Sludge Dewatering Equipment Supplier Pre-Selection Document

REQUEST FOR PROPOSAL
RFP# 10-11-07
CITY OF VISALIA
STATE OF CALIFORNIA

Request for Proposal (RFP) 10-11-07
Furnishing Sludge Dewatering Equipment
for the City of Visalia Water Conservation Plant (WCP) Upgrades

SEALED PROPOSALS will be received by the Purchasing Division located at 707 West Acequia, Visalia, CA 93291, until 3:00 P.M. Pacific Standard Time, on Friday, September 03, 2010 for:

Sludge Dewatering Equipment

Contract documents may be inspected and obtained in the office of the Purchasing Division, 707 W. Acequia Ave., Visalia, California 93291 or by calling (559) 713-4334, or by FAX (559) 713-4802 or may be downloaded via the web site http://www.visaliapurchasing.org.

The City also hereby affirmatively ensures that Minority Business Enterprises and Disadvantaged Business Enterprises (DBE) shall have the maximum opportunity to participate in the performance of contracts. As such, Disadvantaged Business Enterprises (DBEs) will be afforded full opportunity to submit proposals in response to this notice and will not be discriminated against on the basis of race, color, national origin, ancestry, disability, gender or religion in any consideration leading to the award of contract.

No qualified disabled person shall, on the basis of disability, be excluded from participating in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity leading to the award of a contract.

The right is reserved by the City of Visalia to reject any or all proposals, to waive any irregularities or informalities not affected by law, to evaluate the proposals submitted and to award the contract according to the proposal which best serves the interests of said City.

Publication Dates: July 30, 2010
Aug 4, 2010
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SECTION 1 - SUBMISSION INFORMATION

1.1 INTRODUCTION: The CITY of Visalia, hereinafter referred to as the “CITY”, is upgrading its Water Conservation Plant (WCP) under a project entitled “Visalia WCP Upgrades”, hereinafter referred to as the “PROJECT”. The PROJECT is currently being designed by Parsons Water Infrastructure, Inc., hereinafter referred to as the “ENGINEER”. The PROJECT will include a system for dewatering of anaerobically digested sludge. The CITY is now inviting qualified manufacturers, hereinafter referred to as the “EQUIPMENT SUPPLIER”, to submit proposals for furnishing the equipment for the sludge dewatering system meeting the requirements set forth herein.

1.2 PROPOSAL DEADLINE: Proposals will be received in the office of the CITY at 707 WEST ACEQUIA AVENUE, VISALIA, CA 93291, no later than the date and time indicated below.

Proposal Deadline: 3:00 p.m. Pacific Standard Time, on Friday, September 3, 2010

1.3 INQUIRIES: Inquiries regarding this solicitation should be directed to Purchasing Division, CITY of Visalia, 707 WEST ACEQUIA AVENUE VISALIA, CA 93291, (559) 713-4334, purchasing@ci.visalia.ca.us. All questions must be received on or before Thursday, August 19, 2010.

1.4 PROPOSAL LABELING: The proposal shall be submitted in a sealed envelope with original pages intact. Proposal envelopes must be plainly marked and submitted as follows:

CITY OF VISALIA
PURCHASING DIVISION
707 WEST ACEQUIA AVENUE
VISALIA, CA 93291

Attention: Sludge Dewatering Equipment Pre-Selection

1.5 PROPOSAL SUBMITTAL: Proposals to be considered shall be for a sludge dewatering system that uses either screw presses or rotary presses as specified in Section 5 – Technical Specifications. Proposals for systems that use other types of sludge dewatering equipment will be rejected.

All EQUIPMENT SUPPLIERS shall complete and return one (1) original and six (6) copies and one electronic copy (PDF format) of their proposal to the address specified under section 1.4. All proposals delivered in an express courier package shall be sealed in a separate envelope within the courier package. Any proposal found to be illegible or incomplete may
be rejected. Whether sent by courier, mail, or by means of personal delivery, EQUIPMENT SUPPLIERS assume full responsibility for having their proposal deposited at the proper address and not later than the scheduled closing time. Oral, telegraphic, or telephonic proposals or modifications will not be considered. More than one (1) proposal from an individual, firm, partnership, or corporation under the same or different names, will not be considered.

1.6 BID BOND:

Each proposal must be accompanied by Bid Bond made payable to CITY OF VISALIA in the amount of TEN PERCENT (10%) of the EQUIPMENT SUPPLIER’S proposed price (Section 4, Bidding Schedule, Item A) and in the form of a certified cashier’s check or a Surety Bid Bond (on form provided).

The Bid Bond of the EQUIPMENT SUPPLIER shall be retained by the CITY OF VISALIA until such time that the EQUIPMENT SUPPLIER enters into a purchase agreement with GENERAL CONTRACTOR selected under separate procurement.

Bid Bonds for unsuccessful proposers shall be released once the City Council authorizes the award of this RFP to the EQUIPMENT SUPPLIER. This process generally takes approximately two months from the RFP closing date.
SECTION 2 - GENERAL INFORMATION

NOTE: IT IS THE EQUIPMENT SUPPLIER'S RESPONSIBILITY TO EXAMINE THE REQUEST FOR PROPOSAL AND ANY SUBSEQUENT ADDENDA IN ENTIRETY PRIOR TO SUBMITTING A PROPOSAL.

2.1 WAITING PERIOD: It is the CITY’s intent to pre-select the sludge dewatering equipment for developing the design of the PROJECT. The sludge dewatering equipment will not be purchased by the CITY, but will be purchased by the GENERAL CONTRACTOR, to be selected by the CITY for the construction of the PROJECT, at the bid/pre-negotiated price from the EQUIPMENT SUPPLIER. The bid/pre-negotiated price shall be effective until 11/30/2011. The EQUIPMENT SUPPLIER shall provide a cost escalation factor or formula in the event the equipment is not ordered by the GENERAL CONTRACTOR by 11/30/2011. The GENERAL CONTRACTOR is expected to be on-board around September 2011.

2.2 PROPOSAL PREPARATION COSTS: The CITY is not, nor shall be deemed liable for any costs incurred by EQUIPMENT SUPPLIERs in the preparation, submission, or presentation of their proposals.

2.3 PROPOSAL INCLUSIONS: The Request for Proposal documents shall be returned in their entirety, with all applicable portions fully completed by the EQUIPMENT SUPPLIER. Supplementary sheets can be attached if necessary. All EQUIPMENT SUPPLIERs are required to review and confirm that their proposal specifically addresses each of the following proposal requirements prior to submitting.

- Bid Bond
- Bidding Schedule
- EQUIPMENT SUPPLIER Identification Form
- References Form
- Workers’ Compensation Certificate
- Non-Collusion Affidavit
- Exception Form
- Technical Portion of Proposal
- Duly signed copies of all addenda received

In the technical portion of the proposal, the EQUIPMENT SUPPLIER shall provide drawings showing the arrangement of the sludge dewatering equipment with sufficient details for the Engineer to incorporate the proposed equipment into the design of the sludge dewatering system. Material descriptions, including references to appropriate ASTM or other nationally recognized standards, for all major components of the proposed system shall also be provided with the bid. The entire Proposal document shall
be included with each submitted copy of the proposal as well as with the original proposal.

2.4 WITHDRAWAL OF PROPOSAL BEFORE CLOSING: Any EQUIPMENT SUPPLIER may request the withdrawal of their submitted proposal, either in person, by telephone, or written request, at any time prior to the scheduled closing date and time. Upon receiving the written request to withdraw any proposal, the CITY will consider the EQUIPMENT SUPPLIER's proposal null and void, and return the proposal to the EQUIPMENT SUPPLIER unopened.

2.5 MISTAKE IN PROPOSAL: Any EQUIPMENT SUPPLIER may withdraw their proposal after the proposal opening only if the EQUIPMENT SUPPLIER can establish to the CITY's satisfaction that a mistake was made in preparing the proposal.

An EQUIPMENT SUPPLIER declaring a mistake must give a written notice to the CITY within five (5) calendar days following the scheduled closing date, specifying in detail, how the mistake occurred, and how the mistake made the proposal materially different than it was intended.

Withdrawal of the proposal shall only be permitted for mistakes made in the completion of the proposal. An EQUIPMENT SUPPLIER who claims a mistake shall be PROHIBITED from participating in further bidding on the project in which the mistake in proposal was claimed. (Public Contract Code 5105).

2.6 PROPOSAL ACCEPTANCE: The CITY reserves the right to accept or reject any or all proposals, or waive any informality in any proposal in the best interest of the CITY.

2.7 INTERPRETATION OF DOCUMENTS: Should an EQUIPMENT SUPPLIER find discrepancies or omissions in the specifications or Request for Proposal, or should the EQUIPMENT SUPPLIER be in doubt as to their interpretation, the EQUIPMENT SUPPLIER shall contact the person indicated in Section 1.3, above. Should it be found necessary, a written addendum will be made available to all known EQUIPMENT SUPPLIERS. Any addenda issued prior to the scheduled proposal closing date and time, shall form a part of this solicitation and shall become a part of the submitted proposal.

2.8 PROPOSAL PRICE: The proposal prices shall be indicated on the Bidding Schedule provided in this Request for Proposal, for providing all equipment and services as required in Section 5. In case of any inconsistencies in the Bid Prices between words and figures, the Bid Price(s) in words shall prevail.
2.9 **REFERENCES**: The EQUIPMENT SUPPLIER shall provide a list of references for at least five (5) operating sludge dewatering systems in the United States or Canada (form provided) for which the EQUIPMENT SUPPLIER has provided equipment and services that are similar to the Work of this proposal, within the last five (5) years. Of those installations, at least two must be used for dewatering of anaerobically digested sludge. Include the reference name, contact person(s), facility size, year installed, project address, and telephone number(s) and any other pertinent information.

2.10 **AWARD/SELECTION CRITERIA**: The CITY intends to make an award to one (1) EQUIPMENT SUPPLIER, based on the EQUIPMENT SUPPLIER’s proposal that best serves the interest of the CITY. The following criteria will be used in the rating process for the selection of one (1) EQUIPMENT SUPPLIER to provide all required equipment and services.

- Proposed price to provide the required equipment and services to the CITY via the GENERAL CONTRACTOR.
- Percent of sludge solids captured by the dewatering equipment and percent of sludge solids content in the sludge cake produced by the dewatering equipment.
- Polymer quantity and cost required for sludge conditioning
- Life cycle cost analysis of polymer costs required for sludge conditioning based on 20 years, interest rate of 5%, escalation rate of 4%. The corresponding present worth factor is 18.12.
- Equipment maintenance requirements and parts replacement costs
- Sensitivity analysis accounting for escalation in unit power and polymer costs over time.
- Completeness of proposal, specifically addressing each item as noted in this Request For Proposal
- EQUIPMENT SUPPLIER resources and ability to deliver all equipment to the GENERAL CONTRACTOR, according to the GENERAL CONTRACTOR’S schedule.
- Record of performance and level of satisfaction from customers who received identical equipment in the past for similar applications
- Ability of EQUIPMENT to conform to existing staffing levels at the facility

All of the above factors will be considered as determined to be appropriate by the CITY / ENGINEER (not necessarily equal weight). Additionally, 5 percentage points (Local
Preference Points) will be given to any Proposer who has an established business address in the County of Tulare.

2.11 **LIENS AND STOP PAYMENT NOTICES:** The EQUIPMENT SUPPLIER shall pay all sums of money that become due from any labor, services, materials or equipment furnished to EQUIPMENT SUPPLIER on account of said equipment or services to be furnished as a result of this Request For Proposal, and that may be secured by any lien or stop payment notice against the CITY. The EQUIPMENT SUPPLIER shall fully discharge each such lien or stop payment notice at the time performance of the obligation secured matures and becomes due.

2.12 **SHOP DRAWING SUBMITTAL:** In addition to the technical information to be submitted with this equipment proposal, the selected EQUIPMENT SUPPLIER shall submit detailed shop drawings for the CITY’s review during construction of the PROJECT. Shop drawing submittal requirements are specified in the technical specifications of Section 5. The required shop drawings shall be submitted through the GENERAL CONTRACTOR to the CITY prior to commencement of equipment fabrication. A minimum of 8 copies of the shop drawings shall be submitted. The CITY will review each shop drawing submittal, and return the submittal to the GENERAL CONTRACTOR with the CITY’s review comments within thirty (30) calendar days after receipt of the submittal. Shop drawings shall be revised and resubmitted if directed by the CITY and/or the Engineer.

The quality and completeness of the shop drawings shall be such that no more than two submittals (initial submittal plus one re-submittal) are required. For additional submittals beyond this, the EQUIPMENT SUPPLIER shall reimburse the CITY the cost of handling and Engineer’s reviews.

2.13 **COORDINATION WITH GENERAL CONTRACTOR:** The CITY will be contracting with the GENERAL CONTRACTOR for the purchase, at the bid/pre-negotiated price, and installation of the sludge dewatering system. The EQUIPMENT SUPPLIER shall coordinate with the GENERAL CONTRACTOR.

1. **GENERAL CONTRACTOR Responsibility.** The GENERAL CONTRACTOR will be responsible for purchasing, arranging delivery of, unloading, storing, and protecting the sludge dewatering equipment; installation and overall testing.

2. **EQUIPMENT SUPPLIER’s Responsibility.** The EQUIPMENT SUPPLIER shall provide all shop drawings, including revisions thereto and deliver, freight and taxes paid, all approved equipment to the GENERAL CONTRACTOR at the Visalia WCP, instruct the GENERAL CONTRACTOR for the initial unloading and protection of the equipment, certify the installation for initial start-ups, assist in the field testing of
the equipment, submit operation and maintenance manuals and provide training of the CITY’s personnel. EQUIPMENT SUPPLIER shall provide the GENERAL CONTRACTOR with all instructions required for proper installation, testing and start-up, and participate in testing and startup as specified in these pre-selection documents.

3. EQUIPMENT SUPPLIER will be paid by the GENERAL CONTRACTOR at the bid/pre-negotiated price and payment terms.
SECTION 3 – PROJECT DESCRIPTION

3.1 GENERAL PROJECT INFORMATION:

The Visalia WCP is located at 7579 Ave 288, Visalia, CA 93277. The plant is currently providing the received wastewater with primary treatment by a sedimentation process and secondary treatment by a coupled trickling filters/activated sludge process. The sludge generated by these processes is stabilized by an anaerobic digestion process prior to discharge to the plant’s existing sludge drying beds. While the plant has a permitted capacity of 20 mgd, the current average wastewater flow to the plant is about 13 mgd.

The Visalia WCP Upgrades PROJECT is being designed to upgrade the plant facilities for a design capacity of 22 mgd with provisions for future expansion to 26 mgd. Among other features, the PROJECT will decommission the existing trickling filters and convert the existing activated sludge facilities to a new membrane bioreactor (MBR) process. The existing anaerobic digesters will also be upgraded to process the sludge from the existing primary sedimentation basins and thickened waste active sludge from the MBR process.

Digested sludge will be withdrawn from the anaerobic digesters and delivered to the dewatering presses by the sludge pumping equipment. Polymer will be added to condition the digested sludge prior to dewatering. The dewatered sludge cake from the presses will be transported by a screw conveyor system to the sludge cake storage bins. The sludge dewatering system will be operating continuously for 24 hours per day and 7 days per week as long as digested sludge is available for dewatering.

3.2 ENVIRONMENTAL CONDITIONS: The sludge dewatering presses will be installed in an outdoor area of the treatment plant where the ambient temperature may vary from 30 degrees F. to 120 degrees F. The system’s polymer feed equipment, electrical and control panels, however, will be installed inside an air conditioned masonry building.

3.3 SLUDGE DEWATERING EQUIPMENT: The sludge dewatering equipment to be furnished by the EQUIPMENT SUPPLIER shall be the sludge dewatering presses, control instrumentation and electrical panels, and appurtenances as specified in the technical specifications provided in Section 5. Number of units to be furnished, size and capacity of each unit, level of performance and maintenance requirements shall meet all of the requirements set forth in Section 5 and the applicable portions of the supplemental technical specifications provided in the Appendix of these pre-selection documents. All equipment to be furnished shall be capable of continuous operation under the environmental conditions specified above.
SECTION 4 - FORMS

BIDDING SCHEDULE

(Attach Power of Attorney, which authorizes the signatory to commit the company to the terms of this offering. The power of attorney should be signed by a duly authorized company officer and notarized.)

A. LUMP SUM GRAND TOTAL FOR ALL MATERIALS AND SERVICES FOR THE SLUDGE DEWATERING PRESSES AND APPURTENANCES DESCRIBED IN THESE PRE-SELECTION DOCUMENTS:

$ ____________________

________________________________________________________________________

(Lump Sum Grand Total in Words)

B. COST ESCALATION RATE TO BE USED IN THE EVENT THE GENERAL CONTRACTOR FAILS TO ORDER THE EQUIPMENT BY NOVEMBER 30, 2011.

$____________ per month

________________________________________________________________________

(Escalation Rate in Words)

C. LUMP SUM PRICE FOR THE OPTIONAL EXTENDED MAINTENANCE SERVICE PROGRAM SPECIFIED IN PARAGRAPH 5.3.4 OF SECTION 5, IF ACCEPTED BY THE CITY:

$____________________

________________________________________________________________________

(Lump Sum Price in Words)

NOTE: All prices quoted above in Items A and B shall include, as applicable, costs of packaging, applicable insurance and freight for all equipment and materials to the jobsite in Visalia, CA. All applicable taxes, including sales tax at the rate of 9 percent, shall also be included in the lump sum price.
EQUIPMENT SUPPLIER IDENTIFICATION

1. Legal name of Supplier: __________________________________________

2. Street Address: __________________________________________

3. Mailing Address: __________________________________________

4. Business Telephone: _________________________________________

5. Facsimile Telephone: _________________________________________

6. Type of Business:
   □ Sole Proprietor    □ Partnership    □ Corporation
   Other __________________________________________
   If corporation, indicate State where incorporated:
   __________________________________________

7. Business License number issued by the city where the SUPPLIER’S principal place of business is located.
   Number: _____________  Issuing CITY: _______________________

8. Federal Tax Identification Number: _____________________________

9. SUPPLIER’S PROJECT Manager: ________________________________
REFERENCES

Provide at least five (5) references for which equipment of similar type and services have been provided within the last five (5) years in the United States of America or Canada. Attach supplemental sheets, as necessary, to provide project descriptions and/or any unique features of the project(s), which the EQUIPMENT SUPPLIER believes to be important and should be considered. Applications to dewatering municipal sludge (primary and secondary sludge) are required and at least two applications must be specifically for dewatering of anaerobically digested sludge.

<table>
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<th>Client</th>
<th>Size of Facility</th>
<th>Year Commissioned</th>
<th>% Solids in Dewatered Sludge Cake</th>
<th>City</th>
<th>Contact Person Name and Phone Number</th>
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WORKERS' COMPENSATION CERTIFICATE

The EQUIPMENT SUPPLIER shall execute the following form as required by the California Labor Code, Sections 1860 and 1861:

I am aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and on behalf of my firm, I will comply with such provisions before commencing the performance of the work of any contract entered into.

__________________________  ______________________________
Signature  Company Name

__________________________  ______________________________
Printed Name  Supplier License Number

__________________________  ______________________________
Title  Date
"NON-COLLUSION AFFIDAVIT TO BE EXECUTED BY BIDDER AND SUBMITTED WITH PROPOSAL"
(The form can be applied to other states as needed)

State of California )
) ss.
County of ____________________ )

____________________ (name), being first duly sworn, deposes and says that he or she is ____________________ (title), of ____________________ the party making the foregoing proposal that the proposal is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the proposal is genuine and not collusive or sham; that the has not directly or indirectly solicited any other EQUIPMENT SUPPLIER to put in a false or sham proposal, and has not directly or indirectly colluded, conspired, connived, or agreed with any EQUIPMENT SUPPLIER or anyone else to put in a sham proposal, or that anyone shall refrain from bidding; that the EQUIPMENT SUPPLIER has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the proposal price or the EQUIPMENT SUPPLIER or any other EQUIPMENT SUPPLIER, or to fix any overhead, profit, or cost element of the proposal price, or of that of any other EQUIPMENT SUPPLIER, 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 proposal are true; and, further, that the EQUIPMENT SUPPLIER has not, directly or indirectly, submitted his or her proposal 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, proposal depository, or to any member or agent thereof to effectuate a collusive or sham proposal.

____________________
Signature

____________________
Company Name

____________________
Printed Name

____________________
Supplier License Number

____________________
Title

____________________
Date

Visalia Water Conservation
Plant Upgrades
July 2010
Sludge Dewatering Equipment
Pre-selection
SURETY BID BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, _______________________________________

(Full name or legal title of EQUIPMENT SUPPLIER)

as EQUIPMENT SUPPLIER, hereinafter called Principal, and ____________________________

__________________________________________________________

(Name of bonding company)

as Surety, hereinafter called Surety, a corporation authorized to transact business as a Surety in the State of California, are held and firmly bound unto the CITY OF VISALIA, hereinafter called "CITY", in the penal sum of ________________________ DOLLARS ($__________________), lawful money of the United States of America, not less than TEN PERCENT (10%) of the Proposal Price (Section 4, Bidding Schedule, Item A for the sludge dewatering presses), for the payment of which sum well and truly to be made, the said Principal and the said Surety bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS:

The Principal has submitted a proposal to said CITY to perform all work required for the CITY’s Sludge Dewatering System.

NOW THEREFORE:

The condition of this obligation is such that if the CITY does not select the Principal, or in the alternate, selects said Principal to furnish the goods and services represented by this Request For Proposals, and said Principal enters into a purchase agreement with GENERAL CONTRACTOR selected under a separate procurement, then this obligation shall be null and void, otherwise to remain in full force and effect.

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

Signed this ______ day of __________________ , 20__ .

Principal

By: ______________________________

Its ______________________

Surety

By: ______________________________

Its Attorney-in-Fact

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

Visalia Water Conservation

Plant Upgrades

Sludge Dewatering Equipment Page 4-7 Forms

Pre-selection

July 2010
EXCEPTION FORM

Should your firm take exception to ANY of the terms and conditions or other contents provided in the Request for Proposal, submit the following form with your proposal. If no exception(s) are taken, enter "NONE" for the first item. Make additional copies of this form if necessary.

Please note that these exceptions do not mitigate the responsibility of the EQUIPMENT SUPPLIER, in any way, whatsoever, on performance, equipment quality and maintainability.

Page Number: _____   Section Title: ________________________________

Paragraph Number: _____   Exception Taken: ____________________________

Page Number: _____   Section Title: ________________________________

Paragraph Number: _____   Exception Taken: ____________________________

Page Number: _____   Section Title: ________________________________

Paragraph Number: _____   Exception Taken: ____________________________

Page Number: _____   Section Title: ________________________________

Paragraph Number: _____   Exception Taken: ____________________________

Page Number: _____   Section Title: ________________________________

Paragraph Number: _____   Exception Taken: ____________________________
This Agreement, entered into and effective this _____ day of ____________, 2010 ["Effective Date"], by and between the City of Visalia, hereinafter referred to as the “CITY”, and __________________________ hereinafter referred to as the “EQUIPMENT SUPPLIER”, “BIDDER”, or “SUBRECIPIENT”.

REWITALS

WHEREAS, EQUIPMENT SUPPLIER is a _____________________ (type of business) with a primary business address of _____________________________________________ and Tax ID Number or Employer ID Number of : ____________________; and

WHEREAS, CITY is a municipal corporation and Charter Law City; and

WHEREAS, CITY desires to pre-select EQUIPMENT SUPPLIER and guarantee pricing of Sludge Dewatering Equipment for the City’s Water Conservation Plant Upgrade Project, which was let to bid in July, 2010 as evidenced by RFP No. 10-11-07 (the Sludge Dewatering Equipment Pre-Selection Document for Water Conservation Plant in Visalia, CA); and

WHEREAS, City of Visalia reviewed and evaluated responses to the Request for Proposals and determined that EQUIPMENT SUPPLIER shall be the supplier of said equipment and shall furnish Sludge Dewatering Equipment per specifications of RFP-10-11-07 upon order of the City’s General Contractor; and

WHEREAS, EQUIPMENT SUPPLIER represents it is licensed, qualified and willing to supply the equipment to the CITY’s GENERAL CONTRACTOR pursuant to terms and conditions of this Agreement; and

WHEREAS, EQUIPMENT SUPPLIER has supplied to the CITY, a surety bond in the amount of 10% of the total Equipment Price as specified in RFP-10-11-07. This surety bond shall remain in full force and effect until such time as the Equipment Supplier and the City’s General Contractor enter into a Purchase Agreement.

NOW, THEREFORE, CITY and EQUIPMENT SUPPLIER agree as follows:

1. TERM:
The term of this Agreement shall commence on the Effective Date and expire upon completion of all obligations of the parties, unless earlier terminated by the parties. The indemnification and defense provisions shall survive expiration and termination. Suspension or termination of this Agreement may occur if EQUIPMENT SUPPLIER materially fails to comply with any term of the award. Additionally, this Agreement may be terminated for convenience. In the event of
termination or expiration of this Agreement, the Equipment Supplier shall transfer to CITY any funds and/or accounts receivable on hand attributable to the use of CITY funds.

