CITY OF PETALUMA

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ADDENDUM NO. 2

Manor Tank Rehabilitation Project
C67501007

February 17, 2022

This Addendum No. 2 modifies the Bidding Documents for the Manor Tank Rehabilitation Project C67501007. This Addendum shall become part of the Contract and all provisions of the Contract shall apply thereto. Bidders shall acknowledge all Addendums in the Bid Schedule.

RESPONSE TO PROPOSER WRITTEN QUESTIONS

1. Is the Bid Alternative B for "Steel Banding Around Bottom Shell Course" tank for both rings above and below the manway as shown in Detail "SB" on Sheet 6? If so, Note #14 on Sheet 3 stating installation on bottom ring may conflict with that intent.

   Response: *There is no conflict and both rings are included; the Bottom ring is 84" tall, and both bands, with a 30" gap as shown on Detail SB on Sheet 6 will be 60" in total.*

2. Clarification is requested regarding full seal weld on roof plates for Bid Alternative A . The last 3 feet closest to knuckle will be difficult to seal weld and could cause buckling of the knuckle. Please confirm requirement.

   Response: *Seal welding shall be performed over as much of the underside seams as possible. There may be some seams over top of rafters that are impossible to access, and those may be left unsealed with the approval of the City inspector or engineer. Warping of knuckle due to seal welding can be avoided through proper care and technique; minor warping will not affect tank performance.*

3. Are SSPC QP1 and QP2 requirements for coating necessary?

   Response: *Yes, per contract specifications 09 97 14 1.06 C 3.*

4. Will bidders have access to an inspection dive report?

   Response: *The referenced dive report has been included with this addendum. See appendix.*

5. What items are being replaced in the valve vault, Sheet 5 indicates some materials may be reused?

   Response: *The Contractor shall consider all piping, fittings, valves, and appurtenances shall be removed and replaced per details AC and CV on Sheet 5 for bidding purposes. Pipes penetrating through vault wall to existing flanges or plain ends are to remain but may require modification to fit new appurtenances.*

6. Is there on-site water available?

Response: *There is no hydrant in the immediate vicinity of the project. Contractor will need to obtain a hydrant meter from the City for installation at a nearby hydrant. Otherwise, Contractor may elect to make their own arrangements such as providing an on-site water tank or a temporary connection to the mains in the vault.*

7. Is on-site electricity available?

Response: *There is one spare 20A, single-pole breaker available for Contractor's use. Contractor should expect to provide his own electricity for applications requiring greater power demands.*

8. What is the approved method of coating removal?

Response: *Coating removal methods are indicated in specifications section 09 97 14 1.13 Environmental Requirements, subpart H. Also see the same section, 3.06 Climate Control, and Air Quality Protection.*

9. Is removing a door plate necessary for the project?

Response: *The removal of the door plate is considered normal practice for access to the interior of the tank. A bid item has been set for this purpose. The Contractor may, with the approval of the engineer, perform the work without the need for removal of the door plate at their discretion. If the door plate is not removed, the bid item will not be paid as part of the contract. The door plate bid item shall include all work for removal and replacement of door plate including all labor, materials, inspections, and incidentals.*

10. The electrical cabinet is specified to be replaced but no color is specified. Can you please clarify what color the cabinet should be?

Response: *Manufacturer's standard color may be used or light gray. Provide color options available with electrical cabinet submittal package for review by City.*

11. During the site visit it was said that the existing panelboard would be replaced inside the cabinet. The drawing says to reinstall the existing cabinet. Please confirm.

Response: *The existing panelboard is to be removed and reinstalled within the new electrical cabinet per Electrical Cabinet Detail A on Sheet 8. The Existing Panelboard line diagram on Sheet 8 indicates changes to the breakers to be provided and installed by the Contractor.*

12. RTU cabinet- Is this provided by the contractor or the city? Note (1) on detail 120 VAC POWER DISTRIBUTION sheet #8 says provided and installed by others. Please confirm.

