
Hypochlorite Pump Local	Hypochlorite Pump Fail	Hypochlorite Feed Ratio Setpoint (Flow Pace)
Hypochlorite Pump Remote	Chlorine Residual Low-Low, Low	Hypochlorite Residual Setpoint (Residual Pace)
Hypochlorite Pump Run (>4mA Output by PLC)	Chlorine Residual High-High, High	Hypochlorite Feed Rate Bias

5. Shared Variables: Provide additional shared variables as follows:

Type (SCADA Viewpoint)	Description	Range	Units
AO	Hypochlorite Feed Ratio Setpoint (Dosage)	0 to 1.0	PPM
AO	Feed Rate Bias Setpoint	0 to 0.2	PPM
AO	Trim Setpoint	0 to 0.5	PPM

E. **PLC Control:** There is no manual speed setting of the metering pump when in the Auto mode. In Auto, upon the Well Pump running and the waste valve closed, the hypochlorite feed pump will start. The pump shall run as long the well pump is running. Pump speed shall be controlled by one of two selectable operating modes, Flow Pace Mode or Full Mode.

In the Flow Pace Mode, pump speed shall be controlled by the Hypochlorite Feed RATIO setpoint (dosage) entered from either the Operator Interface or remotely from the City SCADA. The Hypochlorite Feed RATIO setpoint (dosage) shall be 0.0-1.00 ppm. The RATIO setpoint can be adjusted with a Hypochlorite Feed BIAS setpoint also entered from either the Operator Interface or remotely from the City SCADA. The Hypochlorite Feed BIAS setpoint shall be 0.0-0.2 ppm.

In the Full Mode, the residual analyzer input signal shall TRIM the Flow Pace Mode calculation as defined about by +/- 50% based upon the allowed setpoint entered from either the Operator Interface or remotely from the City SCADA.

If:

"FLOW" is Well Pump Magmeter analog input flow (0-100%)
"RATIO" is requested Dosage provided by Operator Setpoint (0-1.00 ppm)
"BIAS" is requested bias provided by Operator Setpoint (0-20%)
"TRIM" is allowed output trim based on feedback from residual analyzer as requested by Operator. Based on "Setpoint – Residual", (0-0.5 ppm, equivalent to –50% to +50%)

Then, the calculation for Flow Pace Control is:

PLC Output to Hypochlorite Metering Pump (0-100%) = (FLOW) * (RATIO) + BIAS

And the calculation for Full Mode Control is:

PLC Output to Hypochlorite Metering Pump (0-100%) = (FLOW) * (RATIO) + BIAS + TRIM

PLC shall automatically alternate which metering pump operates.

3.4 MISCELLANEOUS ALARMS

A. **Intrusion Alarm:** There is an intrusion alarm based on series wired switches at each door. The intrusion alarm can be bypassed by setting a spring wound timer located on the PLC Panel.

B. **Safety Shower Alarm:** The safety shower/eyewash unit with flow switch will be connected back to the PLC for alarming.

- END OF SECTION -

Woodcreek North Pump Station Conformed Specs