2. ATTACHMENTS INCORPORATED:
The following are attachments for this Agreement. Said attachments are incorporated into this Agreement as if included in full in the body:

<table>
<thead>
<tr>
<th>ATTACHMENT NO.</th>
<th>DESCRIPTION OF ATTACHMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment 1</td>
<td>General Contract Provisions</td>
</tr>
<tr>
<td>Attachment 2</td>
<td>Insurance Requirements</td>
</tr>
<tr>
<td>Attachment 3</td>
<td>City of Visalia RFP 10-11-07, Furnishing Sludge Dewatering Equipment for City of Visalia’s Water Conservation Plant Upgrades</td>
</tr>
<tr>
<td>Attachment 4</td>
<td>EQUIPMENT SUPPLIER’s proposal in response to RFP-10-11-07</td>
</tr>
</tbody>
</table>

3. EQUIPMENT SCOPE OF SERVICES and COMMITMENTS*:
CONTRACTOR shall provide the following services:

Furnish Sludge Dewatering Equipment per all specifications of: RFP 10-11-07 including any Addenda.

4. CITY COMMITMENTS:
CITY shall perform the following tasks on or before the stated completion dates:

<table>
<thead>
<tr>
<th>TASK</th>
<th>COMPLETION DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare Project Construction Documents to specifying Equipment Proposed by EQUIPMENT SUPPLIER per specifications of RFP-10-11-07</td>
<td>Time of Construction Bid</td>
</tr>
</tbody>
</table>

5. COMPENSATION:
EQUIPMENT SUPPLIER shall be paid compensation for services by the City’s GENERAL CONTRACTOR. Such sum shall be expended and paid on a reimbursement basis as outlined in Section 5.3.5 “Payment” of RFP-10-11-07.

<table>
<thead>
<tr>
<th>Total Compensation:</th>
<th>$ Not to exceed EQUIPMENT SUPPLIER’s Stated Bid Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Funds:</td>
<td>Local Revenues (Wastewater)</td>
</tr>
<tr>
<td>Payment Schedule:</td>
<td>As referenced in RFP-10-11-07</td>
</tr>
</tbody>
</table>

IN WITNESS WHEREOF, this Agreement is executed on the day and year first above written.

CONTRACTOR

Dated: ________________ By: ________________________________
Authorized Officer: I certify under penalty of perjury under the laws of the State of California that I am fully authorized to execute this Agreement for CONTRACTOR in the capacity I have stated, and that such execution is sufficient to bind the CONTRACTOR.

Visalia Water Conservation Plant Upgrades July 2010
Sludge Dewatering Equipment Page 4-10 Forms
Pre-selection
Sample Contract Attachment 1
GENERAL CONTRACT PROVISIONS

A. **Successors and Assigns:** This Agreement shall be binding upon and shall inure to the benefit of any successors to or assigns of the parties.

B. **Prohibition of Assignment:** Neither party shall assign, delegate or transfer their rights and duties in this Agreement without the written consent of the other party.

C. **Notices:** Notice shall be sufficient hereunder if personally served upon the City Clerk of the CITY or an officer or principal of the EQUIPMENT SUPPLIER (also referred to as CONTRACTOR), or if sent via the United States Postal Service, postage prepaid, addressed as follows:

CITY OF VISALIA  
707 W. Acequia Ave.  
Visalia, CA 93291  
Attention: City Clerk

CONTRACTOR  
_____________________

D. **Independent Contractor:** It is understood and agreed by the parties herein that CONTRACTOR, in the performance of this Agreement, shall act as an independent contractor, and therefore shall obtain no rights to any fringe benefits that accrue to regular full-time CITY employees.

E. **Jurisdiction/Venue/Waiver Of Removal:** This Agreement shall be administered and interpreted under the laws of the State of California. Jurisdiction of litigation arising from this Agreement shall be in California. Any action brought to interpret or enforce this Agreement, or any of the terms or conditions hereof, shall be brought in Tulare County, California. The CONTRACTOR hereby expressly waives any right to remove any action to a county other than Tulare County as permitted pursuant to Section 394 of the California Code of Civil Procedure.

F. **Integration/Modification:** This Agreement and each of the documents and exhibits or attachments referenced herein, which are incorporated by reference, represents the entire understanding of the parties as to those matters contained herein. No prior oral or written understanding shall be of any force or effect with respect to those matters covered hereunder. This Agreement may not be modified or altered except in writing signed by the parties, unless otherwise explicitly authorized.

G. **Conflict With Law:** If any part of this Agreement is found to be in conflict with applicable laws, such part shall be inoperative, null and void insofar as it is in conflict with said law, but the remainder of the Agreement shall be in full force and effect.

H. **Indemnification:** The CONTRACTOR waives any and all claims and recourse against the CITY, including the right of contribution of loss or damage to person or property arising from, growing out of, or in any way connected with or incidental to the CONTRACTOR’s performance of this Agreement, except claims arising from the concurrent or sole negligence of the CITY or its officers, agents or employees. The CONTRACTOR will indemnify, hold harmless, and defend (at CITY’s option) the CITY...
against any and all claims, demands, damages, costs, expenses, or liability arising out of the CONTRACTOR’s performance of this Agreement except for liability arising out of the concurrent or sole negligence of the CITY or its officers, agents, or employees.

I. **Guarantees and Warranties:**

1. **IN GENERAL:** All guarantees and warranties specifically called for by the specifications and/or this Agreement shall expressly run to the benefit of the CITY.

2. **GUARANTEE:** Besides guarantees required elsewhere, CONTRACTOR shall and hereby does guarantee the project work for a period of two (2) years after the date of acceptance by CITY.

3. **WARRANTIES:** Warranties required by the Invitation to Bid or this Agreement shall commence on the date of acceptance of the work by CITY. Standard Manufacturer’s Warranty shall apply to materials used.

CONTRACTOR warrants that the materials and equipment furnished under the Agreement will be new and of recent manufacture unless otherwise specified, and that all work will be of good quality, free from faults and defects, and in conformance with the Agreement. Work that does not conform may be considered defective. This warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the CONTRACTOR, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.

CONTRACTOR warrants that title to all work covered by an application for payment will pass to the CITY either by incorporation in the construction or upon the receipt of payment by the CONTRACTOR, whichever occurs first, free and clear of all liens.

CONTRACTOR warrants and guarantees that title to all work, materials, and equipment covered by any application for payment, whether incorporated in the project or not, will pass to CITY no later than the time of payment free and clear of all liens.

No materials or supplies for the project shall be purchased by the CONTRACTOR or SUBCONTRACTOR subject to any mortgage or under a condition of sale contract or other agreement by which an interest is retained by the seller. CONTRACTOR warrants that it has good title to all materials and supplies used by it in the project, free from all liens.

CONTRACTOR shall indemnify and hold CITY harmless from all claims growing out of the lawful demands of SUBCONTRACTORS, laborers, workers, mechanics, material persons, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, incurred in furtherance of the performance of this Agreement. CONTRACTOR shall, at CITY’s request, furnish satisfactory evidence that all obligations of the nature here and above designated have been paid, discharged, or waived. If CONTRACTOR fails to do so, then CITY may, after having served written notice on the CONTRACTOR, either pay directly unpaid bills, of which the CITY has written notice, or withhold from the CONTRACTOR’s unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged where upon payment to the CONTRACTOR shall be resumed, in accordance of the terms of this Agreement, but in no event shall the
provisions of this sentence be construed to impose any obligations on the CITY to either the CONTRACTOR or its surety. In paying any unpaid bills of the CONTRACTOR, the CITY shall be deemed the agent of the CONTRACTOR and any payment so made by the CITY shall be considered as payment made under the contract by the CITY to the CONTRACTOR and the CITY shall not be liable to the CONTRACTOR for any such payments made in good faith.

Any defective work that is either corrected or replaced shall be warrantied and guaranteed for a period of one year from the date of such correction or replacement.

J. **Attorney’s Fees:** In the event either party commences any action, arbitration or legal proceedings for the enforcement of this Agreement, the prevailing party, as determined by the court or arbitrator, shall be entitled to recovery of its attorney’s fees and court costs incurred in the action brought thereon.

K. **Headings:** Section headings are provided for organizational purposes only and do not in any manner affect the scope or intent of the provisions thereunder.
INSURANCE REQUIREMENTS

1. **CONTRACTOR Insurance.** EQUIPMENT SUPPLIER (referred to herein as CONTRACTOR), at its sole cost and expense, for the full term of this Agreement (and any extensions thereof), shall obtain and maintain at a minimum compliance with all of the following insurance coverage(s) and requirements. Such insurance coverage shall be primary coverage as respects CITY and any insurance or self-insurance maintained by CITY shall be in excess of CONTRACTOR’s insurance coverage and shall not contribute to it.

2. **Subcontractor(s)’ Insurance.** If CONTRACTOR utilizes one or more subcontractors in the performance of this Agreement, CONTRACTOR shall obtain and maintain independent insurance as to each subcontractor or otherwise provide evidence of insurance coverage for each subcontractor equivalent to that required of CONTRACTOR in this Agreement.

3. **Types of Insurance and Minimum Limits.** The following types of insurance and minimum limits are required providing at least the following minimum coverage and limits of liability:
   a. **Worker’s Compensation** written in accordance with the laws of the State of California providing coverage for any and all employees of CONTRACTOR in the minimum statutorily required coverage amounts;
   b. **Automobile Liability Insurance** for each of CONTRACTOR’s vehicles used in the performance of this Agreement, including owned, non-owned (e.g. owned by CONTRACTOR’s employees or contractors), leased or hired vehicles, in the minimum amount of $1,000,000 combined single limit per occurrence for bodily injury and property damage.
   c. **Comprehensive or Commercial General Liability Insurance** coverage in the minimum amount of $1,000,000 combined single limit, including coverage for:
      (1) bodily injury;
      (2) personal injury;
      (3) broad form property damage;
      (4) contractual liability;
      (5) cross-liability;
      (6) products and completed operations liability

4. **Other Insurance Provisions.** If any insurance coverage required in this Agreement is provided on a “Claims Made” rather than “Occurrence” form, CONTRACTOR agrees to maintain the required coverage for a period of three (3) years after the expiration of this Agreement (hereinafter “post agreement coverage”) and any extensions thereof. CONTRACTOR may maintain the required post agreement coverage by renewal or purchase of prior acts or tail coverage. This provision is contingent upon post agreement coverage being both available and reasonably affordable in relation to the coverage provided during the term of this Agreement. For purposes of interpreting this requirement, a cost not exceeding 100% of the last annual policy premium during the term of
this Agreement in order to purchase prior acts or tail coverage for post agreement coverage shall be deemed to be reasonable.

5. **Endorsements.**
   All required Automobile and Comprehensive or Commercial General Liability Insurance shall be endorsed to contain the following clauses:

   a. The City of Visalia, its officers, agents, employees, representatives, and volunteers are added as additional insureds as respects operations and activities of, or on behalf of the named insured, performed under contract with the City of Visalia.

   b. It is agreed that any insurance maintained by the City of Visalia shall apply in excess of and not contribute with insurance provided by this policy.

   c. This insurance shall not be canceled, limited in scope or coverage, or non-renewed until after thirty (30) days prior written notice has been given to the City Clerk, City of Visalia, 707 W. Acequia, Visalia, CA, 93291

6. **Proof of Coverage.**
   CONTRACTOR agrees to provide its insurance broker(s) with a full copy of these insurance provisions and provide CITY on or before the effective date of this Agreement with Certificate(s) of Insurance for all required coverages. Copies of all the required Endorsements shall be attached to the Certificate(s) of Insurance or other evidence of insurance acceptable to the City of Visalia, which shall be provided by CONTRACTOR’s insurance company as evidence of the stipulated coverages. This Proof of Coverage shall then be mailed to the City of Visalia at the following address:

   City of Visalia
   707 W. Acequia
   Visalia, CA 93291
   Attn: Purchasing Division
SECTION 5 - TECHNICAL SPECIFICATIONS

SLUDGE DEWATERING SYSTEM

5.1 GENERAL

5.1.1 WORK OF THIS SECTION

A. The Work of this Section includes the furnishing of two or more sludge dewatering presses and appurtenance as specified herein.

B. In addition to this technical specification section, additional specifications are provided in the Appendix to these pre-selection documents. The equipment and devices to be furnished shall also comply with the requirements set forth in those specifications of the Appendix as applicable.

Where installation requirements are included in the technical specifications of the Appendix, such requirements are provided for the EQUIPMENT SUPPLIER’s information such that the sludge dewatering equipment and devices are fabricated to permit the GENERAL CONTRACTOR to comply with the installation requirements.

C. The equipment and devices to be furnished by the EQUIPMENT SUPPLIER will be installed by the GENERAL CONTRACTOR to be selected by the CITY for the construction of the PROJECT. The GENERAL CONTRACTOR will be responsible for off-loading the equipment, providing any temporary storage in accordance with the EQUIPMENT SUPPLIER’s recommendations. Installation by the GENERAL CONTRACTOR will include mounting the units as specified by the EQUIPMENT SUPPLIER, providing power to the equipment and panels and constructing all wiring and piping required between various components of the sludge dewatering system.

D. The EQUIPMENT SUPPLIER shall be regularly engaged in the manufacturing of the sludge dewatering presses specified herein. In addition, the EQUIPMENT SUPPLIER shall have furnished similar presses to at least five municipal wastewater treatment plants in United States or Canada in the past five years, which are currently in successful operation for sludge dewatering, two of which must be for dewatering of anaerobically digested sludge.

5.1.2 CODES AND STANDARDS

A. The design and manufacture of various components of the sludge dewatering presses shall meet requirements and recommendations of the codes and standards listed in Paragraphs 1.2 and 1.3 of Specification Section 11000.
5.1.3 SHOP DRAWINGS AND EQUIPMENT INFORMATION

A. As a part of the EQUIPMENT SUPPLIER’s proposal, the following drawings and equipment information shall be submitted:

1. Completed bid forms provided in Section 4.

2. A complete system description of the presses and components, including motor and drive system rating (both connected and operating) with all nameplate data; guaranteed minimum rated efficiency, actual power consumption and speed torque curves.

3. Sizes and locations of external connections such as sludge feed, cake discharge, filtrate discharge and polymer feed including utility requirements such as water supply and, if applicable, compressed air supply.

4. Complete system interconnection diagrams between power supply, control panels, drive motor, secondary drive motor, and all ancillary equipment connected to control system, including terminal number connection points.

5. Description of control system including functions monitored, controlled, and alarmed. Include sequence of operation and interface requirements.

6. Installation and dimensional drawings certified correct for the specific application, showing details of construction, dimensions and anchor bolts, centrifuge control panels, showing all dimensions, parts and materials of construction.

7. Complete list of supplied tools and spare parts and a list of recommended spare parts not supplied.

8. Calculations showing the quantity and type of polymer used, expected sludge solids capture, cake solids content. Submit validating data for dewatering similar type of sludge from other plants.

9. Information on at least five installations in the United States or Canada, performing successfully, of comparable size, application and complexity constructed in the past five years (form provided in Section 4).

10. A complete bill of materials

11. Comprehensive data on power consumption (KW) with corresponding capacity (gpm of feed sludge and pounds of dry sludge solids per hour) of machines supplied at other plant sites

12. Water supply flow rates and pressure required for wash of the sludge dewatering presses
13. Equipment Maintenance Requirements under normal operation as specified in Paragraph 5.2 of this Section, including the following:

a. Routine maintenance, such as regular inspection, lubrication, adjustment of operating parts

b. Parts replacement, including frequency of parts replacement, cost of replacement parts, and labor hours and tools and equipment required for each replacement

c. Where replacement of parts requires the removal of the major components out of the presses, the cost and labor hours for the EQUIPMENT SUPPLIER to perform the replacement on site

B. During the construction of the PROJECT, EQUIPMENT SUPPLIER shall, in coordination with and through the GENERAL CONTRACTOR, submit shop drawings, equipment information, and operation and maintenance manual in accordance with Paragraphs 1.4 and 1.5 of Section 11000. In addition, the following shall be submitted:

1. Torsional and vibration analysis in accordance with Paragraph 1.11 of Section 11000

2. Warranty documents with a complete description of the warranty

5.1.4 FACTORY TESTING

A. The equipment and devices to be furnished shall be tested in the factory as specified in Paragraph 1.7 of Section 11000. A test report certified by an officer of the EQUIPMENT SUPPLIER shall be submitted to the CITY for approval prior to shipment to the jobsite.

B. The CITY reserves the right to observe the factory testing at the place of manufacture. Prior to testing, the EQUIPMENT SUPPLIER shall notify the CITY through the GENERAL CONTRACTOR at least 21 days in advance of the testing.

C. The presence or absence of the CITY or their representative at the place of manufacture, however, shall not relieve the EQUIPMENT SUPPLIER or the responsibility for furnishing products, materials and equipment which comply with all requirements of these specifications. Compliance is a duty of the EQUIPMENT SUPPLIER, and said duty shall not be voided by CITY’S on-site inspection or lack thereof.

5.1.5 EQUIPMENT PERFORMANCE GAURANTY

A. In the table below EQUIPMENT SUPPLIER shall provide guaranteed performance data for the sludge dewatering presses under the normal operating conditions
specified in Paragraph 5.2. Without this data, the Proposal will be considered non-responsive and will be rejected.

<table>
<thead>
<tr>
<th>Performance Parameter</th>
<th>Level of Performance Guaranteed by EQUIPMENT SUPPLIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum dry solids captured by the press from the sludge fed to the press</td>
<td>_______________ percent</td>
</tr>
<tr>
<td>Minimum dry solids in the dewatered sludge cake produced by the press</td>
<td>_______________ percent</td>
</tr>
<tr>
<td>Polymer usage to produce sludge cake for the guaranteed solids content</td>
<td>Maximum polymer dosage: _____ in pounds of active polymer per ton of dry sludge fed to each press</td>
</tr>
<tr>
<td></td>
<td>Polymer type, percent active, and manufacturer:</td>
</tr>
<tr>
<td></td>
<td>_______________</td>
</tr>
<tr>
<td></td>
<td>Price per pound of active polymer:</td>
</tr>
<tr>
<td></td>
<td>$_______________</td>
</tr>
</tbody>
</table>

The percent of solids capture and percent of solids in the sludge cake produced by the presses to be provided in the table above shall be no less than the minimum requirements specified in Paragraph 5.2.2 A.

B. After the completion of the installation of the sludge dewatering presses and associated equipment, the GENERAL CONTRACTOR will perform a field testing of the sludge dewatering presses verify the guaranteed performance set forth in the preceding paragraph. Each of the presses will be tested for 5 consecutive days using the digested sludge from the anaerobic digesters and the type of polymer listed in the preceding paragraph. At no additional cost to the CITY, EQUIPMENT SUPPLIER shall furnish the polymer to be used for the testing and the service of a factory trained representative on site to direct and supervise this test. During this test, the sludge fed to the dewatering presses and the sludge cake produced by the dewatering presses will be sampled four times a day and analyzed for solids content by the CITY. The daily polymer consumption will also be recorded.
C. If the average test data should show the performance of the dewatering presses fails to provide the guaranteed performance for any of the parameters, the EQUIPMENT SUPPLIER shall make the necessary adjustment or modifications of the presses and have them re-tested until the performance of the presses meet the guaranteed levels. All costs for adjustment and re-testing of the presses shall be borne by the EQUIPMENT SUPPLIER.

D. After repeated testing and making all necessary adjustments and modifications of the presses, if the performance of the presses still fail to meet the guaranteed levels, the CITY, at its sole discretion, may accept the sludge dewatering presses at the discounted equipment price as follows:

1. For each percent of sludge solids capture below the guaranteed level per press, the equipment price shall be reduced by 2 percent.

2. For each percent of solids content in the dewatered sludge cake below the guaranteed level per press, the equipment price shall be reduced by 5 percent.

3. For each pound of polymer used per ton of dry sludge solids fed to the presses exceeding the guaranteed value per press, the equipment price shall be reduced by the present worth of the extra polymer cost to be computed in accordance with Paragraph 2.10 of Section 2 as follows:

\[
\text{Price reduction in dollars} = P \times Q \times M \times 18.12
\]

Where: 
- \( P \) = Price of polymer as provided under Paragraph 5.1.5 A
- \( G \) = Pounds of polymer usage exceeding the guaranteed value
- \( M \) = Annual tonnage of dry sludge solids expected to be fed to the press

The price reduction for the performance parameters specified above are additive.

5.2 PRODUCTS

5.2.1 GENERAL

A. The EQUIPMENT SUPPLIER shall furnish a multiple number of sludge dewatering presses as specified herein and all units presses shall be identical in all respect. The EQUIPMENT SUPPLIER has the option of furnishing either screw presses as specified in Paragraph 5.2.3 or rotary presses as specified in Paragraph 5.2.4.

B. All presses shall be complete with drives and skid mounting and anchor bolts, and all electrical and control panels shall be complete and internally pre-wired and ready for installation when delivered to the jobsite. All the equipment and parts shall be new. The EQUIPMENT SUPPLIER shall have full responsibility for the compatibility between the various equipment and devices being furnished.
5.2.2 DESIGN CRITERIA

A. The sludge dewatering equipment shall be designed to dewater anaerobically digested sludge generated by the primary sedimentation and membrane bioreactor processes of a municipal wastewater treatment plant. The equipment shall be capable of dewatering the sludge with the aid of a suitable polymer to produce sludge cake that can be transported to sludge drying beds in the treatment plant or hauled away for offsite disposal. Typical characteristics of the sludge to be dewatered are as follows:

1. Type of sludge: Anaerobically digested primary and biological secondary sludge

2. Total solids contents, percent: 2 – 3

3. Total Volatile Solids content: 50 – 75

4. pH: 6 – 8

B. The sludge dewatering presses shall be designed to meet the following requirements:

1. The rated sludge solids feed capacity of all the presses combined shall be not less than 2,200 pounds of dry solids/ hour, and the sludge hydraulic feed capacity of all the presses combined shall be not less than 220 gallons per minute. The presses shall be designed for variable speed operation to accommodate the variable rates of sludge being delivered to the units.

2. Capture of the solids in the feed sludge shall be 90 percent minimum.

3. Solids content in the dewatered sludge cake shall be 20 percent minimum.

3. A minimum of 2 presses shall be furnished. However, if any scheduled equipment maintenance requires the press to be off line for more than two consecutive 8-hour shifts at a frequency of more than once every five years, an identical standby unit shall be furnished. If the press consists of multiple sludge dewatering elements driven by a common motor, the entire press must be taken out of service while the scheduled maintenance work is being performed on any one of the sludge dewatering elements.

C. It is intended that all of the sludge dewatering presses will be operated continuously for 24 hours per day and 7 days per week as long as digested sludge is available for dewatering. All components of the dewatering presses shall be designed for such operation under the environmental conditions described in Section 3.

D. In addition to compliance with the codes listed in Paragraph 1.2 of Section 11000, the structures and anchoring systems of all equipment shall comply with California Building Code 2007, and requirements of ASCE 7-05 for Occupancy Category III, Importance Factor 1.25 and Seismic Design Category D. The design shall be
5.2.3 SLUDGE DEWATERING PRESSES – SCREW PRESS OPTION

A. Each of the screw presses shall be furnished with sludge conditioning facilities, interconnecting piping and the necessary appurtenances. If required, an air compressor assembly shall also be furnished to serve all presses. All parts of the press, the sludge conditioning facilities and the interconnecting piping that are wetted or in contact with the sludge shall be made of Type 304 stainless steel or other approved corrosion resistant materials.

B. The sludge to be dewatered shall be conditioned by a suitable polymer prior to delivery to the screw press. Sludge conditioning shall be accomplished either in a conditioning tank or in a segment of the sludge feed pipeline to the press. If a conditioning tank is use, the inlet pipe of the conditioning tank shall have provisions for injection of polymer and the tank shall have a motor driven mixer to thoroughly mix the polymer into the sludge. The conditioning tank shall have sufficient volume to provide the sludge/polymer mixture with the retention time required for proper conditioning prior to drainage of the sludge to the screw press by gravity. The inlet of the tank shall be furnished with a flow meter to monitor the sludge flow being processed and control of the screw press operation. If a segment of the press feed pipeline is used for sludge conditioning in lieu of a conditioning tank, the pipe segment shall be equipped with devices for polymer injection and thorough mixing of the polymer with the sludge. This segment shall be of such size and length as required to provide the sludge/polymer mixture with sufficient retention time for proper conditioning of the sludge. This segment shall also have a flow meter to monitor the sludge flow being processed and control the screw press operation.

C. The screw press shall be designed to press the water out of the sludge by the motion of a tapering pitch screw and the pressure created by a spring loaded or pneumatically actuated backpressure cone. The screw shall be completely enclosed in a screen for capturing the sludge solids while permitting the filtrate (water being pressed out the sludge) to flow out of the sludge. The screen shall be provided with a water spray system to clean the screen. The spray system shall be designed to wash the entirety of the screen. Tertiary treated recycled water will be available for this purpose.