Response: *The RTU panel is to be provided by the Contractor, along with equipment shown on RTU Panel Elevation Detail B on Sheet 8. Space is to be provided within the new RTU cabinet for the City supplied RTU unit. This is also indicated on the 120 VAC Power Distribution diagram on Sheet 8.*

13. Sheet # 8 Detail Electrical Cabinet note # 3 says replace (E) Level/Pressure Transmitter (LIT120). Will the city provide that or the contractor? Please provide detailed specification on desired unit if contractor will be suppling.

Response: *Specification section 26 00 00 – Electrical is being replaced in its entirety. Refer to new Section 26 00 00 (Attachment A), subparagraph 2.07A specifies the level transmitter and other equipment to be used as shown on the drawings.*

NOTICE INVITING BID SECTION ADDITIONS AND UPDATE

The following two (2) paragraphs, #18 and #19 will be added to the "Notice Inviting Bids" as described.

18. FINDING OF SUBSTANTIAL COMPLEXITY

Pursuant to Public Contract Code section 7201(b)(3) the CITY's Public Work's Director has found that the WORK is substantially complex due to:

1. The number of resources needed to complete the project including the number of days, workers, and labor
2. The urgency for project completion
3. The number of tasks needed to complete the project
4. The specialized construction and inspection work for potable water tank coatings.

and therefore, this is a unique project that is not regularly performed and requires a higher retention amount than 5 percent.

Notwithstanding Public Contract Code Section 7201 or any other law or regulation that purports to provide otherwise, public contracting is a quintessential municipal affair, subject to charter cities' home rule power, and the California Constitution grants charter cities supreme authority over municipal affairs, which include public works, procurement, and the mode of municipal contracting (see, Public Contract Code Section 1100.7 and e.g., Bishop v. City of San Jose (1969) 1 C3d 56).; and
it is the courts, not the legislature, that determines which matters are municipal affairs (see, e.g., California Federal Savings and Loan v. City of Los Angeles (1991) 54 C3d 1); and

Article X, Section 67 of the Petaluma Charter provides in pertinent part:

". . . no progressive payments can be provided for or made at any time which, with prior payments, if there have been such, shall exceed in amount at that time ninety percent of the value of the labor done and the materials used up to that time, and no contract shall provide for or authorize or permit the payment of more than ninety percent of the contract price before the completion of the work done under said contract and the acceptance thereof . . .; and"

City charters are documents of limitation and a restriction on the City Council's powers imposed by the voters (see, e.g., City of Glendale v. Trondsen (1957) 48 C2d 93) and, as a result, the City Council's contracting power is limited by the retention requirement in Article X, Section 67, and the City Council and City staff lack the power to provide for public works contract retention other than as specified in the City Charter.

19. GOVERNMENT CODE SECTION 1090

The successful Bidder may be precluded from competing for, or participating in, subsequent contracts that result from or relate to the Work performed pursuant to this Bid. The ethics laws that apply to the City and all its consultants, contractors, and vendors include California Government Code Section 1090 and following, which prohibits government officials, employees, and contractors

from participating in making government contracts in which the official, employee or contractor has a financial interest. Because City contractors always have a financial interest in their City contracts, the Section 1090 prohibition regarding City contractors focuses on whether a contractor is or would be "making a government contract" in a quasi-governmental capacity for purposes of Section 1090. Section 1090 prohibits City contractors from using their role as a contractor to influence how the City spends the public's funds in a way that benefits the contractor. For example: if a City contractor prepared a scope of work the City intended to release to solicit proposals to perform the scope of work, that contractor would most likely be prohibited from being awarded a contract to perform that scope of work, because preparation of the scope of work could influence the spending of City funds in a way that benefits the contractor. Similarly, if a City contractor prepared Plans Specifications and Estimates for a publicly-bid construction project or played a role in developing the scope for a construction project, such as through performing site analysis, environmental studies, or CEQA or NEPA documents for the project, the consultant would most likely be prohibited from being awarded a contract to build the project or to provide construction management services for the project. Penalties for violating Section 1090 are severe and may include felony criminal penalties, permanent disqualification from holding public office in California, disgorgement of any benefit received by the financially interested contractor, civil and administrative penalties, and voiding of the prohibited contract.

The following paragraph of the "Notice Inviting Bids" will be modified as described.