D. If pneumatically actuated backpressure cone is used, the screw presses shall be furnished with a compatible compressed air supply unit. The unit shall be complete with duplex air compressors mounted on a compressed air receiving tank, air filters and an air dryer. The air receiving tank shall conform to the requirements of the ASME code for pressure vessel.
E. The screw shall be driven by an electric motor and a speed reducing gear system with adequate capacity to transmit the torque required to move the screw. The motor shall be furnished with a variable frequency drive (VFD) and the dewatering press’ feed line shall be furnished with a flow meter such that the VFD will modulate the operating speed of the screw to match the flow of sludge being fed to the dewatering press.

F. Dewatered sludge shall be discharged from the press through a port with a configuration suitable for connection with a receiving screw conveyor system to be furnished by the GENERAL CONTRACTOR. Filtrate and screen wash water from the screw process shall be collected into a drain pan with a flanged outlet for connection with the treatment plant’s drainage system.

G. The sludge dewatering mechanism of the press shall be completely enclosed by a weatherproof housing made of Type 304 stainless steel designed to prevent the odor generated by the sludge dewatering operation from escaping to the atmosphere. The housing shall have hinged panels for access to the various parts of the sludge dewatering mechanism.

5.2.4 SLUDGE DEWATERING PRESS – ROTARY PRESS OPTION

A. Each of rotary presses shall be furnished with sludge conditioning facilities, pumping equipment for transferring conditioned sludge to the press, interconnecting piping and valves, an air compressor assembly, and the necessary appurtenances. All parts of the press, the sludge conditioning facilities and the interconnecting piping that are wetted or in contact with the sludge shall be made of Type 304 stainless steel or corrosion resistant materials.

B. The sludge to be dewatered shall be conditioned by a suitable polymer prior to delivery to the rotary press. Sludge conditioning shall be accomplished in a sludge conditioning tank. The tank shall have a motor driven mixer to thoroughly mix the polymer into the sludge. The conditioning tank shall have sufficient volume to provide the sludge/polymer mixture with the required retention time for proper conditioning. The inlet of the tank shall be furnished with a flow meter for monitoring of the sludge flow being processed and control of the rotary press operation.

C. Each rotary press shall be furnished with two progressing cavity pumps (1 duty and 1 standby units) to pump the sludge from the conditioning tank to the press. Each pump shall have the capacity to provide the pressure required to move the sludge through the dewatering channels. The pump motor shall be provided with a variable frequency drive to automatically modulate the pump operating speed to match the flow of the sludge being fed to the conditioning tank.

D. The rotary press shall consist of a number of sludge dewatering channels mounted on a common shaft which is driven by a single electric motor and reduction gear system.
The press shall have a piping system to receive the conditioned sludge and distribute it to the various dewatering channels.

E. The dewatering channel housing shall be of a circular, split case design with a sludge receiving inlet port, a dewatered sludge cake discharge chute and bearings for mounting on the driving shaft. The channel housing shall completely enclose the sludge dewatering mechanism to prevent odor from escaping to the atmosphere.

F. The interior of the channel shall have two rotating screens, a series of stationary scrapers, a stationary deflector and a channel sprinkler. Conditioned sludge shall be received into the space between the two screens and shall be moved from the inlet to the discharge ports in a circular pattern by the rotational motion of the screens while it is dewatered by the pressure of the compressed air supplied by the external air compressor. As the sludge is being dewatered, the rotating screens shall be cleaned by the stationary scrapers and washed by the sprinkler. The filtrate being pressed out of the sludge shall flow through the screens and the screen wash water shall be drained out of the channel to the treatment plant’s drainage system.

G. The presses shall be furnished with a compatible compressed air supply unit. The unit shall be complete with duplex air compressors mounted on a compressed air receiving tank, air filters and an air dryer. The air receiving tank shall be conform to the requirements of the ASME code for pressure vessel.

H. Dewatered sludge cake shall be guided into the press’ discharge chute by a restrictor. The discharge chute shall have mechanism to break the sludge cake into smaller pieces to assist the cake to flow out of the press to the chute’s outlet. The outlet shall be designed for connection with the screw conveyor system to be provided by the GENERAL CONTRACTOR.

5.2.5 ELECTRICAL COMPONENTS

A. Motors shall be premium efficiency motors conforming the requirements of Section 16150 – Induction Motors.

B. Variable frequency drives shall be as specified in Section 16483 – Variable Frequency Drive Controllers.

C. Unit control panels shall be as specified in Section 16485 – Unit Control Panels.

5.2.6 EQUIPMENT CONTROL AND MONITORING

A. The components of the sludge dewatering press control and monitoring system shall conform to the requirements of the following specifications sections:

1. Section 13100 – Instrumentation and Control

2. Section 13320 – Field Mounted Instruments
3. Section 13510 – PLC Based Control System Hardware

B. The sludge dewatering presses shall be provided with a PLC based control system that communicates with the plant’s SCADA system to permit control of the operation of the presses locally and remotely at the plant’s control center as follows:

1. Starting and shutdown of the presses
2. Modulation of the operating speed of the presses’ sludge dewatering elements in proportion with the sludge flow being fed to the presses
3. Modulation of the polymer feed in proportion to the sludge flow being fed to the dewatering presses

C. The control system shall monitor the operating status of each dewatering press locally and transmit the monitoring data to the plant’s SCADA system as follows:

1. Dewatering press start and stop
2. Dewatering press fail
3. Operating speed of the sludge dewatering element
4. Pressure being applied to the dewatering sludge

5.2.7 SPARE PARTS

Separate from the equipment bid price indicated in the forms of Section 4, EQUIPMENT SUPPLIER shall provide a list of recommended spare parts for the sludge dewatering presses and the prices.

5.3 EXECUTION

5.3.1 SHIPMENT

A. EQUIPMENT SUPPLIER shall be responsible for delivery of the dewatering presses and appurtenances to the jobsite and the cost thereof. Packaging and shipment of the equipment shall be in accordance with Paragraph 1.9 of Section 11000. However, no equipment shall be shipped before the shop drawings specified under 5.1.4 B are approved by the CITY.

5.3.2 INSTALLATION

A. EQUIPMENT SUPPLIER shall coordinate with the GENERAL CONTRACTOR and provide him with the necessary information for proper installation of the sludge dewatering presses. Installation information to be provided shall include, but not limited to, manufacturer’s installation instructions, equipment support requirements, anchor bolt templates, wiring diagrams and equipment startup procedures.
B. Upon completion of installation, EQUIPMENT SUPPLIER shall furnish the services of a factory trained representative to inspect the installation and to direct the GENERAL CONTRACTOR for correction of any defects in the installation. EQUIPMENT SUPPLIER shall provide the CITY with a written certification that the installation is satisfactory and meets all their requirements prior to startup. In addition, the representative shall direct and supervise the GENERAL CONTRACTOR in the field testing and fine tuning of the dewatering presses specified in Paragraph 5.1.5 B.

C. Provide the CITY staff with training of the operation and maintenance of the sludge dewatering presses in accordance with Section 11000, Paragraph 1.6 B. The training shall include classroom and field training sessions for a total training time of not less than 16 hours. Written training syllabus and materials shall be delivered to the CITY two weeks prior to training.

5.3.3 WARRANTY

A. EQUIPMENT SUPPLIER shall furnish the CITY with a manufacturer’s warranty against any defect in the manufacture of the sludge dewatering presses for a period of one year. The warranty period shall start upon the CITY’S final acceptance of the equipment and not before. During the warranty period, the EQUIPMENT SUPPLIER shall repair the presses for any malfunction and replace any parts that are defective or worn out at no cost to the CITY.

B. Warranty document shall be submitted to the CITY at the completion of the construction of this PROJECT.

5.3.4 EXTENDED MAINTENANCE SERVICE PROGRAM

A. EQUIPMENT SUPPLIER shall provide the description and price for a 5-year maintenance service program to furnish the labor, equipment and parts for all inspections and maintenance work and parts replacement indicated under Paragraph 5.1.3 A, Item 14. The 5-year maintenance program, if accepted by the CITY, may be purchased at any time during the initial one-year warranty period and shall start upon the expiration of the warranty period specified in Paragraph 5.3.3.

5.3.5 PAYMENT

A. Payment will be made to the EQUIPMENT SUPPLIER through the GENERAL CONTRACTOR according to the following schedule:

1. 50 percent of lump sum for Item A and Item B (if applicable) of the Bidding Schedule upon delivery of the equipment to the jobsite

2. 30 percent of lump sum for Item A and Item B (if applicable) of the Bidding Schedule upon completion of installation
3. Remaining 20 percent of lump sum for Item A and Item B (if applicable) of the Bidding Schedule upon the CITY’S acceptance of the equipment

– END OF SECTION –
APPENDIX
SUPPLEMENTAL TECHNICAL SPECIFICATIONS

DIVISION 11 – EQUIPMENT
SECTION 11000  EQUIPMENT GENERAL PROVISIONS

DIVISION 13 – CONTROL AND INSTRUMENTATION
SECTION 13100  INTRUMENTATION AND CONTROL
SECTION 13320  FIELD MOUNTED INSTRUMENTS
SECTION 13510  PLC BASED CONTROL HARDWARE

DIVISION 16 -- ELECTRICAL
SECTION 16050  GENERAL ELECTRICAL PROVISIONS
SECTION 16100  BASIC ELECTRICAL MATERIALS AND METHODS
SECTION 16120  CONDUCTORS AND CABLES
SECTION 16150  INDUCTION MOTORS
SECTION 16483  VARIABLE FREQUENCY DRIVE CONTROLLERS
SECTION 16460  GENERAL PURPOSE INDUCTION MOTORS
SECTION 16485  UNIT CONTROL PANELS
SECTION 16960  ELECTRICAL EQUIPMENT TESTING
SECTION 11000 – EQUIPMENT GENERAL PROVISIONS

PART 1 – GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this Section includes providing general requirements for the Work of applicable Sections of these Specifications. Unless there are more restrictive requirements in the individual Sections, the provisions of this Section shall apply.

10.2 CODES

A. The Work of this Section shall comply the codes listed below. Except where the specific version is specified, the codes shall be of the version current at the time of bidding:

3. Uniform Fire Code
5. California Building Code 2007(CBC)

1.03 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the applicable standards of the following organizations apply to the Work of this Section:

1. American Society for Testing and Materials
2. American Public Health Association
3. American National Standards Institute
4. American Society of Mechanical Engineers
5. American Water Works Association
6. American Society of Heating, Refrigerating, and Air Conditioning Engineers
7. American Welding Society
8. National Fire Protection Association
9. National Electrical Manufacturers Association
10. Antifriction Bearing Manufacturers Association
11. American Gear Manufacturers Association
B. The current editions of the following apply to the Work of this Section:

1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
2. ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
3. ANSI B46.1 Surface Texture
4. ANSI S12.6 Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
5. ANSI/ASME B1.20.1 General Purpose Pipe Threads (Inch)
6. ANSI/ASME B31.1 Power Piping
7. ANSI/AWWA D100 Welded Steel Tanks for Water Storage
8. AWWA C206 Field Welding of Steel Water Pipe
9. ASTM A 48 Specification for Gray Iron Castings
10. ASTM A 108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
11. ANSI/NFPA 70 National Electrical Code

1.04 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted:

1. Manufacturer's product data including catalogue cuts.
2. Equipment name, identification number and specification numbers.
3. Shop drawings showing details, dimensions, anchorage details, and installation of equipment with all special fittings and appurtenances.
4. Shipping weights.
5. Calculations of equipment anchorage forces and anchorage details.
6. Certification that the single manufacturer accepts the indicated unit responsibilities.
7. Parts list with materials of construction.
8. List of installations and telephone numbers, where identical equipment has been used. At least one installation is required.
9. Documentation of experience of specialist who will perform torsional and vibration analysis.

10. Wiring and control diagrams for all equipment, panels, and instrument components.

1.05 CITY’S MANUAL

A. The following shall be included in the City's Manual:

1. Manufacturer's catalog including installation instructions.

2. Manufacturer's operating and maintenance procedures including lubricating instructions.

3. Manufacturer's certification that products comply with the indicated requirements.

4. Certification that products have been factory-tested.

5. Certification that the Work has been field-tested and the Work complies with the indicated requirements.

6. Notification of testing dates at least 2 weeks in advance.

7. Equipment tolerances and required clearances.

8. Electrical data including control and wiring diagrams.

9. Address and telephone number of local service representative.

1.06 SERVICES OF MANUFACTURER

A. Facility Startup, Physical Checkout, and Shop/Field/Functional Testing: The services of manufacturer shall include the following:

1. Witness the installation of equipment,

2. Physical checkout; shop, field, and functional testing, in accordance with Section 01680,

3. Facility startup in accordance with Section 01660,

4. Perform field adjustments to certify that the equipment installation and operation comply with the Specifications.

B. Instruction of City's Personnel:

1. A factory trained service representative of the manufacturer shall instruct the City's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Training shall be specific to the models of equipment provided.
2. The representative shall have at least 2 years' experience in training. A resume for the representative shall be submitted to the Construction Manager.

3. Training shall be scheduled, on the date specified by the City, a minimum of 4 weeks in advance of the first session.

4. Proposed training material, including detailed outlines for each lesson, training handouts and performance evaluations for each trade group indicated shall be submitted in compliance with Section 01300 to the Construction Manager for review. All comments shall be provided via Construction Manager and shall be incorporated into the material prior to the training session.

5. Training materials shall remain with the trainees.

6. The City may videotape the training sessions for later use with the City's personnel.

C. Service: The manufacturer shall have a factory-employed service staff which is able to respond in emergency situations within 24 hours during the equipment warranty period.

1.07 FACTORY TESTING

A. Product Testing: Products shall be tested at the factory as practical for compliance with the indicated requirements.

B. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.

C. Witnesses: The City and the Construction Manager (at the option of either) reserve the right to witness factory tests.

1.08 FIELD TESTING

A. Testing: Products shall be field-tested for compliance with the indicated requirements.

B. Witnesses: The City and the Construction Manager (at the option of either) reserves the right to witness field tests.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

C. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times.
Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.10 UNIT RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. Unless otherwise indicated, the Contractor shall obtain each system from the manufacturer of the driven equipment, which the manufacturer shall provide all components of the system to enhance compatibility, ease of construction and efficient maintenance. The Contractor is responsible to the City for performance of all systems as indicated.

1.11 TORSIONAL AND VIBRATION ANALYSIS

A. Torsional Analysis: The Contractor shall submit to the Construction Manager a torsional and lateral vibration analysis of the following equipment. The analysis shall be performed by a specialist with 5 years' experience in this type of work and approved by the Construction Manager.

1. All blowers and compressors with drives of 100 horsepower and over.
2. All vertical pumps with universal joints and extended shafts.
3. All equipment with variable speed drives, 5 horsepower and over.
4. All other equipment where indicated.

The torsional natural frequency of the drive train must be avoided by ±25 percent by any exciting frequency of the equipment throughout the operating range.

B. Vibration Analysis: In the bid price the Contractor shall include at least two site visits of the above mentioned specialist, during construction and testing of equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.

PART 2 – PRODUCTS

2.01 GENERAL

A. General: Only products meeting the indicated requirements shall be provided.

B. Manufacturers: Products shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. Products: Materials shall be suitable for the intended purpose and free of defects and shall be recommended by the manufacturer for the application indicated.
2.02 GENERAL REQUIREMENTS

A. Arrangement: The arrangement of equipment shown on the drawings is based upon information available to the City at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revisions to meet actual equipment installation requirements.

Structural supports, foundations, connected piping and valves shown 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 work.

B. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure.

C. Service Factors: Service factors shall be applied in the selection and design of mechanical power transmission components where so indicated in individual Sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

D. Welding: Except as otherwise indicated, welding shall comply with ANSI/AWWA D100 and AWWA C206 and the following:

1. Composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds and shall prevent entrance of air or moisture.

2. Welding shall be by the metal-arc method or gas-shielded arc method described in the American Welding Society's "Welding Handbook" as supplemented by other AWS standards. Qualification of welders shall comply with AWS Standards.

3. In assembly and during welding, the component parts shall be clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall comply with the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. Identification of Equipment Items: Each item of equipment shall have a legible identifying mark corresponding to the equipment number indicated.

F. Vibration Level: Except as otherwise indicated, equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads complying with the manufacturer's written recommendations and with the requirements of Section 15050.
G. Shop Fabrication: Shop fabrication shall be performed in accordance with the shop drawings.

H. Tolerances: The variation in length of members without machine finished ends and which are to be framed shall not exceed 1/16-inch for members 30 feet or less and shall not exceed 1/8-inch for members over 30 feet.

I. Machine Finish: The type of finish shall be the most suitable for the application in micro-inches complying with ANSI B46.1. The following finishes shall be used:

1. Surface roughness of surfaces in sliding contact shall not exceed 63 micro-inches.
2. Surface roughness shall not exceed 250 micro-inches except where a tight joint is indicated.
3. Surface roughness for other mechanical parts shall not exceed 500 micro-inches.
4. Surface roughness of contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall not exceed 32 micro-inches.

J. Safety Devices: The completed Work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, Cal-OSHA, and other federal, state, and local health and safety regulations.

2.03 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment supports, anchors, and restrainers shall be designed for static, dynamic, wind, and seismic loads.

B. Seismic Restraints: All manufactured equipment supplied under this Contract shall be designed, constructed and attached to resist stresses produced by seismic forces specified in this Section. Equipment that does not vibrate during normal operation shall be rigidly attached. Equipment that vibrates during normal operation shall be attached by means of isolators with mechanical stops that limit movement in all directions unless it can be demonstrated by calculations that such stops are not required. Equipment or portions of equipment that move during normal operation shall be restrained with mechanical devices that prevent displacement unless it can be demonstrated by calculations that such restraints are not required.

The design horizontal seismic force shall be as required by the California Building Code. Seismic restraint systems shall be designed by a civil or structural engineer registered in the State of California.

C. Equipment Foundations: Equipment foundation shall be as shown in the Drawings. Where the details of the equipment foundation are not provided in the Drawings, equipment foundation shall comply with the manufacturer's written recommendations. Mechanical equipment including tanks and control cabinets shall be mounted on minimum 4-inch high concrete bases where not otherwise indicated.
D. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

E. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel, size as recommended by the manufacturer.

2.04 PIPE HANGERS, SUPPORTS, AND GUIDES

A. Pipe connections to equipment shall be supported, anchored, and guided to minimize stresses and loads on equipment flanges and equipment. Supports and hangers shall comply with the requirements of Section 15020.

2.05 FLANGES AND PIPE THREADS

A. Flanges on equipment shall comply with ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B1.20.1.

2.06 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to minimize shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.

B. The equipment manufacturer shall recommend the size and type of coupling required for each specific application.

C. Taper-lock bushings may be used where indicated.

D. Where universal type couplings are indicated, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.07 SHAFTING

A. General: All shafting shall be continuous between bearings and shall be sized properly to transmit the power required. Keyways shall be provided in accordance with standard practice.

B. Materials: Shafting materials shall be selected for the type of service and torque transmitted and the effect of corrosive gases, moisture, and fluids shall be considered. Materials shall conform to the following:


3. Corrosion-resistant shafting: Stainless steel or Monel, whichever is most suitable for the intended service.
C. Differential Settlement: Where differential settlement between the driver and the driven equipment is indicated, an extension shaft with 2 sets of universal type couplings shall be provided.

2.08 BEARINGS

A. Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

B. Bearing selection shall include the following criteria: fitting practice, mounting, lubrication, sealing, static rating, and housing strength.

C. Re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location.

D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's best recommended grease to insure maximum bearing life and best performance.

E. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 50,000 hours for intermittent service, and 100,000 hours for continuous service, with the exception of commercially manufactured appliances, small package heating and air conditioning equipment, which shall be furnished with the bearings with L-10 life expectancy of not less than 20,000. Fan bearings shall be rated in accordance with Section 15855.

F. Bearing housings shall be of cast iron or steel and the bearing mounting arrangement shall be in accordance with the published standards of the manufacturer. Split-type housings may be used.

G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.09 GEARs AND GEAR DRIVES

A. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used.

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 and installed for easy reading.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
D. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly 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 location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.

F. Where gear drive input or output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

2.10 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains complying with ANSI standards and of materials best suited for the process fluid.

B. A chain take-up or tightener shall be provided in every chain drive arrangement.

C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

2.11 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Except as otherwise indicated, sprockets shall comply with the following:
   1. Sprockets with 25 teeth or less, normally used as a driver, shall be 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 minimum 0.20 percent carbon steel.
   3. Large diameter sprockets with Type C hub shall be 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 provided complete with keyseat and set screws.

E. Sprockets shall be of the split type or shall be provided with taper-lock bushings.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws in both sides of the hub shall be provided.
2.12 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. Sheaves shall be machined from gray cast iron.

C. Sheaves shall be statically balanced. In applications where excessive vibration is expected, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm shall be of materials and construction recommended by the manufacturer.

D. Sheaves shall be provided complete with taper-lock or QD bushings as required.

E. Finish bored sheaves shall be provided complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.13 DRIVE GUARDS

A. Power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded. Unless otherwise indicated for corrosive environment, the guards shall be constructed of minimum 10 gauge expanded, flattened stainless steel with smooth edges and corners, and securely fastened with stainless steel fasteners. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.14 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of the ANSI B31.1. Two flexible connectors separated by a spool piece shall be provided at all locations where piping joins equipment or exits a structure.

2.15 INSULATING CONNECTIONS

A. Insulating bushings, unions, couplings, and flanges, shall comply with the requirements of Section 15000.

2.16 GASKETS AND PACKINGS

A. Gaskets shall comply with the requirements of Section 15000.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.
C. Packing around rotating shafts (other than valve stems) shall be preformed packing rings with Teflon lantern ring or mechanical seals, as specified and recommended by the manufacturer.

2.17 TOOLS AND SPARE PARTS

A. Tools: The Work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: All equipment shall be furnished with the manufacturers' recommended spare parts, as indicated in the individual equipment Sections.

Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.18 NAMEPLATES

A. Equipment nameplates of Type 316 stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.19 WIRING AND CONTROL DIAGRAMS

A. Point-to-Point wiring and control diagrams shall be furnished for all equipment, panels, and instrument components in accordance with the requirements of Section 01300.

B. Point-to-point wiring and control schematic diagrams shall conform to the format and content requirements contained in Section 13300.

2.20 OVERLOAD PROTECTION

A. GENERAL: WHERE INDICATED, MECHANICAL OR ELECTRONIC OVERLOAD PROTECTION DEVICES SHALL BE INSTALLED ON EQUIPMENT.

B. MECHANICAL SYSTEM: THE OVERLOAD PROTECTION SHALL BE A MECHANICAL DEVICE DESIGNED TO PROVIDE RELIABLE PROTECTION.
IN THE EVENT OF EXCESSIVE OVERLOAD. IT SHALL BE A BALL DETENT TYPE DESIGNED FOR LONG TERM REPEATABILITY AND LIFE. IT SHALL BE INFINITELY ADJUSTABLE BY A SINGLE ADJUSTING NUT WHICH SHALL BE TAMPERPROOF, AND INCORPORATE A TORQUE MONITORING AND CONTROL SYSTEM. IT SHALL ACTIVATE AN ALARM SET FOR 85 PERCENT, AND A MOTOR CUTOUT SWITCH SET FOR 100 PERCENT OF MAXIMUM CONTINUOUS RUNNING TORQUE. A VISUAL TORQUE INDICATOR SHALL BE PROVIDED AND ORIENTED SO THAT IT MAY BE READ FROM THE WALKWAY. THE DIAL SHALL BE CALIBRATED FROM 0 TO 100 PERCENT OF MAXIMUM CONTINUOUS RUNNING TORQUE. THE DESIGN OF THE TORQUE LIMITER SHOULD INITIATE THE MECHANICAL DISENGAGEMENT OF THE DRIVE UPON OVERLOAD. EACH UNIT SHALL BE SUITABLE FOR OUTDOOR AND CORROSIVE ENVIRONMENTS WITH A PROTECTIVE FINISH, CORROSION INHIBITING LUBRICANTS AND A STAINLESS STEEL COVER.

C. ELECTRONIC SYSTEM: OVERLOAD PROTECTION MAY BE AN ELECTRONIC TORQUE MONITORING CONTROL SYSTEM CAPABLE OF DISPLAYING TORQUE, RPM'S, ONE LEVEL OF OVERLOAD, AND TWO LEVELS OF OVERLOAD OF THE DRIVE SYSTEM. IT SHALL INCORPORATE A TIME-DELAY FOR STARTUP AND A VOLTAGE MONITORING AND COMPENSATION CIRCUIT FOR UP TO +15 PERCENT VARIATION.

THE OVERLOAD DEVICE SHALL HAVE AN ENCLOSURE SUITABLE FOR OUTDOOR INSTALLATION AT TEMPERATURES OF 0-70 DEGREES C, AND RELATIVE HUMIDITY UP TO 95 PERCENT. A VISUAL TORQUE DIAL SHALL BE PROVIDED AND ORIENTED SO THAT IT CAN BE EASILY READ FROM THE WALKWAY.

THE TORQUE MONITORING SYSTEM SHALL BE CALIBRATED TO INCLUDE: ALARM AND SHUT DOWN THE SYSTEM IN THE EVENT THE TORQUE DROPS TO 50 PERCENT OF NORMAL RUNNING; ALARM AT 85 PERCENT OF MAXIMUM CONTINUOUS RUNNING TORQUE AND SHUT DOWN THE MOTOR AT MAXIMUM CONTINUOUS RUNNING TORQUE OF THE EQUIPMENT. THE SYSTEM SHALL BE CALIBRATED AT THE FACTORY OF THE EQUIPMENT MANUFACTURER AND IT SHALL BE CAPABLE OF MONITORING TWICE THE MAXIMUM CONTINUOUS RUNNING TORQUE OF THE EQUIPMENT.

DRIVEN MECHANISM CONTINUOUS RUNNING TORQUE RATING, NOT EXCEEDING A SERVICE FACTOR OF 1.0.

2.21 MANUFACTURERS

A. OVERLOAD PROTECTION DEVICES SHALL BE MANUFACTURED BY THE FOLLOWING, OR APPROVED EQUAL:

1. AMERICAN AUTOGARD CORPORATION
2. FERGUSON MACHINE COMPANY

2.22 CONTROL PANELS

A. CONTROL PANELS TO BE FURNISHED BY EQUIPMENT MANUFACTURERS SHALL MEET THE REQUIREMENTS SPECIFIED IN THE APPLICABLE SECTIONS OF DIVISIONS 11, 13 AND 16. IN ADDITION TO THE CONTROL AND MONITORING REQUIREMENTS SPECIFIED IN THE INDIVIDUAL EQUIPMENT SPECIFICATIONS SECTIONS, THE CONTROL PANELS SHALL HAVE THE NECESSARY INSTRUMENTATION TO MEET THE CONTROL, MONITORING AND SCADA REQUIREMENTS SET FORTH IN DIVISION 13 AND THE INSTRUMENTATION DRAWINGS WHETHER SUCH REQUIREMENTS ARE SPECIFIED IN THE INDIVIDUAL EQUIPMENT SPECIFICATION SECTIONS OR NOT.

PART 3 – EXECUTION

3.1 INSTALLATION

A. GENERAL: PRODUCTS AND EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S WRITTEN INSTALLATION INSTRUCTIONS.

B. ALIGNMENT: EQUIPMENT SHALL BE PROPERLY ALIGNED AND OPERATE FREE FROM DEFECTS INCLUDING BINDING, Scraping, vibration, end-shaft runout, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be bolted in position and neat in appearance.

C. LUBRICANTS: THE INSTALLATION INCLUDES OIL AND GREASE FOR INITIAL OPERATION.

3.2 COUPLINGS

A. COUPLINGS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
3.3 INSULATING CONNECTIONS

A. INSULATING CONNECTIONS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.

3.4 PIPE HANGERS, SUPPORTS, AND GUIDES

A. HANGERS, SUPPORTS, AND GUIDES SHALL BE INSTALLED IN COMPLIANCE WITH ANSI/ASME B31.1 AND WITH SECTION 15020.

3.5 BOLTS AND MISCELLANEOUS METALS

A. Bolts, including anchor bolts, and miscellaneous metals shall comply with Section 05500.

3.6 PACKAGED EQUIPMENT

A. When any system is provided as pre-packaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.7 PROTECTIVE COATING

A. Equipment shall be painted and coated in accordance with Section 09800. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

– END OF SECTION –
PART 1 – GENERAL

1.01 WORK INCLUDED

A. It is the intent of these specifications to have the EQUIPMENT SUPPLIER be singularly responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a functional PLC-based Control System (PLC-CS) and to provide future support of the provided Programmable Logic Controller (PLC) hardware and software. To preserve this focused responsibility, the EQUIPMENT SUPPLIER shall be the integrator of all hardware and all database, data acquisition, control, display, and other software associated with the system. Additionally, the EQUIPMENT SUPPLIER shall be responsible for the application programming of the PLC and Human Machine Interface (HMI).

B. The EQUIPMENT SUPPLIER shall be responsible for the following, as a minimum, as it pertains to the system.

1. Procurement of all hardware and software required to conform to these specifications.
2. Design and submit PLC-CS hardware, software, and spare parts submittals.
3. Design and submit PLC-CS factory and on-site training requirements.
4. Perform all required PLC-CS tests, adjustments, and calibrations.
5. Furnish qualified labor to supervise PLC-CS installation and to perform start-up activities.
6. Furnish qualified certified instructors to provide PLC-CS instruction and training.
7. Furnish all required PLC-CS tools, test equipment, spare parts, supplies, Operation and Technical Manuals, reproducible record drawings, and program listings as specified herein.
8. PLC application programming and HMI display programming.

1.02 REFERENCE STANDARDS

NEMA ICS 1 General Standards for Industrial Control and Systems.
NEMA ICS 3 Industrial Systems.
NEMA ICS 6 Enclosures for Industrial Controls and Systems.
NFPA 70 National Electrical Code.
1.03 SUBMITTALS

A. Submit under provisions of Section 01300 – EQUIPMENT SUPPLIER SUBMITTALS

B. Shop Drawings: The EQUIPMENT SUPPLIER shall coordinate the work specified so that a complete instrumentation and control system for the System will be provided and will be supported by accurate shop and record drawings. Interface between instruments, motor starters, control valves, variable speed drives, chemical analyzers, flow meters, existing instruments, and chemical feeders shall be shown in the shop drawing submittal.

C. A complete index shall appear in the front of each submittal volume. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by instrument type. If an instrument type is used in multiple locations, all similar devices may be listed by tag number on one data sheet and one brochure or bulletin may cover all identical uses of that instrument. This submittal shall include:

1. Loop Drawings: These diagrams shall show and identify each component of each loop or system using legend and symbols from ANSI/ISA S5.4, extending the format of ANSI/ISA S5.1 as used on the project drawings. Each system or loop diagram shall be drawn on a separate drawing sheet. PLC input/output (I/O) wiring schematics arranged in a PLC module-per-page basis is acceptable in replacement of the instrument loop diagrams.

2. Data Sheets: A data sheet shall be submitted for each supplied component, together with a technical product brochure or bulletin. As a minimum, the data sheets shall show:
   a. Component functional description used herein and on the drawings;
   b. Manufacturer's model number or other product designation;
   c. Project tag number used herein and on the drawings;
   d. Project system or loop of which the component is a part;
   e. Project location or assembly at which the component is to be installed;
   f. Input and output characteristics;
   g. Scale range and units (if any) and multiplier (if any);
   h. Requirements for electric supply (if any);
   i. Requirements for air supply (if any);
j. Materials of component parts to be in contact with, or otherwise exposed to, process media;

k. Special requirements or features;

l. List of special tools required for calibration or repair (if any).

3. Schematic and Wiring Diagrams: Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted first, using schematic control diagrams. Subsequent to return of this first submittal by the ENGINEER, piping and wiring diagrams shall be prepared and submitted for review by the ENGINEER; the diagrams shall consist of component layout drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves and chemical feeders. The EQUIPMENT SUPPLIER shall furnish all necessary EQUIPMENT SUPPLIER’S shop drawings to facilitate inclusion of this information by the System Integrator. Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication No. ICS-1970, "Industrial Controls and Systems".

4. Assembly and Construction Drawings: These Drawings shall be submitted for each control panel and for other special enclosed assemblies for field installation. These drawings shall be to scale and include dimensions, identification of all components, surface preparation and finish data, nameplates, and the like. These drawings shall include enough details, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

5. Installation Details: Installation, mounting, and anchoring details for all components and assemblies shall be submitted and shall include conduit connection or entry details. In addition to anchoring details for control panels, seismic calculations shall be submitted in accordance with the requirements and criteria described in Section 11 000 - Equipment General Provisions.

Bill of Material: Bills of material shall include all items within an enclosure and shall include manufacturers name and model number for these components.

D. Operation and Technical Manuals: Operation and Technical Manuals shall be supplied for the CITY and the ENGINEER, in accordance with Section 01300 – EQUIPMENT SUPPLIER SUBMITTALS. Operation and Technical Manuals shall include, but not be limited to:

1. Bound copies of operating and programming instructions.

2. Troubleshooting, adjustments, and preventative maintenance procedures and materials.
1.05 INSTALLATION AND SYSTEM TESTS
A. An installation test description shall be submitted in accordance with the requirements of Part 3.02.

B. System Tests procedures shall be submitted in accordance with the requirements of Part 3.02.

1.06 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years experience.

B. The EQUIPMENT SUPPLIER shall guarantee all non-CITY-furnished equipment and installation of all equipment, as specified herein, for a period of one year following the date of completion of the work as specified under the General Conditions of these specifications. Warranty services shall be performed within 3 calendar days after notification by the CITY.

1.07 MAINTENANCE SERVICE
A. Furnish manufacturer's service and maintenance of programmable controllers for one year from Date of Substantial Completion.

PART 2 – PRODUCTS
2.01 GENERAL
A. Code and Regulatory Compliance: PLC-CS WORK shall conform to or exceed the applicable requirements of the National Electrical Code.

B. Current Technology: Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

C. Hardware Commonality: Instruments which utilize a common measurement principle (for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head) shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance.

D. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.

E. Password Protection: No proprietary passwords shall be allowed. Password protection of any PLC component or programming software shall be limited to only those
specified or requested by the CITY. All passwords shall be provided to the CITY upon completion of the project with no exceptions.

F. Loop Accuracy: The accuracy of each instrumentation system or loop shall be determined as a probable maximum error; this shall be the square root of the sum of the squares of certified accuracies of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of plus and minus 0.5 percent of full scale and a minimum repeatability of plus and minus 0.25 percent of full scale unless otherwise indicated. Instruments that do not conform to or improve upon these criteria are not acceptable.

G. 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. Individual loop or redundant power supplies shall be provided as required by the manufacturer's instrument load characteristics to ensure sufficient power to each loop component. Power supplies shall be mounted within PLC panels or in the field at the point of application.

H. Loop Isolators and Converters: 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 wire wound 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.

I. Environmental Suitability: Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the RFP. Taking into account the temperature rise in the enclosure, 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. For example, if the most critical instrumentation device in the enclosure is the HMI with operating temperature limits between 32 and 131 degrees F, devices shall be provided to maintain the internal enclosure temperature between 39 and 105 degrees F. The EQUIPMENT SUPPLIER shall provide 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.

J. Unless indicated otherwise, control panels shall be housed in NEMA rated enclosures in accordance with Section 16050 – General Electrical Provisions. The panels shall be
either free-standing, pedestal-mounted or equipment skid-mounted, as indicated. Internal control components shall be mounted on an internal back-panel.

K. 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 4-20 mA DC except as indicated. Signals within enclosures may be 1-5 VDC. Electric signals shall be electrically or optically isolated from other signals. Pneumatic signals shall be 3 to 15 psig with 3 psig equal to 0 percent and 15 psig equal to 100 percent.

L. Alternative Equipment and Methods: Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the ENGINEER. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage, and maintenance enhancement over the equipment or method indicated, or shall include evidence that an indicated component is not available.

2.02 OPERATING CONDITIONS

A. The PLC-Control System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:

<table>
<thead>
<tr>
<th>Environment</th>
<th>A public wastewater treatment facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Range</td>
<td>40 through 110 degrees F</td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>1 degree F per minute, max</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>5 through 95 percent, non-condensing</td>
</tr>
</tbody>
</table>

2.03 FIELD MOUNTED INSTRUMENTS

A. All field instruments which will be mounted in wet, hazardous, or corrosive areas or in areas subject to splashing shall utilize hermetically sealed switch contacts. Instruments which require external solid state electronic calibrators for calibration such as the Rosemount smart transmitter line shall be supplied with one electronic calibrator for the project.

B. All field instruments mounted outdoors shall have separate sun shields installed over the top, East, South, and West sides. Instruments which are not rated for the ambient air temperature listed in Section 16050 - General Electrical Provisions, shall be installed in an outer enclosure with sun shields.

C. Nameplates: A nameplate shall be supplied for identification of all field-mounted instruments and final control elements, including flow meters and their transmitters, chemical analyzers, and flow control valves. These nameplates shall identify the instrument, valve, analyzer, or meter, descriptively, as to function and system, and by
tag number. These nameplates shall be fabricated from black-face, white-center, laminated engraving plastic. The nameplate shall be permanently attached to the instrument using stainless steel screws or 16 gauge stainless steel wire. Adhesive mounting of nameplates is not acceptable.

2.04 SPARE PARTS

The EQUIPMENT SUPPLIER shall furnish a list of recommended spare parts for field instruments, PLC components and miscellaneous panel components (for example, power supplies, fuses, etc.) with unit prices for the CITY to select from. The total price of selected spare parts by the CITY will not exceed US$10,000 and shall be included in the EQUIPMENT SUPPLIER’s proposal price. All special tools and spare parts shall be submitted before start-up commences, suitably wrapped and identified.

2.05 FACTORY TESTING

A. The EQUIPMENT SUPPLIER shall arrange for the Manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the ENGINEER and CITY to inspect and witness the testing of the equipment at the site of fabrication. Costs for CITY/ENGINEER inspection, including travel and subsistence for two (2) people for up to three (3) days in the place of manufacture, excluding salaries, shall be borne by the EQUIPMENT SUPPLIER and included in his/her proposed price. Equipment shall include the cabinets, special control systems, instrumentation, and other pertinent systems and devices.

B. Submit a Factory Test Plan describing step by step the inputs and expected outputs of the logic to be demonstrated for the ENGINEER review and approval prior to the test. A minimum of ten working days notification shall be provided to the ENGINEER prior to testing.

C. No shipments shall be made without the ENGINEER's approval.

PART 3 – EXECUTION

3.01 DELIVERY

A. Deliver products to site under provisions of Division 1.

3.02 TESTING

A. Analog Loop Tests: The EQUIPMENT SUPPLIER shall provide all necessary labor, tools, and equipment to field test, inspect and adjust each instrument installed under this contract to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument furnished by the EQUIPMENT SUPPLIER which fails to meet any contract requirement, or any published manufacturer performance specification for functional and operational
parameters not specified in the contract, shall be repaired or replaced, at the discretion of the ENGINEER at no cost to the CITY. The EQUIPMENT SUPPLIER shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities specified herein.

1. At least 15 days before the anticipated initiation of installation testing, the EQUIPMENT SUPPLIER shall submit to the ENGINEER a detailed description of the installation tests to be conducted to demonstrate the correct installation of the Instrumentation and control system. Representative examples of test forms shall be included.

2. Elements such as controllers, electronic function modules, etc., shall be tested and exercised by the EQUIPMENT SUPPLIER to demonstrate correct operation, first individually and then collectively as functional analog networks. Each hardwired analog control network shall be tested to verify proper performance within specified accuracy tolerances. Specified accuracy tolerances for each analog network is defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as specified by contract requirements or by published manufacturer accuracy specifications, whenever contract accuracy requirements are not specified.

3. Each analog network shall be tested by applying simulated analog and/or discrete inputs to the first element(s) of an analog network (i.e., applying simulated analog and/or discrete signals to element(s) of the network; e.g., controllers, alarms, indicators, valve operators, etc.). For networks which incorporate analog elements, simulated sensor inputs corresponding to 25, 50, 75, and 100 percent of span shall be applied, and the resulting element outputs read to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discreet devices (i.e., alarms, etc.). Provisional settings shall be made on controllers, alarms, etc., during analog loop tests. All analog loop test data shall be recorded on test forms, which include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

4. When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms, with test data entered, shall be furnished to the ENGINEER together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

B. System Testing: System testing shall comply with the requirements specified herein. System testing shall commence after acceptance of all wire, calibration, and loop tests, and all inspections have been conducted and shall demonstrate that the instrumentation and control system complies with all contract requirements. System testing shall demonstrate proper operation of all process systems provided under this contract with
process equipment operating over full operating ranges under actual operating conditions.

1. All system testing and test activities shall follow detailed test procedures, check lists, etc., previously developed and submitted by the EQUIPMENT SUPPLIER which have been reviewed and accepted by the ENGINEER. All test data shall be acquired using equipment as specified and recorded on test forms, previously reviewed by the ENGINEER, which include calculated tolerance limits for each step. Completion of all system testing 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 testing requirements have been satisfied.

2. The proper operation of all final control elements, control panels, and instrumentation furnished under this contract shall be verified by tests conducted in accordance with the requirements specified herein. Where feasible, system testing 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, or software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments, as required, to eliminate excessive oscillatory amplitudes and decay rates.

3. All electronic control stations incorporating proportional, integral and/or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset and/or rate setting(s) as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 10, 50, and 90 percent of span and the results checked against specified accuracy tolerances. Specified accuracy tolerances are defined as the root mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as specified in the contract or as specified by published manufacturer accuracy specifications whenever contract accuracy requirements are not specified.
4. The EQUIPMENT SUPPLIER shall submit an instrumentation and control system completion report which shall state that all contract requirements have been met and which shall include a listing of all instrumentation and control system maintenance/repair activities conducted during the system testing. Prior to the start of the plant operational test, acceptance of the system testing must be provided in writing by the ENGINEER. Final acceptance of the control system shall be upon plant completion as stated in the general conditions.

3.03 TRAINING

A. The EQUIPMENT SUPPLIER shall train the CITY’s personnel on the operation and maintenance of the PLC-CS. The training shall be performed by an instructor certified by the Equipment Supplier with a minimum of 3 years experience. The proposed instructor’s resume shall be submitted for the CITY’s review and approval. The training session shall be scheduled a minimum of 3 weeks in advance, and the course outline shall be submitted at this time for the CITY’s review and comments.

B. The training class shall be a minimum of 8 hours duration and shall include operation and maintenance procedures, trouble shooting, set point changes, etc.

C. Within 10 days after the completion of the training session, the EQUIPMENT SUPPLIER shall submit the following:
   1. A list of CITY personnel that attended the session.
   2. An evaluation of the CITY personnel via written testing or equivalent evaluation.
   3. A copy of the training material used during the lesson with all notes, diagrams, and comments.

3.04 START-UP

A. Plant Operational Testing: The EQUIPMENT SUPPLIER shall provide start-up support to include electrical personnel and any instrument manufacturers’ representatives as required during the testing period to produce a fully operational system. This support shall be provided at no additional cost to the CITY. The plant operational test shall be conducted in accordance with the requirements of Section 01202 – EQUIPMENT SUPPLIER’S Field Services

3.05 FIELD QUALITY CONTROL

A. Perform operational testing on control systems to verify proper operation and field wiring connections.

– END OF SECTION –
SECTION 13320 – FIELD MOUNTED INSTRUMENTS

PART 1 – GENERAL

1.01  WORK OF THIS SECTION

A. This Section specifies field mounted process instrumentation, auxiliary equipment and
supplies directly related to the installation and operation of these instruments, to
perform the required functions in conjunction with information and equipment specified
in other Sections of Division 13. **This specification is only applicable to the
instruments in the EQUIPMENT SUPPLIER’S scope.**

1.02  QUALITY ASSURANCE

A. Manufacturer. In addition to requirements of Section 13100, instrumentation and
control equipment furnished shall be manufactured by a firm regularly and currently
engaged in the design and manufacture of similar equipment. All equipment furnished
shall be new and of current design.

B. Maintainability. All instruments shall be designed for ease of maintenance and repair,
and access to critical parts shall not require a major disassembly. Internal field
adjustments where permitted or required herein shall be easily accessible upon removal
of a panel or cover.

C. Materials and Installation shall comply with the requirements of the current editions of
referenced instrumentation and electrical codes and standards, and the codes and
standards referred to shall be used for establishing the minimum quality of the materials
and equipment supplied and installed. All equipment of the same type shall be product
of the same manufacturer.

PART 2 – PRODUCTS

2.01  LEVEL TRANSMITTERS AND SWITCHES

A. Ultrasonic Level Transmitters and Switches

   1. General. The level sensor shall measure continuous level and discrete level points in a
liquid material application. The ultrasonic primary element shall be an electronically
excited device. The output signal from the remote amplifier unit shall be 4-20
milliampere (mA) and two independently adjustable contacts to reflect the presence
(or absence) of level. The output contacts shall be single-pole, double-throw (SPDT),
rated at 120 VAC, 2 ampere pilot duty.

   2. Specific Requirements. The type of process medium, temperature range, measuring
pressure range, level measurement range, and other requirements shall be as required
by the application. Unless otherwise specified the accuracy shall be plus or minus 0.25 percent of full range.

3. Construction. The transducer of the ultrasonic type level transmitter shall be resistant to steam and corrosive chemicals. The enclosure of transmitter shall be hermetically sealed. It shall be totally enclosed with temperature compensation and shall be suitable for accurate level measurement in the presence of vapor and gases over the liquid level. The level transmitter shall be microprocessor based for input power of 120 VAC and with output of 4-20 mA. It shall be programmable for different operating parameters, including, but not limited to range, span, units of measurement, selection of reading from tank bottom up or from sensor face down. Echo loss and sensor fault detection and remote transmission shall also be provided. Integral display of level measurement, span and signal strength shall be provided. The transmitter shall be suitable for wall, rack or panel mounting as required by the application. The deadband of switches shall be individually adjustable.

4. Manufacturer. The ultrasonic type level transmitter shall be as manufactured by Siemens, Model HydroRanger 200 (transmitter) and XPS-15 (transducer). No Substitution.

B. Tilt Liquid level Switch

1. The level switch shall be micro switch encapsulated type in a polypropylene casing.

2. The cable shall be sheathed with a PVC compound from switch to junction box terminals without splices.

3. Switch contacts shall be SPDT contacts rated at 4 amperes at 250 VAC and at 1/2 hp.

4. Capsule shall be suspended in sump and field adjusted for low level, high level and high-high level alarms as required.


C. Submersible Level Transmitter

1. The level sensor shall measure the reservoir water level utilizing a bottom diaphragm that measures head pressure as an indication of level.

2. Diaphragm, isolation rings and coating material will be selected to handle the process fluid requirements.

3. Upper assembly housing shall include signal conditioning, protective electronics, terminal blocks and the expansion bag of the sealed breathing system. The upper assembly shall be powered by a 24 VDC power supply located in a PLC panel on a 2-wire 4-20 mA configuration.
4. Connecting cable between the upper and lower assemblies will have a 1/2 - inch polyurethane jacket, a 3-conductor shielded AWG #16 cable, and an integral flexible breather tube that is part of the sealed breathing system.

5. Manufacturer shall be US filter, System A1000i or approved equal.

D. Radar Level Transmitters

1. General. The level sensor shall measure continuous level and discrete level points in a liquid material application. The radar primary element shall be an electronically excited device. The output signal from the remote amplifier unit shall be 4-20 mA and two independently adjustable contacts to reflect the presence (or absence) of level. The output contacts shall be SPDT, rated at 120-VAC, 2-Amperes.

2. Specific Requirements. The type of process medium, temperature range, measuring pressure range, level measurement range, and other requirements shall be as required by the application. Unless otherwise specified the accuracy shall be plus or minus 0.25 percent of full range.

3. Construction. The transducer of the radar type level transmitter shall be corrosion and penetration resistant to a full range of chemicals and gases. The enclosure of the transmitter shall be NEMA 4 and suitable for use in areas specified. It shall be totally enclosed with powerful sonic pulses and temperature compensation and shall be suitable for accurate level measurement in the presence of vapor and gases over the liquid level. The level transmitter shall be microprocessor based for input power of 120 VAC and with output of 4-20 mA. It shall be programmable for different operating parameters, including, but not limited to range, span, units of measurement, selection of reading from tank bottom up or from sensor face down, etc. Echo loss and sensor fault detection and remote transmission shall also be provided. Integral display of level measurement, span and signal strength shall be provided. The transmitter shall be suitable for wall, rack or panel mounting as required by the application. The dead band of switches shall be individually adjustable.

4. Manufacturer. The radar type level transmitter shall be as manufactured by Endress & Hauser, Model FMR 240. No Substitution.

2.02 PRESSURE SWITCHES AND GAUGES

A. Pressure Switches

1. Pressure switches shall be diaphragm actuated; single set point adjustment pressure switches with two (2) SPDT contacts rated for a minimum of 5 amperes, continuous, at 120 Vac. The adjustable set point range shall be such that the indicated set point falls between 15 and 100 percent of the nominal range. The deadband shall be a maximum of +/- 4 percent of the maximum allowable pressure range. The switch enclosure shall be rated NEMA 4X in an unclassified area or NEMA 7/9 in classified
area, unless otherwise specified. Unless otherwise indicated, each unit shall be automatic reset type. The diaphragm shall be Buna-N, and the lower housing shall be Type 316 SS with a 1/2-inch bottom sensing connection, unless otherwise indicated.

2. Pressure switches shall be Ashcroft B Series type 400 (unclassified area) or type 700 (classified area). No Substitution.

B. Pressure Diaphragm Seals

1. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, threaded connection, and a top housing. 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 instrument 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 any other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing of the diaphragm capsule without the need to refill. All surfaces exposed to process fluids shall be Type 316 stainless steel or other compatible material suitable for the process connection.

2. Pressure diaphragm seals shall be Ashcroft Series 201. No Substitution. The model number may vary with process compatibility.