~~18~~ **20. CITY'S RIGHTS RESERVED:** The CITY reserves the right to reject any or all bids, to waive any minor irregularity in a bid, and to make awards to the lowest responsive, responsible bidder as it may best serve the interest of the CITY.

CHANGES TO DRAWINGS

1. All references to level transmitter LIT 120 on the drawings are to be replaced with LIT 151 as indicated on the drawings and in the specifications, section 26 00 00 Electrical, subparagraph 2.07A.

CHANGES TO SPECIFICATIONS

1. Specification Section 26 00 00 – Electrical is being replaced in its entirety. New Section 26 00 00 is hereby included to replace the existing section. See the specification section included in this Addendum No. 2.

This Addendum No. 2 shall become part of the Contract and all provisions of the Contract shall apply thereto. Bidders shall acknowledge all Addendums in the Bid Schedule.

Summary of Changes: Question Responses, Changes to Drawings, Changes to Electrical Specifications, Changes to Notice Inviting Bids, Inclusion of Dive Inspection Report, Non-Mandatory Pre-Bid Meeting sign-in sheet.

City of Petaluma,

Dan Herrera, P.E.
P.E. No. C77596

A signed copy of this Addendum and the attached acknowledgement form shall be attached to the bid proposal. Failure to do so may cause rejection of your bid as being non-responsive.

ADDENDUM NO. 2

Manor Tank Rehabilitation Project
C67501007

February 17, 2022

ACKNOWLEDGEMENT

Receipt of Addendum No. 2 is hereby acknowledged by _____
(Contractor's Name)

on the _____ day of _____, 2022.

By: _____
Signature

_____
Title

_____
Company

SECTION 26 00 00 - ELECTRICAL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall install, ready for use, the electrical and instrumentation system as specified herein and shown on the Contract drawings. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices. All components and devices shall be furnished and installed as necessary/required to provide a complete operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter.

B. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals, and services to provide a complete and operational electrical & instrumentation system, as shown on the E&I - Series Drawings included in these Specifications or required for a fully operating facility.

C. Examine the specification and Drawings for mechanical equipment and provide all circuit breakers, switches, pushbuttons and appurtenances which are not specified to be with the mechanical equipment. Erect all electrical equipment not definitely stated to be erected by others, furnish and install conduit, wire and cable and make connections required to place all equipment in complete operation.

D. It is recommended that the Electrical Contractor attend the job walk for the site and shall have accomplished the following:

1. Thoroughly examine existing conditions before submitting his bid proposal to perform any work. He shall compare site conditions with data given on the plans or in these Specifications. No allowance shall be made for any additional costs incurred by the Contractor due to his failure to have examined the site or to have failed to report any discrepancies to the Owner prior to bid.
2. It is the Contractor’s responsibility to be fully familiar with the existing utility locations, conditions and local requirements and regulations.
3. Verify all measurements and conditions and shall be responsible for the correctness of same. No extra compensation will be allowed because of differences between Work shown on the Drawings and measurements at the site.

E. Any major deviations in location and conduit routing that the Contractor makes without the express written review or direction of the Engineer, shall be considered to have been made at the Contractor’s sole responsibility. Such deviations made

by the Contractor shall be reflected on the Contractor supplied "Record Drawings." The Owner will reimburse the Engineer and the Owner will then deduct an amount equal to said reimbursement from the Contractor's contract for all engineering, drafting, and clerical expenses associated with updating the Record Drawings due to any major unauthorized changes.

F. The major areas in the scope of work shown on E&I - Series Contract Drawings which includes the furnishing and installation:

1. Control Cabinet, manual transfer switch, RTU cabinet, tank & vault lighting and miscellaneous devices.
2. Instrumentation and other miscellaneous devices. This includes all wiring and cables.
3. Provide all necessary conduits, junction boxes, grounding system, field interconnection wiring, hardware, fittings, and devices to connect the designated equipment and wiring.
4. Installation of primary devices, equipment and instruments are not completely detailed on Contract Drawing plan sheets. Use Device Indexes and Contract Drawings installation details for installation and mounting requirements.
5. All necessary miscellaneous shut off, sample, and calibration valves to sensors.
6. Grounding system and equipment grounding.
7. Concrete pads and supports for electrical and instrumentation equipment
8. Remove and dispose of all excess dirt, paving, concrete, and other materials from site work.
9. RTU backpan, PLC programming and configuration of SCADA system will be by Others.