C. Iso-Ring Diaphragm Seals

1. The isolation ring seal shall consist of a ring assembly that fits between standard pipe flanges, like many butterfly valves. It has a flexible inner cylinder, behind which is the fill fluid. The process liquid exerts pressure on the cylinder, which transmits the pressure to the measuring instrument, through the fill fluid.

2. Iso-ring diaphragm seals shall be used in applications where considerable fouling or clogging can occur due to the process liquid characteristics.

3. Manufacturer shall be Ashcroft Series 80. No Substitution.

D. Pressure and Vacuum Gages

1. Pressure and Vacuum Gages. Pressure and vacuum gages shall, unless otherwise specified, conform to the following requirements. Gages shall be of the stem mounting type unless a panel mounted type is required.

2. Construction. Gages shall be liquid filled and be of the Bourdon tube or bellows type with 270 degrees pointer travel. Dials shall be white with black numerals. Accuracy shall be 0.5 percent and dial size shall be 4-1/2 inches unless otherwise indicated. Panel mounted gages shall have round bezels for flush mounting and rear connection; others shall have a stem mounting bottom connection. Connections shall be male 1/4-
inch NPT with square wrench flats. Wetted parts shall be Type 316 stainless steel or as indicated otherwise; and shall be the manufacturer's best quality standard. When required, the gage shall be supplied with a silicone oil filled stainless steel diaphragm seal or shall be equipped with pulsation dampeners. Cases shall be black phenolic or anodized aluminum.

3. Manufacturer. The gages shall be a product of Ashcroft, Type 1279 or 1188. No Substitution.

2.03 MAGNETIC FLOW METERS

A. General. Magnetic meters shall use the principal of electromagnetic induction to produce a DC current proportional to the rate of liquid flow. Coil excitation shall be DC. The coils shall generate a magnetic field, which in turn induces a voltage in the flowing liquid, which is sensed by a pair of electrodes in contact with the liquid.

1. The coils shall be protected from contact with the liquid and the electrodes shall be made of Hastelloy. When specified, the meters shall be housed to be splash and drip-proof and shall withstand submersion up to 12 feet for a period of 48 hours. They shall otherwise be housed in a dust and weatherproof case. The metering tube shall be suitably lined to withstand abrasion of the fluid.

2. The meters shall be designed to operate from a 120 VAC, 60 Hz, single-phase power supply and a 10 percent variation in power line voltage shall not affect the meter output accuracy in excess of 0.2 percent of full scale.

3. Each magnetic flow meter system shall have an accuracy within 1 percent of rate over the application operating range indicated in the Schedule. Meters shall have a repeatability of 0.1 percent of full scale.

4. Each magnetic flow meter shall be equipped with a signal converter transmitter to transmit an isolated analog 4 – 20 mA dc signal. When specified, a frequency and/or a scaled pulse rate to drive totalizing counters shall also be provided for local indication only. The pulse rate shall be scaled to provide one pulse per unit of measurement. Span adjustment shall provide for outputting full-scale analog and pulse signals for 30 percent of maximum flow. Signal shall be linear with flow within the accuracy specified above. The converter shall be pedestal or wall mounted as specified in the data sheet. The meters shall have automatic zero correction. Interconnection between meters and signal converters shall be by cable furnished by the manufacturer. The converter shall be provided with two adjustable flow switches of the change over type (form C contacts).

B. Construction. The magnetic flow meters shall be of the short-form type with a laying length approximately 1-1/2 times the diameter for line sizes 3 inches and larger. Meters shall be designed with end connections as shown in the data sheet. Field coils shall be either completely encapsulated in the meter lining material or the meter tube shall be of
Type 304SS with a suitable liner. A suitable protective shield shall be provided, where indicated in the data sheet, at each end of the liner to withstand the scouring velocities of the process fluid at the maximum flow rates.

C. Grounding. Provide a grounding circuit for each magnetic meter. Provide grounding rings, grounding electrodes or protective shields to serve as a liquid ground, when the meter is installed in a nonconductive line or when indicated in the data sheet.

D. Manufacturer. Meter and signal converters shall be ABB MagMaster series. No Substitution.

2.04 VENTURI METERS

A. General

1. Basic Design: The meter differential pressure shall indicate flow change as a modified Venturi tube without use of devices which employ entire or partial pilot effects, or which amplify differential, or which introduce noise. The tube coefficient of discharge shall be constant for all water flow Reynolds numbers over a 10:1 range. Maximum head loss at maximum flow shall not exceed 9 percent of differential pressure output. Minimum discharge coefficient shall be 0.97. The accuracy shall be plus and minus 1 percent of actual rate of flow corresponding to the differential produced over the ranges indicated. The total overall error of each flow measurement loop, including flow tube, transmitting, receiving, and totalizing equipment shall not exceed 2 percent of actual rates of flow over the indicated flow ranges.

2. Compatibility: Similar flow metering equipment shall be obtained from a single manufacturer.

3. Characteristics of Flow Tubes: Meter shall be of the pressure differential-producing type utilizing static pressures sensed at the inlet and at the throat, without the use of devices which amplify differential through change in flow at the cross-sections where inlet and throat static pressure is sensed.

4. Tube Design: The inlet section with high pressure tap shall be a cylindrical section of the same diameter as the pipe. The throat section with low pressure tap shall be a cylindrical liner with a length equal to half its diameter. The metering element shall be free of debris-collecting cavities or annular chambers and shall have single pressure connections at the inlet and at the throat. Pressure taps shall be perpendicular to the axis of the meter and shall be straight-through-port easy to clean.

B. Basic Materials

1. Flanged Body Type: The Venturi body shall be of carbon steel, with a Type 316 stainless steel throat. The tubes shall have flanged ends to match ANSI 150 lb. piping.
2. A stainless steel nameplate shall be provided and attached to the completed venturi pipe section.

C. Manufacturer: Lambda Square Model FT-10 Low Head Loss Venturi. No Substitution.

2.05 ROTAMETERS

A. General

1. The meters shall be suitable for the service and chemicals conveyed, at process temperatures.

2. All meters shall be rated for a minimum working pressure of 150 psi.

3. Contractor shall verify that all material selected is suitable for the corrosive fluid application.

B. Basic Materials

1. Threaded (NPT) Meters shall be specified for Chemical Solutions. All threaded rotameters for chemical solutions and other service, where shown, shall be calibrated in gallons per hour, pounds per 24 hours (for chlorine gas), or cubic feet per minute for other gases and air. Flow accuracy shall be plus or minus 2 percent. The scales shall be suitable for the capacity ranges specified. Where indicated, the flow meter shall have an integral 2-wire transmitter with a 4-20 mA dc output signal linear to the measured flow rate.


2.06 VANE FLOW SWITCHES

A. Vane Type Flow switch shall be magnetically actuated to trip on high flow conditions. The lower housing shall be constructed from brass, and shall be leak proof, holding the flow vane and magnet that sense the flow, and actuate the switch mechanism located in the electrical, upper housing. Vane material shall be stainless steel, upper housing shall be constructed from brass. Enclosure shall be NEMA 4X. Contacts shall be SPDT, with a rating of 125 VAC at 5 amperes.


2.07 THERMAL FLOW SWITCHES

A. Thermal Type Flow switch shall be the insertion type and shall be provided with temperature compensation to ensure the accuracy of the flow switch set point. All wetted materials shall be Type 316L SS or better. The switch enclosure shall be Nema
4X, suitable for the electrical area classification it is located in. Contacts shall be 2 SPDT, with a rating of 115 VAC at 6 amperes.


2.08 ELECTRONIC DIFFERENTIAL PRESSURE (AND FLOW RATE) TRANSMITTERS

A. Electronic differential 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, block and bleed valves, and conduit connections. Pressure applied to the transmitter shall be transmitted by a sealed fill fluid to both sides of a sensing diaphragm. The sensing diaphragm and the sensor body shall function as the moving and fixed electrodes of a differential capacitor respectively. As the applied pressure causes the diaphragm to move, the capacitance of the cell shall change. The amplifier unit shall convert the change in capacitance to a 4-20 mA DC signal, two-wire type, with an allowable loop load of no less than 600 ohms. Static pressure rating shall be a minimum of 500 psig. The maximum overrange pressure limit shall be a minimum of 150 percent of the minimum range. Span shall be adjustable over a minimum of 5:1 range: External adjustments shall include zero and span. Damping shall be provided as an internal adjustment. All equipment shall be suitable for an ambient operating range of minus 40 to plus 175 degrees F. All wetted parts shall be constructed of Type 316 SS. All block and bleed valves shall be constructed of Type 316 SS. The integral indicator shall be calibrated in engineering units. The differential pressure transmitter shall be housed in a NEMA 4X watertight enclosure and shall be suitable for use in a Class 1 Division 1 hazardous area. Power supply shall be 24 Vdc. Accuracy, including linearity and repeatability, shall be a plus or minus 0.075 percent of span.

B. Electronic differential pressure transmitters shall be Rosemount Model 3051CD. No Substitution.

2.09 ELECTRONIC GAUGE PRESSURE TRANSMITTERS

A. 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, block and bleed valves, and conduit connections. Pressure applied to the transmitter shall be transmitted by a sealed fill fluid to both sides of a sensing diaphragm. The sensing diaphragm and the sensor body shall function as the moving and fixed electrodes of a differential capacitor respectively. As the applied pressure causes the diaphragm to move, the capacitance of the cell shall change. The amplifier unit shall convert the change in capacitance to a 4-20 mA DC signal, two-wire type, with an allowable loop load of no less than 600 ohms. Static pressure rating shall be a minimum of 500 psig. The maximum overrange pressure limit shall be a minimum of 150 percent of the minimum range. Span shall be adjustable over a minimum of 5:1 range: External adjustments shall include zero and span.
span. Damping shall be provided as an internal adjustment. All equipment shall be suitable for an ambient operating range of minus 40 to plus 175 degrees F. All wetted parts shall be constructed of Type 316 SS. All block and bleed valves shall be constructed of Type 316 SS. The integral indicator shall be calibrated in engineering units. The gauge pressure transmitter shall be housed in a NEMA 4X watertight enclosure and shall be suitable for use in a Class 1 Division 1 hazardous area. Power supply shall be 24V DC. Accuracy, including linearity and repeatability, shall be a plus or minus 0.075 percent of span.

B. Electronic gauge pressure transmitters shall be Rosemount Model 3051L (Level) or 3051T (Non-Level). No Substitution.

2.10 TEMPERATURE MEASURING SYSTEMS

A. Insertion type RTDs shall be 100 ohms nominal at 0 degree C, tip-sensitive, three-wire platinum in 0.25-inch and moisture proof accessory seal. Time constant in agitated water shall not exceed 6.0 seconds. RTD shall comply with IEC-751. Accuracy shall be plus or minus 0.5 degree C or plus or minus 0.5 percent of reading, whichever is smaller. Three-wire lead configuration for ambient temperature compensation shall be provided as a minimum. Where indicated with thermowells, RTDs shall be provided with appropriate NPT dimension and Type 316 SS thermowell and insertion length as specified in the data sheet, spring-loading device, extensions, unioncoupler and explosion-proof aluminum connection head. Union shall extend out beyond pipe lagging.

B. The RTD type temperature transmitter shall be a resistance sensing unit. The transmitter shall be a two wire device with continuously adjustable span, zero and damping adjustments, integral indicator scaled in engineering units, solid-state circuitry, and 4-20 mA output proportional to temperature. Accuracy shall be plus or minus 0.5 percent of span. The materials of construction shall be injected low copper aluminum with a Type 316 SS NEMA 4X housing and suitable for use in Class 1, Division 1 hazardous location.

C. The temperature transmitter shall be Rosemount Model 3144P. No Substitution.

2.11 PROCESS ANALYZER MEASURING SYSTEMS

A. General

1. Power Input: Analyzers shall be the fully isolated 2-wire type, unless the type is not available, in which case the analyzer shall be the fully isolated four wire type with power supply of 120 volts plus and minus 10 percent, 60 Hz plus and minus 5 percent.
2. Signal Output: Outputs shall be current regulated 4-20 mA DC, capable of driving 0 to 600 ohms.

3. Ambient Conditions: Analyzers shall be suitable for continuous automatic on-line analysis of the indicated parameter under the conditions indicated.

4. Equipment shall operate satisfactorily in ambient temperatures between 40 and 110 degrees F or shall be provided with isothermal enclosures so that accuracies will not exceed 1 percent of span.

5. Process fluid temperatures will typically range between 65 and 80 degrees F but in occasional cases can be as low as 40 and as high as 110 degrees F unless indicated otherwise.

6. Sample Flow: Samples shall not pass through housings containing electronics unless indicated otherwise. Some analyzers may require submersible sample pump.

7. Local Indication: Each analyzer shall be provided with local indication scaled in process units.

8. Calibration: Each analyzer shall be fitted with calibration connections at the analyzer.

9. Single manufacturer: All electrodes, fittings, and transmitters on analyzers measuring the same parameter shall be products of a single manufacturer.

B. Oxidation-Reduction Potential Measuring System

1. Each Oxidation-Reduction Potential (ORP) analyzer system shall consist of an indicating analyzer/transmitter, ORP sensor with mounting hardware.

2. ORP analyzer/transmitter shall continuously measure and indicate the oxidation-reduction potential of the solution in the process tank or stream. The analyzer shall produce an isolated 4-20 mA dc output signal proportional to a range of -2000 to +2000 mV. Three (3) SPDT alarm relays shall be provided for remote status information.

3. The ORP measurement shall be of Differential Electrode Method which uses two ORP electrodes to compare the process signal to a reference. Sensor shall be submerged in the aeration tank and is cleaned using a soft cloth by wiping the end of the sensor off approximately once per month. Accuracy shall be +/-20 mV.

4. ORP analyzer/transmitter shall have local indication. The display shall be graphic dot matrix LCD with backlighting. It shall be mounted in a NEMA Type 4X enclosure. The unit shall be suitable for either surface or panel mounting. The analyzer/transmitter shall be provided with a sunshade resistant to ultraviolet light and corrosive environments.
5. The sensor shall be provided with a pole mounting kit, allowing for a minimum of 10-inch separation from the wall, with a minimum insertion depth of 18 inches into the process. Provide pivoting pole mounting kit for the sensor mounting from the Hach Company.

6. The sensor assembly shall be convertible style with protector constructed of chemically-resistant Ryton, and the reference junction is coaxial porous Teflon. Mounting brackets shall be provided to hold the sensor in the water. The brackets shall be designed to permit easy withdrawal and inspection of the sensor.

7. Each unit shall operate on a 120 VAC, 60 Hz power source.

8. The Oxidation-Reduction Potential Measuring System shall be Hach Model SC100 with a Hach pHD type ORP sensor. No Substitution.

C. Turbidity Measuring System

1. Turbidimeter shall measure turbidity in the range of 0.001-100 NTU and be a continuous-reading, on-line nephelometric instrument meeting all design and performance criteria specified by USEPA method 180.1.

2. The unit shall be provided with an infrared light source as required by ISO 7027 with a minimum lamp life of 10 years. The light shall generate a beam of light which will pass through the sample. One detector arranged at a 90° angle to the sample shall measure the light.

3. The unit shall include a circulation fan to maintain a dry environment to eliminate interferences from transient moisture. Bubble rejection shall be included to eliminate air in the sample without influencing response time.

4. The measuring chamber shall consist of a rotational flow through assembly with replaceable glass cuvette.

5. The unit shall have all electronics, operator controls and measurement cell mounted in a single NEMA 4X housing. It shall have an integral LCD display for turbidity levels and measurement for guidance in setup, calibration and troubleshooting.

6. An isolated 4-20 mA DC output and 2 configurable SPDT alarm relays shall be available for interfacing with any control system. It automatically accepts an input of 120 VAC, 60 Hz.

7. The turbidity measuring system shall be Hach model 1720E with SC100 controller. No Substitution.

–END OF SECTION–
SECTION 13510 – PLC-BASED CONTROL SYSTEM HARDWARE

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The EQUIPMENT SUPPLIER, shall provide a PLC-based Control System (PLC-CS) complete and operable, in accordance with the RFP.

1.02 SUBMITTALS

A. Shop Drawings: PLC-CS submittals shall be in accordance with the applicable requirements of Section 13100 – Instrumentation and Control.

B. Submittals: The PLC hardware submittal shall be a single submittal which includes at least the following:

1. A complete set of PLC I/O wiring diagrams, PLC panel wiring diagrams and assembly drawings.

2. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.

3. Data sheets shall be included for each PLC-CS component together with a technical product brochure or bulletin. These data sheets shall show the component name as used within the RFP, the manufacturer's model number or other identifying product designation, the project tag number, the project system of which it is a part, the input and output characteristics, the requirements for electric power, the ambient operating condition requirements, and details on materials of construction.

4. 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 PLC system. Bills of material shall include all items within an enclosure.

5. Calibration, adjustment, and test details for all PLC components.

C. Operation and Technical Manuals: General requirements for Operation and Technical Manuals are as described in Section 01300 – EQUIPMENT SUPPLIER SUBMITTALS. The following items shall also be included in the PLC manual:

1. A documented PLC program listing including the I/O list and housing configuration for each PLC, a memory usage report for each PLC, and a register layout list for each PLC.

2. Operation and Technical Manuals for all hardware furnished under this Section.
1.03 QUALITY ASSURANCE

A. The CONTRACTOR / EQUIPMENT SUPPLIER shall arrange for visits by, and services of, technical field representatives of the manufacturer for installation certification, system testing, training, and start-up. These services shall be part of the WORK and provided at no additional cost to the CITY.

B. Warranty Requirements: Special warranty requirements shall be in accordance with the applicable requirements of Section 13100 – Instrumentation and Control

1. Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the EQUIPMENT SUPPLIER to attain compliance. The cost for doing so shall be the EQUIPMENT SUPPLIER’S responsibility. Following replacement or modification, the EQUIPMENT SUPPLIER shall retest the system and perform any additional procedures needed to place the complete system in satisfactory operation and attain design compliance approval from the ENGINEER.

2. The EQUIPMENT SUPPLIER warrants the materials and workmanship used for the PLCs equipment and materials and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the Work to be as required and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

3. The EQUIPMENT SUPPLIER warrants/guarantees the satisfactory performance of the equipment and materials under operating conditions for a period of two years after the date of final acceptance. In the event that tests and inspections disclose latent defects or failure to meet the specified requirements, the EQUIPMENT SUPPLIER shall proceed at once to correct or repair any such defects or non-conformance. The delivery of new equipment or parts as may be necessary for conformity to the requirements shall be made at no additional cost to the CITY. In case of any required repairs or other corrective or remedial work covered under warranty, the goods repaired, corrected, or replaced under the provisions of this warranty shall be subject to the same warranty provisions for the remainder of the original warranty period or for a minimum period of twelve months from the date of repair or replacement, whichever is longer. If the CITY performs repair, the EQUIPMENT SUPPLIER shall reimburse the CITY for all costs incurred in the removal of the defective material and installation of the replacement.

PART 2 – PRODUCTS

2.01 GENERAL

A. All materials and all PLC-CS 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. Hardware Commonality: Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a single manufacturer.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Manufacturers: The PLC shall be Allen-Bradley CompactLogix 1769-L35E with a built in Ethernet communication port.

B. Each PLC shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment and designed to provide high reliability specifically in this process application. The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply, and all power and interface cables necessary to function as a complete and operable PLC system. The PLC shall be furnished with an onboard RS-232 communication port and other communication ports including but not limited to Ethernet/IP and Profibus DPV1.

C. Design: Each PLC shall have all of the facilities required to implement the control schemes and database indicated. PLC shall have the following functions and features:

1. Modular, field expandable design allowing the system to be tailored to this process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and/or user software.

2. The processor plus input and output circuitry shall be of a modular design with interchangeability provided for all similar modules. Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.

3. The PLC shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.

4. All PLC hardware shall be suitable for an ambient temperature range of 0 to 60 degrees C (32 to 140 degrees F), with an ambient temperature rating for storage of -40 to +85 degrees C (-40 to +185 degrees F), and shall function continuously in the relative humidity range of 5 to 95 percent with no condensation. The PLC system shall be designed and tested to operate in the high electrical noise environment of a wastewater treatment plant.

5. The PLC shall provide a means for mounting the chassis in a standard cabinet.

6. It shall be possible to communicate with remote I/O racks or other PLC’s via fiber optic cable by inserting fiber optic modems.
D. Central Processors (CPU): Each CPU shall contain all the relays, timers, counters, number storage registers, shift registers, sequencer, arithmetic capability, and comparators necessary to perform the indicated control functions.

It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet requirements. Specifically, the PLC shall have the following features and capabilities:

1. All PLC's shall be provided to support and implement closed loop floating and PID control which is directly integrated into the PLC's control program.

2. The CPU shall be a self-contained unit, and shall provide control program execution and support remote or local programming. This device shall also supply I/O scanning and inter-processor and peripheral communication functions.

3. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

4. The main chassis front panel shall include two-color indicators showing the following status information:
   a. Program or Run mode of the CPU
   b. The ok/fault status of the I/O configuration
   c. The ok/fault status of the CPU
   d. Forces Present/Active
   e. If a remote device is communicating via the RS-232 communications link

5. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. Only at the time of a hardware change shall this configuration status be altered or reentered.

E. Program Creation and Storage (Memory)

1. The program storage medium shall be of a static RAM type.

2. The PLC system shall have a user memory size of 1.5MB minimum.

3. Memory capacity shall be configurable to allow for the most efficient match to the intended application. It shall be possible to upgrade to a processor with a larger memory size simply by saving a program, replacing the processor, and downloading the program to the new system without having to make any program changes.

4. Memory shall contain battery back-up capable of retaining all stored program data through a continuous power outage for 4 months under worst case conditions. The
capability shall exist to remove all batteries from the system without removing system power. A low battery condition must be detectable in ladder logic, but shall not automatically generate a major fault.

5. Each PLC unit shall be supplied with sufficient memory to implement the indicated control functions plus a 40 percent reserve capacity. This reserve capacity shall be totally free from any system use.

F. Programming Techniques

1. The programming format shall be IEC 61131-6 compliant Ladder Logic.

2. The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

3. It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions.

4. The PLC shall have the capability to remove an entire logic rung into an edit buffer where individual parameters may be easily altered.

5. A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact.

6. It shall be necessary to issue a two-part command in order to delete all relay ladder rungs from memory. This will provide a safeguard wherein the operator must verify their intentions before erasing the entire program.

7. A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal, user program, or message generation.

8. Latch functions shall be internal and programmable.

9. The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment. The PLC shall have support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, and square root.

10. The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered.
11. The system shall have the capability to enter address comments and symbols. These entities may be entered at the same time the ladder logic is entered.

12. The capability shall exist for adding, removing, or modifying ladder logic rungs during program execution. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs before removal of the prior logic rung is executed.

13. It shall be possible to manually set (force) either on or off all hardwired input or output points from the programming terminal. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

14. The ability to program control logic via symbols from the global database of the PLC shall exist.

15. An instruction shall be supported to incorporate closed loop control systems. The "proportional", "integral", and "derivative" elements shall be accessible to the user in order to tune a closed loop system. This instruction must fully support floating point math.

16. The CPU shall support indexed and indirect addressing of inputs and outputs, along with all data table words (integer, binary, floating point, timers, and counters) for the software instruction set.

G. PLC Power Supply: The PLC shall operate in compliance with an electrical service of 120 VAC. The 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 supply shall be by the same manufacturer as the PLC and shall be of the same product line. A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Auxiliary power supplies shall provide power to remotely located racks.

1. The power supply shall automatically shut down the PLC system whenever its output current is detected as exceeding 125 percent of its rated current. The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120/240 VAC power, the system shall function properly within the range of 85 to 265 VAC.

2. Design features of the PLC power supply shall include diagnostic indicators mounted in a position to be easily viewed by the user.

3. At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the AC voltages are within specifications.

4. The power supply shall offer fuse protection.
H. PLC Input/Output (I/O) Modules: All I/O housings and modules shall be suitable for hostile industrial environments as described above. All I/O modules shall be isolated and conform to Institute of Electrical and Electronics Engineers (IEEE) Surge Withstand Standards and NEMA Noise Immunity Standards. The I/Os shall be 4-20 mA DC for all analog inputs and outputs and shall be 24 VDC 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 a swing-arm or plug-in wiring connector. Each PLC I/O location shall contain the I/O modules required to provide all of the I/O points contained in the I/O Lists. As a minimum, each PLC I/O location shall contain an installed spare capacity of 20 percent. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel. Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel. Upon remote channel shutdown the CPU shall see all inputs on the malfunctioning channel as they were when the shutdown occurred and all outputs shall de-energize on that channel. Circuit components for both remote input and output shall be mounted on plug-in modules and keyed to prevent module insertion into the wrong slot. Isolation shall be used between all internal logic and external power circuits.

1. Discrete Input Modules: Defined as contact closure inputs from devices external to the programmable controller module. Individual inputs shall be optically isolated from low energy common mode transients to 1500 volts peak from users wiring or other I/O Modules. The modules shall have LED’s to indicate status of each discrete input. Input signal level shall be 120 VAC. Input modules shall have 16 points each. Discrete Input Modules shall be Allen-Bradley 1769-IA16.