G. Existing site is limited in space. It is the Contractor's responsibility to provide an electrical and instrumentation package to fit in the allocated space.

H. Provide all necessary hardware, conduit, wiring, fittings, and devices to connect the electrical equipment provided under other Sections.

I. All electrical equipment and materials, including installation and testing, shall conform to the applicable codes and standards listed in this and other Sections. All electrical work shall conform with the National Electric Code (NEC) 2021 issue. Nothing on the Drawings or in the Specifications shall be construed to permit work or materials not conforming to these codes and standards.

J. The following specifications incorporate specific equipment and devices that are standards of the Owner because of their serviceability, because of the local availability of labor, parts and materials, or because of the ability of the Owner to

umbrella the equipment under existing maintenance contracts; however, favorable alternatives proposed in writing will be considered by the Owner.

K. Contractor shall field verify all existing conditions, equipment, wires, conduit, etc. as required to complete the project.

1.02 CODES AND STANDARDS

A. All electrical/instrumentation equipment and materials, including installation and testing, shall conform to the following applicable codes and standards:

1.	ANSI	-	American National Standards Institute, Inc.
2.	EIA	-	Electronics Industries Association.
3.	ETL	-	Electrical Testing Laboratories.
4.	FM	-	Factory Mutual.
5.	GO128	-	General Order No. 128, Rules for Construction of Underground Electrical Supply and Communication Systems, Public Utilities Commission of the State of California.
6.	IEEE	-	Institute of Electrical and Electronics Engineers.
7.	ICEA	-	Insulated Power Cable Engineers' Association.
8.	ISA	-	International Society of Automation (ISA) Standards (formerly Instrument Society of America.
9.	NEC	-	National Electrical Code, 2021 Edition.
10.	NEMA	-	National Electrical Manufacturers Association.
11.	NETA	-	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, International Electrical Testing Association.
12.	NESC	-	National Electrical Safety Code.
13.	NFPA	-	National Fire Protection Agency & NFPA820
14.	OSHA	-	Occupational Safety and Health Act Standards.
15.	UL	-	Underwriter's Laboratories, Inc.

B. The revisions of these codes and standards in effect on the date of issuance of the Contract Documents shall apply.

C. Codes and standards referenced shall be considered minimum acceptable work.

D. In instances where two or more codes are at variance, the most restrictive requirements shall apply.

E. All electrical work shall conform with the National Electric Code (NEC) 2021 issue and the latest NFPA 70E. Nothing on the Drawings or in the Specifications shall be construed to permit work or materials not conforming to the preceding codes and standards.

F. All work shall also be performed in accordance with the Owner, State, County or Owner standards, and local Utility codes.

G. The Contractor shall furnish without extra charge any additional material and labor which may be required for compliance with these codes and standards, even though the work is not explicitly mentioned in the Specifications or shown on the Contract E- Series Drawings.

H. Amperage listed on the single-line Drawings for motors are per NEC Table 430.250 and may not necessarily match that of the equipment supplied. It is the electrical system supplier and Contractor's responsibility to furnish equipment sized for the motors supplied for this project at no additional cost.

1.03 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Provide electrical system that interfaces to work performed under other Mechanical and Equipment plans.

1.04 ELECTRICAL CONTRACTOR QUALIFICATIONS

A. It is the intent of this Division that the complete responsibility for management and installation of the electrical and instrumentation required for this project be by a qualified Electrical Contractor. This responsibility includes, but not limited to, supervision and coordination of work performed by all suppliers of Division 16.

B. Uncertified electricians shall not perform electrical work for which certification is required per Labor Code Section 3099. Electricians shall be required to carry proof of certification on their person at all times. Electricians found on the jobsite without proof of certification will be asked to leave, prohibited from working on-site until proof of certification has been provided and may be reported to the Contractors State License Board (CSLB).