2. Discrete Output Modules: Defined as contact closure outputs for ON/OFF operation of devices external to the programmable controller module. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak. All output modules shall have LED’s to indicate status of each output point. Output contact rating shall be 2.0 A minimum, 24 VDC. Discrete output contacts shall be provided with interposing relays located in the PLC panel. Output modules shall have 16 points each. Discrete Output Modules shall be Allen-Bradley 1769-OW16.

3. Analog Input Modules: Defined as 4-20 mA DC signals, where an analog digital conversion is performed with 16-bit precision and the digital result is entered into the processor. The analog to digital conversion shall be updated with each scan of the processor. Input modules shall be source or sink to handle 2-wire or 4-wire transmitters respectively. Analog input modules shall have 8 input channels. Analog Input Modules shall be Allen-Bradley 1769-IF8.

4. Analog Output Modules Defined as 4-20 mA DC output signals where each output circuit performs a digital to analog conversion minimum of 16-bit precision with each scan of the processor. The EQUIPMENT SUPPLIER shall provide current loop...
isolators as required to break ground loops. Analog Output Modules shall have 8 current outputs. Analog Output Modules shall be Allen-Bradley 1769-OF8C.

5. A Profibus interface module shall be provided for interface with the VFDs and motorized control valves. The Profibus module shall be Prosoft DPV1.

2.03 PLC ENCLOSURES

A. Each PLC and its corresponding I/O modules, power supply module(s), communication interface device(s), and peripheral equipment. All I/O wiring from the field to the I/O modules shall be terminated on terminal blocks in the enclosure. The PLC panel enclosure shall house the UPS, 24 VDC power supplies and interposing relays. Provide segregation between 120 VAC and 24 VDC components.

B. All panel front mounted instruments, switches, indicating lights, etc. shall be identified by suitable nameplates, fastened with a permanent but dissolvable adhesive or by screws. For NEMA 12 panels, nameplates shall be black lamicoid with minimum 1/4-inch high white letters for major area titles, 3/16-inch for component titles, and 5/32-inch for sub-titles. For NEMA 4X panels, nameplates shall be Type 316L SS with minimum 1/4-inch high engraved letters for major area titles, 3/16-inch for component titles, and 5/32-inch for sub-titles.

C. PLC enclosures shall be provided in accordance with Section 16050 - General Electrical Provisions.

D. Doors with concealed hinges and flush three-point vault type key-locking latches shall be provided. These latches shall be in addition to any required screw clamps. Keys in duplicate shall be provided for each panel door and each instrument, which has a separate lock.

2.04 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Provide and install UPS to power all PLC hardware furnished under this Specification.

B. The Uninterruptible Power Supply (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.

1. The UPS shall incorporate a battery pack, a battery charger, an inverter, and a microprocessor based controller to provide continuous, on-line, computer grade uninterrupted power. Output voltage regulation shall be +3 percent with less than 5 percent total harmonic distortion. UPS efficiency shall be at least 85 percent. The UPS shall be rated for operating temperatures from 32 degrees F to 104 degrees F and relative humidity from 0 to 95 percent non-condensing.

2. Each UPS shall maintain power to all of its connected loads for a minimum of 12 minutes full load. The equipment submittal shall include sizing calculations which
support the model and size selected. The UPS shall be supplied with a low output voltage cutoff to prevent damage to loads when the battery power is exhausted.

3. A bypass switch shall be provided to manually bypass the UPS for maintenance purposes. During bypass operation, the load shall be directly connected to the primary power source.

4. Provide seismic strapping for the UPS.

5. The UPS shall be EATON Powerware PW9130 series, or approved equal.

2.05 HUMAN MACHINE INTERFACE (HMI)

A. The HMI unit shall be an industrial-hardened graphics display touchscreen terminal. The touch screen terminal shall be 12.5” diagonal or as indicated otherwise. It shall be TFT color graphic display flush mounted on the control panel door. The screen shall be scratch-resistant and suitable for indoor installation. It shall be NEMA 4X or as indicated otherwise and suitable for operating temperature range of 32 to 131 degrees F. The application memory shall be 64 MB RAM/64 MB Flash minimum. The HMI shall be Allen-Bradley PanelView Plus 12.5” TFT Touch terminal. Communication between the HMI and PLC shall be through Ethernet.

2.06 PANEL COMPONENTS

A. The main disconnecting mean (fused switch or circuit breaker) shall be provided and shall have a door-mounted handle interlocked with the door, and shall be provided with manual defeater unless otherwise specified or shown.

B. Pushbuttons, selector switches, and pilot lights shall be of the heavy-duty, oil-tight type. Miniature style devices are not acceptable. Devices shall be as manufactured by G.E, Square D, Allen-Bradley or equal.

1. Pilot lights shall be full voltage LED cluster style.

2. Provide hazardous location type pilot devices in classified locations.

C. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by Square D, Potter Brumfield, Allen-Bradley or equal.

D. Time delay relays shall be combination “on delay” and “off delay” (selectable) with adjustable timing ranges. Provide socket with screw terminal connections and retaining strap.

E. Ethernet switches shall be industrial type manufactured by Phoenix Contact.

F. PLC Panel Power Supplies: PLC panels shall be provided with redundant 24 VDC 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. Power supplies shall have an excess rated capacity of 40 percent. The failure of a power supply shall be annunciated at the control panel HMI and repeated to the SCADA System.

G. One grounded 120 VAC, 60 Hz single phase power receptacle shall be provided in the PLC panel.

2.07 PANEL WIRING

A. Control wires shall be #14 AWG minimum, machine tool grade type MTW, UL approved and rated for 90 degrees C at dry location.

B. Instrumentation Signal Cables shall be single twisted pair or multi twisted pairs of stranded, copper cables with 600 volt, 15 mil polyvinyl chloride insulation with 4 MIL nylon jacket over each conductor, overall aluminum-mylar tape shield, overall tinned copper drain wire and 45 mil minimum polyvinyl chloride jacket overall, 90 degrees C dry / 75 degrees C wet rating. Twisted pair cables that are required to be shielded, shall have aluminum-mylar tape shields and tinned copper drain wires over individual twisted pairs of cable. Single twisted pair cables shall be #16 AWG minimum. Cables shall be Okonite "Okoseal-N-type P-OS, type TC", Dekoron type TC or equal.

C. Each control or power panel shall be provided with identified terminal strips for the connection of all external conductors. Terminal blocks shall be screw terminal, heavy duty, rated at 20 amperes minimum, 600 volt AC. The EQUIPMENT SUPPLIER shall provide sufficient terminal blocks to connect 25 percent additional conductors in the future. Termination points shall be identified in accordance with accepted shop drawings.

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.

2.08 SOFTWARE

A. The PLC programming software shall be RSLogix 5000 Enterprise series Professional edition latest version. HMI programming software shall be RSView Studio Machine Edition latest version.

2.09 SPARE PARTS

A. PLC system spare parts shall be furnished in accordance with Section 13100 – Instrumentation and Control
PART 3 – EXECUTION

3.01 STORAGE AND HANDLING

A. All equipment and materials delivered to the Site shall be stored in a location which shall not interfere with the operations of the CITY's personnel or interfere with construction. Storage and handling shall be performed in a manner which shall afford maximum protection to the equipment and materials. It is the CONTRACTOR's responsibility to assure proper handling and on-site storage.

3.02 INSTALLATION

A. The CONTRACTOR shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it provides. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it provides.

3.03 CALIBRATION, TESTING, AND INSTALLATION

A. Calibration: All analog inputs and outputs of the PLC shall have their calibration checked at a minimum of 4 points to verify consistency with the balance of the analog loop. This calibration check shall be done in conjunction with the analog loop tests in Section 13100. Workstation displays and PLC registers shall both be verified for correctness.

B. Testing: After the PLC installation has been certified and the analog points have been calibrated, the PLC shall be tested to verify that all discrete inputs and outputs of both the PLC system and the workstation system are correct. All points shall be checked “end to end”. For example, valve status inputs shall be checked by stroking the valve and a pump start output shall be checked by using it to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Workstation displays shall be verified for correctness at the same time. An I/O checklist shall be used to record test results and a copy provided to the ENGINEER upon completion.

3.04 LADDER LOGIC DOCUMENTATION

A. The EQUIPMENT SUPPLIER shall annotate the PLC ladder logic by providing a descriptive label for all relays and function blocks and functional description of each rung. The EQUIPMENT SUPPLIER shall hand over to the CITY the PLC ladder logic program and all related documentation in electronic format at the end of the warranty period.

– END OF SECTION –
PART 1 – GENERAL

1.01 WORK INCLUDED

The WORK included under this specification consist of furnishing all equipment, materials, start-up services, specialty tools, and other equipment necessary for the electrical and control equipment fabrication, delivery, and testing as specified herein.

C. The intent of the electrical specifications is to provide enough information to the manufacturer to illustrate the electrical equipment standards and requirements for which the power and control system are to be fabricated. All field installation (except the required manufacturer's checking, start-up, and testing) will be done by others.

1.02 REFERENCE STANDARDS

A. All equipment, materials, and methods of design and manufacture are to comply with the National Electrical Code, the basic Electrical Regulations of the State where the equipment is to be installed, the Occupational Safety and Health Act (OSHA), and the requirements of all other applicable codes. Codes and standards of the following organizations may be referred to in this section and shall be considered as the minimum acceptable. A reference herein to any portion of the standard or code is not to be considered as negating any other portion of the standard or code.

ANSI  American National Standards Institute, Inc.
IEEE  Institute of Electrical & Electronic Engineers
ASTM  American Society for Testing & Materials
UL  Underwriters Laboratories, Inc.
NEMA  National Electric Manufacturers Association
IPECA  Insulated Power and Cable Engineers Institute
NEC  National Electric Code
ISA  Instrument Society of America

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.
D. Where these specifications require a higher degree of workmanship or quality of material than the above codes and standards imply, then these specifications will prevail.

1.03 EQUIPMENT SUPPLIER SUBMITTALS

A. Make all submittals in accordance with Section 01300 – EQUIPMENT SUPPLIER SUBMITTALS.

B. Within 15 days after the contract award, submit material lists for this section of the work. Lists will include manufacturer and brand name of each class of material.

C. Submit complete shop drawings for review prior to manufacture or assembly of the equipment.

1. Drawings will show:
   a. Elevations
      Layout and Construction details
   b. Bill of Material
      Nameplates
      Temperature limitations
      Voltage requirement, phase, and current, as applicable
      Grounding requirements (if applicable)
      Catalog cut sheets or brochures for mass produced, non-custom manufactured material.

E. Package drive diagrams are to be of the elementary type and show terminal identifications and associated field connections for each drive.

F. Provide Operation and Technical Manuals in accordance with Section 01300 – EQUIPMENT SUPPLIER SUBMITTALS.

1.04 QUALITY ASSURANCE

A. All equipment furnished under this section will be guaranteed for a minimum period of one (1) year from date of accepted installation against defective materials, design, and workmanship in accordance with the provisions of the General Conditions.

B. Tests

1. The EQUIPMENT SUPPLIER shall be responsible for all factory tests required by specifications in Division 16 and by the ENGINEER or other authorities having jurisdiction. The EQUIPMENT SUPPLIER shall furnish necessary testing equipment and replacement parts resulting from damaged/failed equipment from testing.
2. Where test reports are indicated, proof of design tests 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. Test reports shall be submitted for review prior to Submittal completion.

3. Equipment or material that fails a test shall be removed and replaced. All tests which do not pass shall be repeated after identifying and correcting the problems. Any corrections to equipment or materials that are furnished with a factory warranty shall be corrected per the recommendations of the manufacturer and in a manner which does not violate the terms of the warranty.

1.05 AREA DESIGNATIONS

A. Electrical equipment and components location shall comply with requirements listed in the table below:

<table>
<thead>
<tr>
<th>Area</th>
<th>NEMA ENCLOSURE CLASSIFICATION</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below grade vaults, manholes, etc.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Outdoors, non-hazardous, non corrosive locations</td>
<td>X</td>
<td>UL listed for outdoor &amp; wet locations</td>
</tr>
<tr>
<td>Outdoors, non-hazardous, corrosive locations</td>
<td>X</td>
<td>UL listed for outdoor &amp; wet locations</td>
</tr>
<tr>
<td>Outdoors, hazardous, non-corrosive locations</td>
<td>X</td>
<td>UL listed for outdoor &amp; wet locations, or add rain Shields</td>
</tr>
<tr>
<td>Outdoors, hazardous &amp; corrosive locations</td>
<td>X</td>
<td>UL listed for outdoor &amp; wet locations, and epoxy coated</td>
</tr>
<tr>
<td>Building Interior, non-hazardous, non corrosive locations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Building Interior, non-hazardous, corrosive locations</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Building Interior, hazardous, non corrosive locations</td>
<td></td>
<td>Class 1, Div 1/2 as required by applicable codes.</td>
</tr>
<tr>
<td>Area</td>
<td>NEMA ENCLOSURE CLASSIFICATION</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3R</td>
</tr>
<tr>
<td>Building Interior, hazardous &amp; corrosive locations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Electrical WORK not included in the table above shall be NEMA 4X, unless applicable code requires otherwise.

C. Installation in hazardous locations shall conform strictly to the requirements of the Class, Group and Division indicated or required by applicable codes.

**PART 2 – PRODUCTS**

2.01 GENERAL

A. All equipment and material is to be new, free from defects, of current manufacture, and listed by Underwriters Laboratories, Inc., (UL) where UL requirements apply. All materials are to be products of reputable and experienced manufacturers. Similar items in the project are to be of the same manufacturer. Use only equipment and materials of industrial quality and durability, and capable of long, reliable, trouble free service.

2.02 MOUNTING HARDWARE

A. Miscellaneous Hardware

All nuts and bolts shall be stainless steel.

Anchors for attaching equipment to metal skids shall be stainless steel.

2.03 ELECTRICAL IDENTIFICATION

A. Nameplates: Nameplates shall be fabricated from white-letter, black face laminated plastic engraving stock, Formica Type ES-1, or equal. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes as required. Engraved characters shall be block style with no characters smaller than 1/8-inch top to bottom.

B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices such as manufactured by Brady, Thomas & Betts, or equal, or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place, or equal.
2.04 SIGNAGE AND MARKINGS

A. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal and state OSHA and NEC requirements.

2.05 TERMINAL BLOCKS

B. Terminal Blocks where required shall be screw terminal, heavy duty, rated at 20 amperes minimum, 600 volt AC. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the drawings. Each terminal block shall be uniquely identified.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Documents: The EQUIPMENT SUPPLIER shall provide detailed installation drawing depicting necessary wiring, interlocks, etc. for use by a subsequent installation CONTRACTOR.

3.02 EQUIPMENT IDENTIFICATION

A. Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for pumps and motors, control and instruments. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.

2. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.

3. Equipment names and tag numbers, which indicate on the Drawings, shall be utilized on nameplates.

4. Terminal point on terminal blocks shall be labeled by identifiers attached to the terminal strip. Identifiers shall be pre-printed by the terminal manufacturer custom printed markers, hand lettered markers shall be acceptable.

– END OF SECTION –
SECTION 16100 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in Conditions of the Contract and Section 16050 form a part of this section. This Section outlines the requirements for the basic electrical materials and methods for the electrical work, and forms a part of all other Sections of Division 16 unless otherwise specified.

A. Related Work Included in Other Divisions or Sections (Related Work not Included in This Section).

1. Instrumentation, Division 13.
2. Induction Motors, Section 16150.
3. Variable Frequency Drive Controllers, Section 16483
4. Conductors and cables, Section 16120.
5. Electrical Equipment Testing, Section 16960.

1.02 SUBMITTALS

Submit for the CITY’s approval material lists, shop drawings, factory test reports and technical data to the extent required in this Section and Section 16050.

1.03 WIRING

Wiring for furnished equipment shall include the following:

A. Wiring for Furnished Equipment. The wiring diagram from components to a skid mounted terminal box (if any) shall be provided.

PART 2 - PRODUCTS

2.01 GENERAL

Provide basic materials and all wiring installations as indicated, specified and required.

2.02 METAL CONDUITS (IF APPLICABLE)

A. Metal conduits shall be steel, hot-dipped galvanized (including threads) and equipped with couplings and thread protector caps. The surfaces and threads shall be corrosion-resistant coated. Conduits shall be in ten foot lengths and manufactured in accordance with U.L. 6 by Triangle, Pittsburgh, V.A.W., and Wheatland, Allied or equal. Conduits shall be a minimum size of 3/4 inch.
A. PVC Coated Conduit shall have a polyvinyl chloride coating bonded to the outer surface of rigid steel conduit and couplings. The plastic coating for all PVC coated conduit shall have an average thickness of 0.040 inches. The bonding of the PVC coating to the conduit shall be stronger than the tensile strength of the PVC coating. The polyvinyl chloride coating shall be bonded to the galvanized surface of rigid steel conduit by Youngstown, Kor-Kap, Occidental Coating, Robroy or equal.

2.03 FLEXIBLE CONDUIT (IF APPLICABLE)

A. Liquid-tight Flexible Conduit shall have an interlocked, flexible, galvanized steel core, permanently bonded UV resistant exterior gray polyvinyl chloride jacket and shall be UL listed.

B. Conduits, 1-1/4 inch and smaller shall have an internal copper bonding conductor wound spirally in the space between each convolution.

C. Manufacturers of liquid-tight flexible conduit shall be Anaconda (by Anamet, Inc.), Type UA, Electri-Flex Type LA, Universal or equal.

D. All above ground, outside conduits shall be PVC coated conduits.

2.04 CAST METAL BOXES AND FITTINGS (IF APPLICABLE)

Cast boxes and fittings shall be finished as specified in Section 16050. The outlet bodies, boxes, fittings, covers and supports shall be cast iron alloy with threaded hubs. The materials shall be manufactured by Crouse-Hinds, Appleton, Pyle-National, Esco or equal.

A. Covers and Gaskets shall be provided for all conduit outlet bodies, boxes and fittings. The covers shall be cast iron alloy and equipped with neoprene gaskets. Explosion-proof boxes shall have externally threaded surface covers.

B. Seal Fittings shall be Crouse-Hinds Type EYS or equal. Ceramic or other non-asbestos fiber materials and sealing compound, UL listed to match the fitting, shall be provided for completing the seal.

C. PVC Coated Fittings shall have the same polyvinyl chloride coating that is on the conduit to which they shall be connected. The PVC coating shall have an average thickness of 0.040 inches and the bonding shall be stronger than the tensile strength of the PVC coating. The PVC coating shall be bonded to the surfaces of cast outlet bodies, boxes, fittings, supports, etc. by Occidental Coating, Kor-Kap, Robroy, Youngstown, or equal.

D. Plastic Fittings shall be solvent weld type and shall be compatible with the conduit to which they shall be connected.
E. Expansion/Deflection Fittings shall consist of cast metal conduit hubs securely attached to a flexible outer neoprene jacket. A flexible copper grounding strap shall be provided inside the fitting and connected to the two hubs. The linear expansion or contraction shall be a movement up to 3/4 inch. The linear misalignment shall be a movement up to 3/4 inch. The angular misalignment shall be a movement up to 30 degrees. The expansion/deflection fittings shall provide flexible and watertight conduit joints.

F. Thread Lubricant shall inhibit corrosion and maintain grounding continuity, and shall be Crouse-Hinds STL, Thomas and Betts "Koper-Shield" or UL listed equal.

g. Couplings and Elbows. For rigid steel conduits, the couplings and elbows shall be steel, hot dipped galvanized, threaded and one-piece. For plastic conduits, couplings and elbows shall have plain ends for tight weld fits, which form watertight joints. For joining plastic and rigid steel conduit systems, couplings shall have a plain end and a threaded end.

2.05 STEEL BOXES AND FITTINGS (IF APPLICABLE)

A. Pull Boxes. Boxes 24 inches square and smaller shall have gasketed screw type covers. Larger boxes shall have bi-parting gasketed hinged doors with latch mechanisms, handles and cylinder locks complete. Provide two keys for each lock. Pull boxes shall be painted as specified in Section 16050. The pull boxes shall be Hoffman, Boss, Circle A-W or equal.

B. Outlet Boxes and Fittings for connections to concealed steel electrical metallic tubing (EMT) shall be galvanized, pressed steel, one piece, knock-out type. Box extensions, plaster rings and covers shall fit. See Article 3.03. of this Section for required sizes. Outlet boxes and fittings shall be Appleton, Bowers, Steel City or equal.

2.06 WATER AND GAS SEAL FITTINGS (IF APPLICABLE)

A. Water and gas seal fittings shall consist of a thick, synthetic rubber, sealing ring secured between two metal plates by socket head screws. When the conduit water and gas seal fitting is in place and the screws are tightened, the synthetic rubber shall become compressed between the metal plates and be forced against the conduit inside wall and also against the conductor insulation to form a watertight seal inside the conduit. The synthetic rubber shall resist aging, ozone, sunlight, water, chemicals and extreme temperature variations. The water and gas seal fittings shall be O-Z/Gedney Type CSB or equal.

B. Water and gas wall and floor seals shall consist of a synthetic rubber sealing ring between two pressure rings or a series of synthetic rubber links between pressure plates held together with corrosion resistant bolts, nuts and washers. When the bolts are tightened, the synthetic rubber expands to provide a watertight seal between the outer surface of the entering conduit, and the inner surface of the wall or floor penetration. The synthetic rubber shall resist aging, ozone, sunlight, water, chemicals and extreme
temperature variations. The seals shall be Thunderline "Link-Seal", O-Z/Gedney Type CSM, and FSK, WSK or equal.

2.07 CONDUIT FITTINGS

Conduit fittings shall be hot dipped galvanized steel and cast iron as required.

A. Liquid-tight Conduit Fittings shall be Types LT, ST, CT as manufactured by Crouse-Hinds, Appleton, Pyle-National or equal. Fittings 1-1/2 inch and larger shall have provision for a separate equipment ground conductor.

B. Unions shall be type UNY or UNF. Running threads are not acceptable. Unions shall be Appleton, Crouse-Hinds, Pyle-National or equal.

C. Bushing reducers shall be Appleton, Thomas and Betts, Efcor or equal.

D. Conduit Enlargers shall be Appleton, Thomas and Betts, Efcor or equal.

E. Locknuts shall have notches all around for tightening with a screwdriver. Locknuts shall be Appleton, O-Z, Thomas and Betts or equal.

F. Metallic Insulated Bushings shall have ground terminals and smooth and well rounded surfaces to protect the conductor insulation. The conduit threads shall be deep, clean and easily attached to the conduits. The bushings shall be O-Z, Efcor, Thomas and Betts or equal.

G. Plugs shall be the recessed type and Appleton, Crouse-Hinds or equal.

H. Interchangeable Hubs shall have an insulated throat, sealing ring and vibration-proof nut. Machined serrations on hub and nut shall bite into the metal enclosure assuring an equipment ground. The hubs shall be Myers "Scru-Tite", Efcor "Space-Saver" or equal.

I. Conduit seals shall be Crouse-Hinds type EYSX expanded fill sealing fitting or equal.

2.08 CONDUCTORS AND CABLES (IF APPLICABLE)

Conductors and cables shall be new, single conductor, copper, not smaller than #12 AWG (except control wires when installed inside conduit which may be #14 AWG) unless otherwise indicated, and as shown on the drawings. Control wires at panel and cabinet can be #16, machine tool grade type MTW, UL approved and rated for 90 degree C at dry location. All multi-conductor cables shall be approved for cable tray installation.

A. Conductors 250 kcmil and larger shall be stranded, 600 volts, flame retardant, ethylene propylene rubber insulation, UL labeled, Type RHW, without outer covering. Insulation other than ethylene propylene rubber shall not be used. Conductors shall be Rome FR-EPR, Okonite-FMR, Houston Wire and Cable FREP or equal.
B. Conductors smaller than 250 kcmil shall be stranded (except #10 and #12 for lighting and receptacle circuits which shall be solid), 600 volt and Type THWN or THHN. Conductors shall be Rome, Carol Cable, Techbestos, Triangle, Atlas, Northern or equal. Sizes #10 and smaller shall have colored insulation where indicated.

C. Ground and Neutral Conductors.
   1. Insulated ground and neutral conductors shall be the same type as the phase conductors, except for circuits above 600 volts which shall be Type THWN.
   2. Bare ground conductors shall be copper, soft drawn, annealed, concentric lay, stranded conforming to ASTM Specifications B3 and B8.

D. Fixture Wires shall be rated 90° centigrade, #16 AWG stranded, thermoplastic insulated with an outer jacket. The wire shall be Type TFFN and manufactured by Brand-Rex, Carol Cable or equal.

E. Instrumentation Signal Cables shall be single twisted pair or multi twisted pairs of stranded, copper cables with 600 volt, 15 mil polyvinyl chloride insulation with 4 MIL nylon jacket over each conductor, overall aluminum-mylar tape shield, overall tinned copper drain wire and 45 mil minimum polyvinyl chloride jacket overall, 90° centigrade dry/75° centigrade wet rating. Twisted pair cables that are required to be shielded, shall have aluminum-mylar tape shields and tinned copper drain wires over individual twisted pairs of cable. Single twisted pair cables shall be #16 AWG minimum. Cables shall be Okonite "Okoseal-N-type P-OS, type TC", Dekoron type TC or equal.