C. The Electrical Subcontractor shall meet the following minimum qualifications:

1. Has a current C-10 Electrical Subcontractor's License.
2. Has regularly engaged in similar electrical contracting for the Municipal Water Industry.
3. Has successfully performed work of similar or greater complexity on at least two previous projects under one company name and under the present company name.
4. Has all persons performing work as electricians certified by the California Apprenticeship Council per California Labor Code Section 3099.
5. Has been actively engaged in the type of electrical and instrumentation work specified in this Division for a minimum of two years.

1.05 SYSTEM SUPPLIER QUALIFICATIONS

A. General:

1. It is the intent of this Division that complete responsibility in the supplying of the RTU system, and all instrumentation and other equipment required for this project be supplied by one System Supplier. This responsibility includes, but not limited to, all work necessary to select, furnish, program, supervise installation, calibrate, and place into operation all transmitters, instruments, controllers, alarm equipment, monitoring equipment, and accessories as specified herein.

2. The system supplier shall have an on staff project engineer with prior experience on similar sized projects. This project engineer shall coordinate the technical aspects of this project and prepare the submittals and drawings. The system supplier project engineer shall attend all coordination meetings and be on-site when requested by the Owner's Engineer.

B. Pre-Qualified System Suppliers

1. The Suppliers listed below have been determined to meet minimum qualifications specified in this Division and are pre-qualified by the Owner for providing supplier bids as system suppliers on the project.

   a. Tesco (phone 916 395-8800)

   b. Technical Systems Inc. (TSI) (phone 530 710-3325)

   c. Primex Controls (phone 707 449-0341)

C. Non-Pre-Qualified System Suppliers

1. System Suppliers not pre-qualified by the Owner shall submit the information listed herein at least 14 calendar days prior to bid opening, and if approved by the Owner, will be listed in a Contract addendum prior to bid.

   a. Company history.

   b. List of five (5) completed projects of similar size and nature for water treatment plants.

      1) Provide completion dates of projects.

      2) References of Owner Representative in charge of project, including contact name and telephone number.

   c. List of projects in progress.

      1) Description of scope of projects.

      2) Dollar amount of projects.

      3) References of Owner Representative in charge of project, including contact name and telephone number.

d. Complete 2020 Year End Financial statement prepared by a Certified Accountant or complete 2020 Company Tax Returns listing assets and liabilities.

2. Factory test for this project shall be held within 150 miles of project location at the System Suppliers shop.

3. Additional information for clarification as requested by the Owner in writing shall be provided by the System Supplier asking for the qualification or qualification will automatically be denied.

4. System Supplier providing financial statements lacking detail or stating that detailed financial records are proprietary will be disqualified as a qualified System Supplier and is grounds alone for disqualification.

5. Any qualification package deemed incomplete or lacking sufficient information to determine qualification will result in System Supplier not being qualified.

6. No reason will be released on why a System Supplier was not qualified.

1.06 CONTRACT DOCUMENTS

A. The Contract drawings and specifications are intended to be descriptive of the type of electrical system to be provided; any error, omission, or minor details missing in either shall not relieve the Contractor from the obligations there under to install in correct detail any and all materials necessary for a complete operational system, at no additional cost.

B. The Contract drawings are generally diagrammatic; exact locations of electrical products shall be verified in the field with the Engineer. Except where special details on drawings are used to illustrate the method of installation of a particular piece or type of equipment or materials, the more restrictive of the two shall take precedence in the event of conflict.

C. The Contract Electrical elementary, elevation and one-line diagrams are the basis of the electrical system to be provided and are for reference only. It is the Contractor's responsibility to adjust and make minor revisions to the diagrams as necessary for operational system at no additional cost to the Owner. Additional isolators, relays, wiring, terminal blocks, and appurtenances, shall be provided for an operation system at no additional cost to the Owner.

D. Location at facilities of new equipment, inserts, anchors, panels, pull boxes, conduits, stub-ups, and fittings for the electrical system are to be determined by the Contractor and Engineer at time of installation. Contractor shall make minor adjustments to locations of electrical equipment required by existing conditions and coordination with other trades at no additional cost.