F. Wire Lubricant shall be Burndy "Slikon", Holub "Hi- Green", Ideal "Yellow 77" or equal.

G. Identifications on the conductors and cables shall be continuous and include the type, voltage, size and name of the manufacturer.

2.09 WIRE CONNECTORS (IF APPLICABLE)

Connectors shall be provided for splices and terminal connections of all conductors and cables. The connector shall fit the conductor to which it shall be connected, and the assembly shall have joint contact surfaces not less than 50 percent.

A. Compression Connectors shall be copper lugs for terminal connections, and two-way copper sleeves and taps for splice connections. A crimping tool shall be provided to make tight and neat compression connections. The connectors and crimping tool shall be Anderson-Square D, Thomas and Betts, Buchanan or equal.
B. Tapered Spring Connectors shall have live springs attached to inner steel housings and enclosed with plastic insulators, and shall be Buchanan B-Cap, 3-M, Scotchlok Type Y, R, G, B, Ideal Wire-Nut or equal.

C. Connectors in all manholes, handholes and flush with grade pull boxes shall be watertight. Connector splice kits for the wire range size for which they apply shall be 3M Type DB-6 and DBR-6, Buchanan B-cap Twist and Seal, or equal.

D. Electrical Tape shall be plastic, 0.007 inches thick, and resistant to abrasion, alkalies, acids, corrosion, moisture, low and high temperatures. The tape shall be Scotch No. 33 Plus, Plymouth Premium Black No. 4453 or equal.

E. Wire Markers. The individual conductor wire markers shall be adhesive and manufactured by Thomas and Betts, Brady, Scotch 3M or equal. The wire marker to identify groups of conductors shall be nylon cable tie markers as manufactured by Thomas and Betts, Panduit or equal. The marker pads on the cable tie markers shall be large enough to show the motor or device numbers using minimum 3/16 inch high numbers and letters. Manufacturer shall provide permanent marking pens.

2.10 PANELBOARDS (IF APPLICABLE)

Panelboards shall be factory assembled, metal enclosed, dead front and equipped with bus, time switches, contactors, terminals and thermal-magnetic molded case circuit breakers as shown on the drawings.

A. Circuit Breakers shall be molded case, quick-make, quick-break, single and multipole, bolted type, and arranged as shown on the drawings. Each circuit breaker shall have clear indications for "ON", "OFF" and "TRIP" positions. The minimum interrupting capacity shall be 14,000 symmetrical amperes at 240 volts (65,000 symmetrical amperes at 480 volts). As indicated, provide devices to lock the branch circuit breaker in the "ON" and "OFF" positions. Ground fault protection, 5 milliampere sensitivity, shall be provided for the indicated branch circuits, which shall be an integral part of the regular branch breaker. A circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than the regular circuit breaker. Branch circuits that have exterior convenience outlets, toilet convenience outlets, laboratory convenience outlets and as indicated shall be equipped with ground fault protection.

B. Copper Bus shall be provided for panelboard. Bus shall be provided for the complete length of the panelboard branch circuit area including circuits indicated as spaces. Bus bars shall be drilled and tapped for the indicated spaces for installation of future circuit breakers.

C. Single Phase Panelboard, three wires, shall be bussed so that any two adjacent single-pole breakers shall be connected to opposite polarities. A single handle two-pole
D. Three Phase Panelboard, four wires, shall be bussed so that any three adjacent single-pole breakers shall be connected to different phases. A single handle two-pole breaker or three-pole breaker can be installed in any location, and in the same space of two or three adjacent single pole breakers.

E. Terminals and connectors shall be provided for all feeder, branch, neutral and ground conductors shown on the drawings.

F. Circuit Numbers shall start at the top of the panelboard. Odd numbers shall be assigned in sequence on the left side, and even numbers shall be in sequence on the right side of the panelboard.

G. The Cabinet shall enclose the bus and breaker assembly, and shall be steel fabricated and coated with corrosion-resistant finish as specified in Section 16050. The front of the panelboard shall include a trim, hinged door, flush cylinder lock with catch. The lock shall be furnished with two keys, and all locks shall be keyed alike. Fronts shall not be removable when the door is in the locked position.

H. Time Switches shall be provided as indicated and specified in Section 16900.

I. Contactors shall be provided as indicated and specified in Section 16900.

J. Metal Circuit Directory frame and card with clear plastic covering shall be provided on the inside of the door. The directory card shall provide a space at least 1/4-inch high and 3 inches long for each branch circuit. The card shall be completely typed to identify each connected circuit, spare and space.

K. Manufacturers for three phase, 480Y/277 volt panelboard shall be Square D Type NHEB, Cutler-Hammer POW-R-LINE 2, General Electric Type AE or equal. The single phase 120/240 volt and three phase 208Y/120 volt panelboard shall be Square D Type NQOD, Cutler-Hammer POW-R-LINE 1, General Electric Type AQ or equal.

2.11 SUPPORTS

A. Channels shall be steel, cold rolled and PVC coated. One side of the channel shall have a continuous slot. On both sides of the slot, the edges turn inward and form a guide for the spring nuts. The fittings shall be fabricated from steel and attached to the channel with bolts and spring nuts. The channel, fittings and hardware shall be hot-dipped galvanized, and then PVC coated and manufactured by Unistrut, Power-Strut, Kindorf or equal.

B. One-Hole Clamps shall be malleable iron, galvanized for steel conduits and equipped with clamp-backs. The clamps shall be Efcor, Thomas and Betts, Appleton or equal.
C. Beam Clamps shall be malleable iron, galvanized, right angle and parallel types. The clamps shall be manufactured by Efcor, Thomas and Betts, Appleton or equal.

D. Spacers, provided to support underground conduits in concrete encasements, shall be plastic. The spacers shall be Carlon, Johns-Manville, Underground Products or equal.

E. Steel Anchors shall be sleeve and stud types for securing equipment to concrete foundations, floors and walls. The anchors shall be Phillips "Red Head", Diamond or equal.

F. Toggle Bolts shall be steel, spring wing type for securing equipment to hollow walls and ceilings. Toggle bolts shall be Phillips "Red-Head", Diamond or equal.

G. Stanchions shall be structural steel as shown on the drawings, shop fabricated, coated with a rust inhibiting primer per requirements of "Painting and Protective Coatings" Section of the Specifications.

H. Conduit Hangers shall be heavy gauge formed steel, galvanized and then PVC coated and equipped with carriage bolts, 1/4-inch rods and nuts. The hangers shall be Efcor, Kindorf, Appleton or equal.

I. U-Bolts shall be heavy gauge steel, galvanized and equipped with two hexagon steel nuts. The U-bolts shall be Efcor, Kindorf or equal.

J. Fixture Hangers shall be cast iron alloy, cushion type, equipped with cover, screw terminal blocks, and permits the pendant to swing 20 degrees from perpendicular in any direction. Hangers shall be Crouse-Hinds Type ALT, Appleton Type ALT, Pyle-National Type A-2152M or equal.

K. Guardrail clamps, guardrail and conduit in a location should be of the same metal. Where dissimilar metals shall be joined together, the clamps shall be PVC coated and attached with stainless steel hardware.

L. Hardware for corrosive areas shall be 316 stainless steel.

2.12 NAMEPLATES

A. The Nameplates shall be engraved, laminated black plastic with minimum 1/4 inch high letters showing through from the white core, NEMA ES-1, 3-ply (Black-White-Black), 1/16-inch thick, beveled and satin finished. Nameplate inscriptions shall include the identifications for the equipment and loads and shall identify the controls on control equipment as shown on the Drawings. Nameplates shall be provided on receptacle plates with 1/8 inch high letters.
2.13 TAGS

Tags shall be 1/16 inch thick stainless steel and shall have embossed (raised) lettering. Lettering shall be a minimum of 3/8 inch high. Provide a 1/8 inch hole at each end for mounting or wire attachment. All corners shall be rounded and edges ground smooth.

PART 3 – EXECUTION

3.01 GENERAL

Provide the wiring installations and equipment installations, including connections and interconnections as indicated, specified and required in a neat and workmanlike manner. Assure proper fits for all equipment and materials in the spaces shown on the drawings.

3.02 RACEWAYS

Provide all conduit installations, including the outlet bodies, boxes, gaskets, covers, fittings and supports to complete the raceway systems as shown on the drawings and as required. Conduits shall be a minimum size of 3/4 inch. All exposed conduits shall be PVC coated. Install ground conductors in all conduits. This paragraph applies if electrical equipment and components mounted on skids are pre-wired in the factory to a common pull-box or marshalling box.

A. No run of conduit, between device, equipment, box or fitting and another device, equipment, box or fitting, shall contain more than the equivalent of three 90 degree bends (270 degrees total), including offset bends located immediately at the device, equipment, box or fitting.

B. Couplings and Elbows shall be of the same type as the conduit to which they shall be connected, except where rigid steel bends and risers are connected to non-metallic conduits where conduits rise above grade.

C. Flexible Conduits. Flexible conduits shall be liquid-tight with fittings for short tight connections (30 inches maximum) to equipment, except in Class 1, Division 1 areas. A separate ground conductor shall be installed in flexible conduit that does not have the internal copper bonding conductor included by the manufacturer.

D. Threads. All steel conduit threads shall be coated with a conductive, corrosion resisting lubricant, and the connections shall be made watertight. The lubricant shall maintain the grounding continuity.

E. Conduit Connections. Where conduits are connected to couplings, fittings, boxes, etc., a minimum of 5 threads shall be engaged so that the system is rigid and sturdy. Also, the tapered portion of the threads shall be sufficiently engaged to provide electrical continuity. The use of lock-nuts, or other gimmicks with threaded fittings to add rigidity, is not acceptable. Unions shall be provided, as required, for conduit connections to threaded outlet bodies, boxes and equipment, and for connecting two
steel conduits together. Conduit enlargers shall be provided for connecting two conduits of different sizes together.

F. Water and gas seal fittings shall be provided on all conduits that enter or leave corrosive areas. The seal fitting shall prevent corrosive gases from passing from a corrosive area to a non-corrosive area through the conduit system. Ceramic or other non-asbestos fiber material and sealing compound shall be placed in the fitting to complete the seal.

G. Water and gas seal fittings shall be installed on the ends of exterior conduits that terminate at indoor equipment. The fittings shall provide a water and gas tight seal between the wires and cables and the inside of the conduit.

H. Water seal fittings shall be installed to completely water seal the areas around conduits that pass through concrete floors and outside walls, unless concrete is placed after conduit is installed.

I. Tool Marks. Conduits and fittings that have tool marks shall be smoothed and finished with paint that matches the original finish.

3.03 BOXES AND FITTINGS

Conduit outlet bodies, boxes, fittings, gaskets, covers and supports for lighting outlets, lighting switches, receptacles, control stations, alarm, switch and thermostat outlets, etc. in exposed conduit installations, shall be installed as indicated, specified and required, and shall be of sufficient size to provide free space for all conductors that shall be enclosed.

A. Cast Iron. Cast iron outlet bodies, boxes, gasketed covers and fittings shall be connected to expose galvanized rigid steel conduits.

B. PVC Coated. Outlet bodies, boxes, gasketed covers and fittings shall be PVC coated and connected to PVC coated steel conduits.

C. Sheet Steel. Sheet steel boxes shall be of sufficient size to accommodate the connected conduits and enclosed conductors and provided with close-fit holes for steel conduit connections. Weatherproof boxes shall be provided with interchangeable conduit hubs for steel conduit connections as indicated.

D. Interchangeable Hubs. The hubs shall be installed in steel enclosures for rigid steel conduit connections. Cut a close fitting hole in the sheet steel enclosure and place the interchangeable hub in the opening. Connect the hub on the conduit and make a tight connection to the enclosure.
3.04 CONDUCTORS, CABLES, CONNECTIONS AND WIRE MARKERS

Install all the conductors, cables and connections for the wiring as indicated, specified and required. Recommended pulling tensions shall not be exceeded. Provide separate neutral conductors as required. Ground conductors shall be insulated wire unless noted otherwise on the Drawings.

A. Conductors. Conductors shall be completely installed and connected. Apply wire lubricant to ease the pulling of conductors in conduits. Splice and terminal connections shall be made tight with spring and compression connectors. The connectors shall be crimped with a tool that provides uniform and tight connections. Connectors shall be sized as outlined in paragraph on Wire Connectors in this Section. Include all the required wiring interconnections. When routing conductors and cables through pull boxes, the longest (not shortest) route from entrance to exit shall be used.

B. Connections.

1. Low Voltage Connectors. Connectors for conductors No. 8 AWG and larger shall be compression type. Use the provided crimping tool to make tight and neat compression connections. Connectors for conductors No. 10 AWG and smaller shall be tapered spring type.

2. Conductor and cable splices shall be located only in pull-boxes, junction boxes, handholes and manholes.

C. Insulate. All connections shall be insulated as required with tight wraps of plastic tape.

D. Furnished Equipment. Provide wiring installations as shown on the drawings, and specified in other Sections of the Specifications for furnished equipment.

3.05 SUPPORTS

Install the required structural channels, brackets, stanchions, U-bolts, clamps, anchors, hangers, fittings and other hardware to securely attach and support all the equipment, materials and conduits, as indicated, specified and required. Supports shall be PVC coated in corrosive areas.

A. Painting. Brackets, stanchions and other unfinished steel supports shall be painted per requirements of Section 09900 (NOT APPLICABLE).

3.06 NAMEPLATES

Nameplates shall be provided as indicated to identify equipment, and the positions and circuits within the equipment. Also, individually enclosed equipment shall be provided nameplates as indicated. Plastic nameplates shall be positioned and lined-up to provide a neat appearance, and shall be attached to the cleaned metal surfaces of enclosures with stainless steel screws.

A. Plastic Nameplates. Nameplates shall be provided on primary interrupters, switchgears, substations, switchboards, service equipment, motor controllers, motor control centers,
panelboards, and individually enclosed circuit breakers, disconnect switches, magnetic starters, manual starters, relays and control stations unless otherwise indicated. Provide lighting switch nameplates as indicated on the drawings.

B. Nameplates shall be attached to the object, or adjacent to the object, with self taping screws. Adhesive materials shall not be used for attachment. Objects such as explosion proof enclosures, that would have their UL listing nullified by drilling for mounting screws shall have their nameplate mounted on an adjacent wall or plate provided by the Constructor.

3.07 CHECKING, ADJUSTING AND TESTING

Provide the required labor and equipment, and all checking, adjusting and testing in the factory.

a. Check. All wire terminals shall be checked to assure tight connections.

B. Tests.

1. Tests shall be per Section 16960.

2. For items not included in Section 16960, tests shall be performed per NETA and IEEE standards, to detect wrong connections, short circuits, continuity and ground. Tests shall be made with a hand crank test instrument (megger) on all transformer windings, motor windings and all cables and conductors.

NOTE: WARNING. Do not make insulation tests on any conductors either signal or power that are connected to semi-conductor type equipment. Disconnect the conductors from the equipment before insulation testing; severe damage may result from megger-type instruments. Power feeders and branch conductors shall be tested phase to phase and phase to ground. Phase to ground tests on shielded cable shall mean "conductor to shield". After insulation resistance tests have been performed, high voltage and medium voltage shielded cables shall be "hi-Pot" tested in accordance with the current ICEA Standards and the manufacturer's recommendation. Voltage shall be applied and removed in a slow, even manner, and the conductors shall be grounded for at least one minute after the voltage is removed to insure that no charge remains. Test voltage and application time for the various cables and conductors shall be submitted to the CITY. Correct any defects in the wiring systems.

C. Equipment Tests. Perform equipment tests as indicated and directed at the factory.

D. Test Data. Test data for equipment shall be submitted to the CITY.

– END OF SECTION –
SECTION 16120 – CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 WORK INCLUDED

G. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less. This specification is applicable for all factory wired and skid mounted equipment and electrical components.

1.02 REFERENCE STANDARDS

H. This section references the latest revisions of the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ASTM B 3  Soft or Annealed Copper Wire

ASTM B 8  Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard or Soft

ASTM B 33  Tinned soft or Annealed Copper Wire for Electrical Purposes

PART 2 – PRODUCTS

2.01 GENERAL

A. Cables shall be identified on the overall jacket as to the manufacturer's name, cable size, number of conductors, type of insulation, type of jacket, cable type, and voltage rating.

2.02 600 - VOLT CABLE

A. Wire: All conductors shall be copper. No aluminum shall be used. Sizes No. 12 and 14 American Wire Gauge (AWG) shall be solid conductors; wires No. 10 AWG and larger shall be stranded. All control wire installed inside conduit shall be stranded, No. 14 AWG minimum. Provide conductors with Type Thermoplastic High Heat-resistant Nylon-coated/ Thermoplastic High Water-resistant Nylon-coated (THHN/THWN) insulation, unless installation conditions or applicable codes requires otherwise.

C. Identification: All 600-V wiring used in power circuits shall be color coded in accordance with the following table. Wire sizes No.6 AWG and smaller shall be factory colored; wire sizes No.4 AWG and larger shall be black with colored vinyl tape applied at all splices and terminations.
<table>
<thead>
<tr>
<th>Use</th>
<th>Cable</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase, 480V/277V power and lighting</td>
<td>Phase A&lt;br&gt;Phase B&lt;br&gt;Phase C&lt;br&gt;Ground&lt;br&gt;Neutral</td>
<td>Brown&lt;br&gt;Orange&lt;br&gt;Yellow&lt;br&gt;Green&lt;br&gt;Gray or White with distinctive stripe</td>
</tr>
<tr>
<td>Three-phase, 208Y /120V</td>
<td>Phase A&lt;br&gt;Phase B&lt;br&gt;Phase C&lt;br&gt;Ground&lt;br&gt;Neutral</td>
<td>Black&lt;br&gt;Red&lt;br&gt;Blue&lt;br&gt;Green&lt;br&gt;White</td>
</tr>
<tr>
<td>Single-phase, 3 wire 120/240V power</td>
<td>Phase A&lt;br&gt;Phase B&lt;br&gt;Ground&lt;br&gt;Neutral</td>
<td>Black&lt;br&gt;Red&lt;br&gt;Green&lt;br&gt;White</td>
</tr>
</tbody>
</table>

D. Sources: The Okonite Company. Anaconda-Ericsson, or approved equal.

2.03 SIGNAL CABLE

A. Instrumentation cable shall be stranded conductor, tinned copper, polyethylene insulated, aluminum polyester shield, stranded tinned copper drain wire, chrome PVC jacket, 100% shield coverage, 300V, 150°C

Single pair cable (1 TSP) shall be #16 gage, Belden, or equal.

Two pair cable (2TSP) shall be #20 gage, Belden, or equal.

E. Computer cable shall be RS-422, general purpose, 4-conductor, shielded.

2.04 PORTABLE CORD

A. Portable cord shall be UL listed, Type SO for sizes No. 10 AWG and smaller. Cords with conductors larger than No.2 A WG shall be UL listed Type G. Cords shall contain an equipment grounding conductor. Cable characteristics shall be as follows:

Conductors: Flexible rope stranded per ASTM B 189 and B 33. Conductors shall be coated except ground conductors may be uncoated.

Insulation: Insulation shall be ethylene propylene as per ICEA S-68-516 and rated for continuous operation at 90 degrees C, 600V

Heavy-duty mold cured neoprene as per ICEA S-68-5 16.
2.05 SPLICING AND TERMINATION MATERIALS

A. 600V Conductor and Cable Connectors

Connectors shall be I-piece tool applied compression type of required size, UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated ring tongue or locking-spade terminal. Connectors for wire sizes No.8 AWG and larger shall be 1-hole lugs up to size No. 3/0 AWG, and 2-hole or 4-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

In-line splices and taps shall be used only with prior approval of the ENGINEER. When used, they shall be of the same construction as other connectors.

F. Portable Cable Fittings: Portable cable fittings for terminating the cable shall provide a watertight seal between the cord and the terminator and between the terminator and mounting hub. The cable terminator shall be provided with a neoprene liner which grips the cord jacket when the back nut on the fitting is tightened. In addition, on pendant cord applications and other applications where specified, a stainless steel wire mesh cord grip shall be provided as an integral part of the cord terminator.

G. Wire Markers: Each power and control circuit conductor size No. 10 A WG or smaller shall be identified as specified at each terminal to which it is connected with a legible permanent coded marking sleeve. Sleeves shall be hollow or white tubing, sized to fit the conductor insulation, with machine printed black marking, and shall be TMS Thennofit Marker System by Raychem Co., sleeve style wire marking system by W.H. Brady Co., Floy Tag and Mfg. Co., or equal. Adhesive strips are not acceptable. Conductors No.8 A WG and larger shall be identified by cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

PART 3 – EXECUTION

3.01 GENERAL

A. Cables crossing hinges shall be made up into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved. These groups shall be protected by spiral wrap and have a minimum 12-inch loop.

3.02 WIRE AND CABLE TERMINATION

A. Power conductors No. 10 AWG and larger may be terminated directly in box-type lugs without terminals. Insulated terminals of the spade or ring-tongue type shall be used on all stranded control and power conductors No. 12 A WG and smaller. Insulated terminals shall be used also on all stranded instrumentation wiring special instrumentation cables shall be terminated in accordance with the recommendations of the manufacturer of the equipment and subject to acceptance of the ENGINEER.
H. No splices shall be used in power and control wiring continuous from point-to-point.

I. The wiring shall be all control conductors in instrument and relay compartments of motor control centers, in control panels, instrument panels, field panels and control stations as well as connections to mechanical equipment shall be tagged at each end with legible, permanently coded wire-marking sleeve showing the complete wire designation.

J. All field wiring to pushbutton stations and other isolated control devices shall be labeled at each end with the complete circuit number. All wiring to other panels, relay compartments of the same panel or interlocking wiring shall have the applicable double identification at each end of the conductors.

3.03 600-VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment, No.6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct.

K. Stranded conductors shall be terminated as described in Paragraph 3.02 except where terminals will not accept such terminations. In these cases, the conductors shall be terminated directly on the terminal block. Compressions lugs and connectors shall be installed using manufacturer's recommended tools.

3.04 PORTABLE CORD

A. Portable cord feeding permanent equipment, such as pumps, cranes, hoists and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Weatherproof strain relief fittings shall be used for all connections. Forty-five-degree and 90-degree connectors shall be used where applicable to prevent unnecessary strain on cords. Flexible cords feeding submersible motors shall be similarly protected, but the cord shall be of nonwicking neoprene construction.

– END OF SECTION –
PART 1 – GENERAL

1.01 DESCRIPTION

Requirements specified in Conditions of the Contract, Section 16050 and Section 16100 form a part of this Section. This Section outlines the electrical requirements for squirrel-cage induction motors.

1.02 SUBMITTALS

Submit for the CITY’s approval shop drawings, factory test reports, manufacturers' certified reports and technical data for motors supplied with driven equipment to the extent required in this Section, Section 16050 and the Specification Sections for mechanical equipment.

A. Shop Drawings. In addition to information to be included in the shop drawings as specified in Section 16050, shop drawings shall include the following:

1. Motor locked rotor and full load currents.
2. Power factors and efficiencies at full load, three quarters load and half load.
3. Motor housing material, winding material, NEMA Design letter, NEMA Code Letter, ambient temperatures and maximum elevations in which motor is designed to operate continuously, service factor, NEMA insulation Class, temperature rise, type of enclosure, voltage, bearing life and dynamic balance; all of which shall comply to the requirements of the specifications.
4. Nameplate data.
5. Dimensions and weights of motors.
7. Speed torque/current at 100 percent volts.
8. Wiring diagrams, internal and typical external connections.
9. Letter or standard motor manufacturer’s literature confirming that motor (or motors) are designed for use with adjustable frequency drives/SCR drives.
10. Time-current damage curves, plotted on full size log-log paper for motors 100 horsepower and larger.

B. Current Data. Submit eight copies to the CITY of field recorded current data. The data shall indicate the full load current for each motor and current rating for the overload relay in each motor starter and controller.
PART 2 – PRODUCTS

2.01 GENERAL

Motors shall be supplied by the manufacturer of the driven equipment as specified in this section, and specifically outlined in the driven equipment specifications. The Motors shall be completely fabricated, assembled, checked and tested at the factory in accordance with NEMA MG-1. The induction motors shall be Baldor, General Electric, Toshiba, Reliance, Siemens, and U.S. Electrical Motors.

A. Motor Ratings.

1. Torque and slip characteristics shall be as recommended by the manufacturer of the driven equipment and as specified. Motor manufacturer shall confirm motor capability to the specifications.

2. Motors shall have a continuous rating and shall operate continuously and satisfactorily in ambient temperatures from minus 10 degrees Celsius to plus 40 degrees Celsius at a maximum elevation of 3,300 feet without exceeding nameplate horsepower rating.

3. The motors shall have high power factor and the minimum power factor shall be 80 percent at full load.

4. Motors shall be designed for high efficiency. Motors with the following minimum efficiencies, at full load, shall be provided:
   a. 84 percent minimum efficiency shall be provided for motors through 5 horsepower.
   b. 87.5 percent minimum efficiency shall be provided for motors 7-1/2 through 15 horsepower.
   c. 91 percent minimum efficiency shall be provided for motors 20 through 40 horsepower.
   d. 93 percent minimum efficiency shall be provided for motors 50 through 125 horsepower.
   e. 95.4 percent minimum efficiency shall be provided for motors 150 to 400 horsepower.

5. The motors shall be sized so that the maximum BHP of the load does not exceed 90 percent of the full load nameplate horsepower of the motor unless otherwise indicated in the driven equipment specifications.

6. The motor must be able to accelerate the driven machine from zero to top speed at 90 percent of rated voltage without overheating.
7. The maximum locked rotor KVA/HP code letter for motors smaller than 15 HP shall not exceed the requirements for NEMA Design B motors. The maximum locked rotor KVA/HP code letter shall be Code G for motors 15 HP through 250 HP unless otherwise indicated. The maximum locked rotor KVA/HP code letter shall be Code F for motors 300 horsepower and larger unless otherwise indicated.

8. All motors shall be insulated and braced for full voltage across the line starting regardless of the starting method used.

9. Motors 1/2 HP and larger shall be NEMA MG1-1.16 Design B and shall have NEMA MG1-1.66 Class F insulation, minimum.

10. The temperature rise by resistance above the temperature of the cooling medium, for each of the various parts of the motor shall not exceed the values of the NEMA MG1-1.66 Class B insulation system as indicated in NEMA MG 1-12.43.

11. All motors shall have a 1.15 service factor at the specified maximum ambient temperature

12. Motors 1/2 HP and larger shall be 460 volts, 3 phase, 60 Hertz unless otherwise indicated.

13. Motors smaller than 1/2 HP shall be 115/230 volts, 1 phase, 60 Hertz unless otherwise indicated.

14. Motors for variable speed application equipped with adjustable frequency drive controller shall be of the inverter duty type with winding temperature switches for alarm and shutdown application. The permeate pump and air scour blower motors shall be inverter duty type with winding temperature switches for alarm/shutdown applications.

B. Motor Construction.

1. Enclosures for induction motors shall be approved for the installations and as indicated. The enclosure types shall be one of the following as outlined in the driven equipment specifications unless otherwise indicated.
   a. Weather Protected 1.
   b. Totally-enclosed fan cooled.

2. Housing, end brackets and all outside components shall be cast iron.

3. A condensate drain hole shall be provided on all non explosion-proof enclosed motors. The drain hole shall be provided in each end bracket on horizontal motors. A single drain hole shall be provided in the lower bracket of vertical motors.

4. The motors shall be equipped with terminal boxes for all conduit and wire connections as required.
a. The terminal boxes shall be properly sized, diagonally split, cast iron, and rotatable in 90-degree steps. Provide a gasket between the box and motor frame and between the box and the cover. Terminal boxes shall be attached to the motor frame with grade 5 zinc plated and chromated steel bolts or cap screws. All terminal boxes shall have threaded holes for conduit entrance.

5. The castings shall be coated with a red-oxide zinc-chromate primer, and finished with a corrosion resistant epoxy coating. All fabricated steel enclosures shall be coated on all inside and outside surfaces except shafts and register fits.

6. Provide stainless steel nameplates of ample size with clear numerals and letters.
   a. Nameplates shall indicate the manufacturer, serial number, model number, type, horsepower, phase, hertz, volts, design, full load amperes, locked rotor code letter, service factor, speed, insulation class, temperature rating, information required by NEMA MG 1-10.39, NEMA MG 1-10.40 and other essential data.
   b. Nameplate data shall be in the English language and units.
   c. Nameplates shall be secured to the motor frame with corrosion resisting pins in accessible locations.

7. Ground lugs shall be provided in all main motor terminal boxes for grounding.

8. All motors shall have copper windings.

9. Antifriction bearings shall be grease lubricated except for vertical high thrust motors which may require oil lubrication.
   a. at one year B-10 bearing life.
   b. Pre-
   c. lubricated, double shield bearings are acceptable only on single phase and 56 frame motors Grease lubricated bearings shall include accessible fittings for in-service, periodic relubrication.
   d. Oil lubricated bearings shall be a reservoir type with a sump for settling foreign matter, accessible and exterior fill and drain plugs and a visual oil level indicator with maximum and minimum indicator levels.
   e. Horizontal, direct connected motor bearings shall be designed for 1 year minimum B-10 bearing life at NEMA minimum V-belt criteria for the rating.
   f. Horizontal, V-belt connected motor bearings shall be designed for 3 year minimum B-10 bearing life for the application V-belt drive or 1 year minimum B-10 bearing life at NEMA minimum V-belt criteria whichever is more restrictive.
g. Vertical motor bearings shall be designed for 2-year minimum B-10 bearing life at design operating thrust. At maximum operating thrust, B-10 life shall not be less than one year. Transient (shut-off) thrust shall not exceed 30% of the static deformation limit. Motor shall be designed for 30% momentary upthrust capacity except 3,600 RPM units, which must have 30% continuous upthrust capacity. Any system, which exceeds 30% upthrust must be designed for continuous upthrust.

10. The dynamic balance of motors built in frame size 143 and larger shall be 0.001 inches total amplitude or peak-to-peak displacement.

11. Accessories shall include the following:
   a. Space heater shall be provided for all outdoor motors and motors installed in confined and damp location. The space heater shall be 120 volt, 1 phase, and adequately sized to raise the temperature inside the motor to a minimum of 6 degrees Fahrenheit above ambient and provide temperature switches on the windings for alarm and shutdown functions.
   b. For motors 200 HP and larger provide temperature sensors in stator windings of pump motor. Six (6) RTD type temperature sensors shall be provided.
   c. For motors 200 HP and larger provide temperature sensors in pump motor’s bearings. Two (2) RTD type temperature sensors shall be provided.

12. Motors shall have a guaranteed maximum noise level in accordance with NEMA MG1-12.49 for integral horsepower motors and NEMA MG1-20.50 for large motors, except where more restrictive requirements are outlined in other Sections of the Specifications.

PART 3 – EXECUTION

3.01 GENERAL

Provide all the equipment installations and wiring installations, including connections as indicated, specified and required. Assure proper fits for all equipment and materials in the spaces as shown on the Drawings.

A. Motors.

   1. Provide power, control, alarm, and grounding installations for all motors as indicated and required.
   2. Check the connections and provide correct rotation for all motors.
   3. Record the full load current to each motor, and the overload relay rating in each motor starter for the certified data submittal.
   4. Provide the wiring for heaters in the motor frames and the required controls to deenergize the heater when the motor operates.
5. Provide the required wiring for all control equipment that shall be furnished and installed by other Sections of the Specifications.

6. Install the motor control stations as shown on the Drawings.

7. Field damaged factory finish on equipment shall be touched-up with paint that is equal in quality and color to the original factory finish.

3.02 FACTORY TESTS

A. All Motors shall be given a standard commercial test as defined by NEMA MG 1-12.51 and IEEE 112 a and b.

B. Conduct megger test and record reading of all motor windings just prior to connecting the motor to its feeder to determine if accumulation of moisture has occurred in the motor during storage. The reading shall be documented, submitted to the ENGINEER for review, and included in the final Operation and Technical Manuals.

C. Noise Tests shall be determined by measurement in accordance with the latest revision of IEEE-85, Test Procedure for Air Borne Noise Measurements and Rotating Electrical Machinery. The motor shall be operating during test on rubber at no load with rated voltage and frequency.

D. Vibration Tests shall be per NEMA MG 1-12.07 for small and medium motors and MG 1-20.54 for large motors, except 3,600 RPM motors greater than 250 horsepower and motors with sleeve bearings shall be tested at full nameplate horsepower load and temperature.

E. All Testing, other than locked rotor conditions shall be at full voltage ±5 percent.

3.03 FIELD CHECKS

A. Motor Installations shall be complete and correct.

B. Operation Tests shall be performed to observe that motors start, run and stop satisfactorily under design load.

– END OF SECTION –
SECTION 16483 – VARIABLE FREQUENCY DRIVE CONTROLLERS

PART 1 – GENERAL

1.01 WORK INCLUDED

A. This Section includes solid-state, Pulse Width Modulation (PWM), VFDs for speed control of three-phase, induction motors. VFDs are to be integral to motor control centers when applicable. All VFD Controllers shall be equipped with Profibus System Accessory Interface module and Communication Module with input points.

1.02 SUBMITTALS

A. Product Data: For each type of VFD, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. The following shall be included in the Proposal package:

1. Description of equipment and tests included in Proposal to meet the indicated power quality requirements.

2. Nearest factory authorized service center meeting all requirement of 1.3A.

3. Qualification and name of engineering and technical persons responsible for support and warranty of this project.

C. The following shall be included in the submittal package and be approved by the ENGINEER prior to any construction of the VFD system:

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current ratings of integrated unit.
   d. UL listing for series rating of overcurrent protective devices in combination controllers.
   e. Features, characteristics, ratings, and factory settings of each motor controller (VFD).

2. Wiring Diagrams: Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD.

4. Carrier frequency information.

D. Qualification Data: For testing agency and manufacturer.

E. Field Test Reports: Written reports specified in Part 1.12 below.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in other sections, include the following:

1. Routine maintenance requirements for VFDs and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, preferably in Visalia, CA, a service center capable of providing training, parts, and 24 hour emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

C. The system shall be pre-integrated with the necessary harmonic mitigation equipment.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


PART 2 – PRODUCTS

2.01 COORDINATION

A. Match features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

B. Match features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load. See Divisions 11 and 13 sections for information on motor control requirements.
2.02 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency. Refer to Section 16150 for additional information on motors controlled by VFDs.

All VFD control keypad, pushbuttons, switches and pilot lights shall be mounted on the face of the control panel for easy access.

B. VFDs will be required for the following:

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Equipment</th>
<th>Constant / Variable Torque</th>
<th>Rpm</th>
<th>Enclosure Type</th>
<th>Voltage / Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>3600</td>
<td>12</td>
<td>480/3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>1800</td>
<td>12</td>
<td>480/3</td>
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<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>1800</td>
<td>12</td>
<td>480/3</td>
</tr>
</tbody>
</table>

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 6 to 120 Hz, with horsepower constant throughout speed range.

E. Unit Operating Requirements:

1. Input ac voltage tolerance of 480 V, plus or minus 10 percent.
2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
3. Output Rating: 3-phase; 6 to 66 Hz, with amperage equal or greater to motor nameplate amperage including altitude derating.
4. Minimum Inverter Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent lagging.
6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
7. Starting Torque: Default to be 50% with adjustment to 120%.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over an 10:1 speed range.
F. **Internal Adjustability Capabilities:**

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: Adjustable from 0.01 to 3600 seconds.
4. Deceleration: Adjustable from 0.01 to 3600 seconds.
5. Current Limit: 50 to 110 percent of maximum rating.

G. **Self-Protection and Reliability Features:**

1. Input transient protection by means of surge suppressors.
2. Snubber networks to protect against malfunction due to system voltage transients.
3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Filtering to prevent noise interference with other electronic equipment.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
10. Short-circuit protection.
11. Motor overtemperature fault.

H. **Automatic Reset and Restart:** To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bi-directional auto speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. **Power-Interruption Protection:** To prevent motor from re-energizing after a power interruption until motor has stopped. VFD to automatically re-start motor after outage.

J. **Carrier Frequency Adjustment:** Provide ability to manually adjust drive carrier frequency. VFDs 100HP and less shall provide carrier frequency adjustment capability from 1 to 10 kHz. VFDs over 100HP shall include carrier frequency adjustment information recommended by the manufacturer.
K. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

M. Provide line and load side filtering to minimize total harmonic distortion.

N. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   External fault.


P. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   3. Motor status (running, stop, and fault).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

Q. Control Signal Interface: Provide VFD with the following:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 ma.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.

4. Output Signal Interface:
   a. Provide analog output signals (0/4-20 mA), which can be programmed for the following:
      b. Output frequency (Hz).
      c. Output current (load).
      d. DC-link voltage (VDC).
      e. Motor torque (percent).
      f. Motor speed (rpm).
      g. Set-point frequency (Hz).

5. Remote Indication Interface: Provide dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high or low speed limits reached.

6. Communication link: Profibus

R. Provide bypass switch and contactor to allow manual bypass of the drive and across-the-line starting.
S. Integral Disconnecting Means: Provide Heating, Air Conditioning & Refrigeration (HACR) rated breaker as indicated on drawings.

2.03 ACCESSORIES

A. Devices shall be factory installed in motor control center.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   7. Motor output voltage (V).

F. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 per-cent, or loss of supply voltage; with adjustable response delay.

H. Harmonic Mitigation: Complying with IEEE Standard 519-1992 shall be a requirement of this project. Harmonic filters, 18 pulse converter configurations, phase multiplication devices, or any other components required to mitigate harmonic voltage and current to
IEEE Std. 519-1992 shall be an integral part of the VFD system. Designs which are not pre-integrated and factory wired as part of the UL label will not be acceptable.

1. Designs which cause voltage rise at the VFD terminals must document coordination with the total system variation to prevent nuisance tripping.

2. Designs which do not provide both true and displacement, measured at the VFD terminals, of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads are not acceptable.

I. Relevant data for VFD EQUIPMENT SUPPLIER calculations to meet IEEE Std. 519-1992 requirements are as follows:

1. The point of common coupling (PCC) shall be defined per IEEE Std. 519- 1992.

2. The calculated load current (IL) shall be the total combined full load current of each ASD system supplied as part of this project or the total combined amperage of loads designated as “non-linear”.

3. The short circuit current (ISC) available at the PCC is estimated at 65,000 amps.

2.04 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:


2. Or approved equal

B. Contractor job site integration of reactors, harmonic filters, power components, etc. will not be acceptable. Start-up, harmonic testing and warranty support services must be supplied by the above or other ENGINEER pre-qualified vendor/manufacturer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.

B. Select rating of controllers to suit motor controlled. The VFD vender shall certify that the supplied equipment is properly matched to the loads being fed.
C. The drive shall be capable of operating in compliance with IEEE 519-1992, with point of common coupling (PCC) as defined by the standard. Drive manufacturer shall provide harmonic calculations and on-site post installation harmonic testing with certified reports prior to final acceptance of installation. See 1.1 2.A.3.

3.03 IDENTIFICATION

A. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.


B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFDs.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
3.06 STARTUP SERVICE
   A. Delete first paragraph below if factory-authorized service representative is not required.
   B. Engage a factory-authorized service representative to perform startup service.
   C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
   D. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING
   A. Set field-adjustable switches.

3.08 CLEANING
   A. Clean VFDs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.09 DEMONSTRATION
   A. Engage a factory-authorized service representative to train CITY's maintenance personnel to adjust, operate, and maintain VFDs.

– END OF SECTION –
SECTION 16485 - UNIT CONTROL PANELS

PART 1 - GENERAL

1.01 WORK OF THIS SECTION

A. The Vendor shall provide complete unit control panels (UCP) as shown and as specified herein or in other Sections of the Specification. The UCP shall be designed to provide the vendor’s sequence of operation relevant mechanical sections.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. UCP shall comply with the requirements of NEC, NEMA, and UL.
B. UCP shall meet the requirements of UL 508A.
C. All work specified herein shall conform to the requirement of Section 16050 – General Electrical Provisions and Section 16100 – Basic Electrical Materials and Methods.

1.03 SUBMITTALS

A. The Vendor shall submit shop drawings in accordance with the requirements specified in Sections 01300 - Contractor Submittals, and 16050 – General Electrical Provisions.
B. Ladder diagrams and written descriptions explaining system operation shall be provided with shop drawings.
C. When microprocessor based solid-state control unique to the specific control systems are provided, written description of the operation of the systems with supplemental ladder diagrams or brochures shall be submitted.
D. Provide catalog cuts of all control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Vendor shall provide the UCP that satisfy the functional requirements specified in the relevant mechanical equipment, and Instrumentation & Control specification sections and as shown on the Electrical Elementary Schematics. Each UCP shall be fabricated with UL labeled components. UCP not specifically specified as being provided in other Sections of the Specification shall be furnished and installed under this Section. All UCP 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 panels shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with the requirements specified in Section 16050 and 16120.
C. Each UCP shall be provided with identified terminal strips for the connection of all external conductors. The Vendor shall provide sufficient terminal blocks to connect 25
percent additional conductors in the future. Termination points shall be identified in accordance with accepted shop drawings. The UCP shall be the source of power for all interconnected devices and items. All equipment associated with the UCP 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 shall meet the requirements of AREA CLASSIFICATION and ENCLOSURES specified in Section 16050 – Electrical Work, General.

F. Main disconnecting mean (circuit breaker rated 65 KAIC unless otherwise shown on the drawings) shall be provided and shall have a door-mounted handle interlocked with the door, and shall be provided with manual defeater unless otherwise specified or shown.

G. The UCP manufacturer shall provide short-circuit and overload protection for the system and equipment connected and controlled by the panel, unless otherwise shown on the drawings or specified elsewhere.

H. Identification of panel-mounted devices, conductors, and electrical components shall meet the requirements specified in Section 16050.

I. All panel-mounted devices shall be mounted a minimum of 3 feet above finished floor elevation.

2.02 PANEL COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be of the heavy-duty, oil-tight type. Miniature style devices are not acceptable. Devices shall be as manufactured by G.E, Square D, Allen-Bradley or equal.

1. Lens colors shall be red for "run," or " closed "; green for "stopped ", " open ", and amber for alarm or shutdown.

2. Pilot lights shall be full voltage LED cluster style.

3. Provide hazardous location type pilot devices in classified locations.

A. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by Square D, Potter Brumfield, Allen-Bradley or equal.

B. Elapsed time meters shall be non-re-settable type read to a maximum of 99999.9 hours and shall be as manufactured by G.E., or equal.

C. Combination magnetic starters shall meet the following requirements:

1. Minimum size of starter shall be NEMA-1. IEC or dual NEMA / IEC rated type are not acceptable.

2. Starter shall be combination starters with magnetic only instantaneous trip circuit
breakers such as G.E., "Mag-Break," or equal.

3. Control power transformer shall be provided, with primary and secondary fuses, 120 VAC maximum control voltage.

D. Terminal strips shall be provided for all panels and shall be of the flanged fork or ring lug type suitable for No. 12 A.W.G. stranded wire minimum. Provide 25 percent spare terminals in each panel.

E. Current-to-current converter/isolators shall be 4-20 mA input, 4-20 mA output for operation from 120 volt AC power, and shall be by Moore, A.G.M., or equal.

F. Process alarm relays (current trip relay) shall have a 4-20 mA input and two (2) independent SPST contact outputs as manufactured by A.G.M., Moore, or equal. Power input shall be 120 VAC.

G. Digital indicators shall have 4-20 mA input and shall display the signal in process units. 0-100% as a displayed signal shall only be acceptable to indicate speed. Indicators shall be as manufactured by Newport, Red Lion, or equal for operation from 120 VAC. Provide splash-proof covers in NEMA 4X panels, and viewing windows in NEMA 7 panels.

H. Single and Multi-Loop Controllers shall have the following features:

1. Analog and digital inputs and outputs as specified, or shown on the P & ID.
2. PID control algorithms.
3. Graphic display indicating input, setpoints and all alarms.
4. Operate on 120 VAC. Face shall be approximately 3"W x 6"H.
5. Unit shall be provided completely programmed and ready for use. Include a portable programming device.
6. Provide window kit for the UCP enclosure over all controllers.

I. Manual loading stations shall have 4-20 mA outputs and 4-20 mA inputs for remote or auto control. Switching from local and remote or from manual to auto shall be by means of controls on the face of the unit or by isolated contact closure as shown on the elementary schematics. Provide window kit for the enclosure over all manual loading stations.

J. Time delay relays shall be combination “on delay” and “off delay” (selectable) with adjustable timing ranges. Provide socket with screw terminal connections and retaining strap.

K. Reset Timers: Reset timers shall be synchronous motor driven with a solenoid operated clutch. Timer shall be on-delay for semi-flush panel-mounting. The timers shall be rated 120-volt, 60 Hz, with 10-amp rated contacts, and with time range as shown.

L. Any relays, devices and switches, etc, located in Hazardous Areas and connected to the panels shall be explosion proof type or intrinsically relay or barrier shall be installed in the unit control panel.
M. Programmable logic controller(s) (PLC’s) may be supplied with panel, in lieu of relays, provided the programmable logic controllers match the PLCs furnished under Section 13510 – PLC Based /control Hardware.

2.03 FACTORY TESTING

A. Each UCP shall be factory assembled, and tested for sequence of operation prior to jobsite delivery. Depending on the complexity of the UCP, the Client has the options to witness a scheduled factory testing of said UCP. The Vendor shall notify the Client 2 weeks in advance of any scheduled factory testing.

2.04 SPARE PARTS

A. Provide a minimum of 10% spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

1.1 PART 3 - EXECUTION

3.01 INSTALLATION

A. UCP shall be installed in accordance with the requirements specified in Section 16050 and in accordance with the Manufacturer's recommendations.

B. UCP shall be protected at the jobsite from loss, damage, and the effects of weather. Stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion, and humidity.

C. Panel 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 relevant section of this specification.

3.02 FIELD TESTING

A. Each UCP 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 16960 – ELECTRICAL EQUIPMENT TESTING

PART 1 – GENERAL

1.01 DESCRIPTION

Requirements of Conditions of the Contract, Division 1, Section 16010 and Section 16100 form a part of this Section.

A. Work Included in This Section.
   a. Testing of all electrical equipment and components.

B. Related Work Included in Other Divisions and Sections.
   a. Basic Electrical Materials and Methods, Section 16100.
   b. Induction Motors, Section 16150.

1.02 REFERENCES

The inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.

A. National Electrical Code - NEC (NFPA 70).

B. National Electrical Manufacturer’s Association - NEMA.

C. American Society for Testing and Materials - ASTM.

D. Institute of Electrical and Electronic Engineers - IEEE.

E. National Electrical Testing Association - NETA.

F. American National Standards Institute - ANSI.

G. State and Local Codes and Ordinances.

H. Insulated Cable Engineers Association - ICEA.

I. OSHA Part 1910; Subpart S, 1910.308.

J. National Fire Protection Association - NFPA.

1.03 SUBMITTALS

A. Prior to the Start of Work
1. Written test procedures by the manufacturer. The CITY shall be provided a copy of the test procedures.

2. Manufacturer’s Test and Report Forms.

B. Upon completion of testing provide formal Test Report to include the following:
   1. Summary of test.
   2. Description of equipment tested.
   3. Description of test.
   4. Test results.
      a. The following is a list of reports and forms that the manufacturer shall use in reporting the results:
         1. Instrument Calibration Test and Data Sheet (2 sheets).
         3. Polarity Index Test Results (for 200 hp or larger motor).
   5. Conclusions and recommendations.
   6. Appendix, including appropriate completed test forms.
   7. List of test equipment used and calibration date.

1.04 SYSTEM DESCRIPTION
   A. The inspections and tests shall utilize the following references.
       1. Manufacturer’s instruction manuals applicable to each particular apparatus.
       2. Drawings submitted by manufacturers and vendors.
   B. All instruments used to evaluate electrical performance shall meet Specifications for Test Instruments (refer to Part 2 of this Specification).
   C. Electrical performance tests shall include the following:
       1. 600 volt feeder cables.
       2. Induction motors.
D. The EQUIPMENT SUPPLIER shall notify the CITY when equipment becomes available for electrical tests. Work shall be coordinated to expedite project scheduling.

E. The EQUIPMENT SUPPLIER shall notify the CITY prior to commencement of any testing.

F. Set points shall be noted on all calibration stickers.

G. Any system material or workmanship, which is found defective on the basis of electrical tests shall be replaced and retested at no additional cost to the CITY.

H. The manufacturer shall maintain a written record of all tests and upon completion of the project, assemble and certify a final test report.

PART 2 – PRODUCTS

2.01 TEST INSTRUMENT TRACEABILITY

A. The manufacturer shall have a calibration program, which maintains applicable test instrumentation within rated accuracy.

B. The accuracy shall be traceable to the National Institute for Standards and Technology in an unbroken chain.

C. Instruments shall be calibrated in accordance with the following frequency schedule:

   a. Laboratory instruments - 12 months.
   b. Leased specialty equipment - 12 months. (Where accuracy is guaranteed in writing by the lessor.)

D. Dated calibration labels shall be visible on all test equipment.

E. Records must be kept up to date which show date and results of all instruments calibrated or tested.

F. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

PART 3 – EXECUTION

3.01 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

   1. Occupational Safety and Health Act - OSHA.

3. Applicable State and local safety operating procedures.

4. NETA Safety/Accident Prevention Program.


3.02 TABLES

Table 16960.1 – Insulation Resistance Test Voltage

<table>
<thead>
<tr>
<th>Maximum Voltage Rating of Equipment</th>
<th>Minimum Test Voltage, DC</th>
<th>Minimum Insulation Resistance in Mega-ohms</th>
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<tr>
<td>250</td>
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Values of insulation resistance less than manufacturer’s minimum or kV + 1 in megohms should be investigated. Overpotential tests should not proceed until insulation resistance levels are raised to said minimum.

Table 16960.2 – Insulation Resistance Conversion Factors for Conversion of Test Temperature to 20°C

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Transformer</th>
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