E. The Conduit and Wire Routing Schedule, wire fill, and number of conduits are based on the best information available.

1. It is the Contractor's responsibility to modify the conduit schedule based upon Shop Drawings for the actual equipment. Such modifications in conduit sizes and numbers of conductors shall be at no additional cost to the Owner, if such changes are the direct result of the equipment selected by the Contractor.

2. A copy of the Conduit and Wire Routing Schedule and Electrical plans showing conduit routing shall be updated weekly by the Contractor. Progress payments will be withheld if during monthly checks it is found that the Contractor fails to maintain the Conduit Schedule updates.

F. Electrical & instrumentation, conduit & wire lengths shown on Contract Drawings are approximate. The Contractor is responsible for determining actual lengths for bidding and installation purposes. Contractor is to be made aware that equipment may be installed in the lower levels of the building and instrumentation manufacturer's cable length depends on conduit routing.

G. The Contractor shall examine the architectural, mechanical, structural, electrical and instrumentation equipment provided under other Sections of this Contract in order to determine the exact routing and final terminations for all conduits and cables. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences, and the physical location of wire terminations on equipment. Conduits shall be stubbed up as near as possible to equipment.

H. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. The Engineer reserves the right to require minor changes in location of equipment, without incurring any additional costs.

I. Provide means to furnish equipment and accessories, do the installation, complete connections, submit documentation, perform start-up and be responsible for the warranty.

J. Where conduits are shown as "home runs" on the Contract drawings or stated to be furnished, but not explicitly shown as part of the scope of work; the Contractor shall provide all fittings, boxes, wiring, etc., as required for completion of the raceway system, in compliance with the NEC and the applicable specifications in this Section.

K. No changes from the Contract drawings or specifications shall be made without written approval of the Engineer. Should there be a need to deviate from the Contract documents, submit written details and reasons for all changes to the Engineer for favorable review within 30 days after award of Contract.

L. When existing conduits are to be used, it is the Electrical Contractor's responsibility to verify conduit size and routing. This includes all potholing or other location

methods. Existing conductors and conduits damaged by Contractor during construction shall be repaired or replaced at no cost to Owner.

M. The resolution of conflicting interpretation of the Contract documents shall be as determined by the Engineer.

N. The Contractor shall coordinate with other Suppliers on the project for a complete and operable system.

O. It is the System Supplier's responsibility for obtaining instrumentation transmitter configuration software, manuals, USB drives and disks necessary for the Contractor to program and configure the instrumentation transmitters.

P. The Electrical Contractor shall maintain a separate set of neatly and accurately marked set of Record Documents, consisting of spreadsheets, specifications and full size blue-line Electrical (E-Series) and Instrumentation (I-Series) Contract Drawings.

1. These documents are to be used specifically for recording the as built locations and layout of all electrical and instrumentation equipment, routing of raceways, junction and pull boxes, and other diagram or document changes.
2. These Record documents shall be kept up-to-date during the progress of the job, with all "change orders," submittal modifications, and construction changes shown and stamped with “As-Built” at end of job.
3. These Record documents shall not be used for daily construction use and shall not contain any mark-ups that are unrelated to as-built corrections.
4. The following lists the record documents shall be as-built by Electrical Contractor:
    a. E-Series Drawings.
    b. Panelboard schedules.
    c. Conduit and Wire Routing Schedule.
    d. Lighting Schedule.
    e. Duct banks and their routing with offset measurement and indicate changes in depth. Duct bank elevations shall not be drawn or penciled in by hand. Provide CAD drawings of duct banks.
5. The following lists the record documents that shall be as-built by System Supplier to be maintained by Electrical Contractor:
    a. I-Series Drawings
    b. Instrumentation Index.
6. Record documents shall be kept current weekly with all "change orders," submittal modifications, and construction changes shown. Record Documents shall be subject to the inspection by the Engineer at all times,

progress payments or portions thereof may be withheld if Record Documents are not accurate or current.

7. When documents are changed, they shall be marked with erasable colored pencils using the following coloring scheme:
   a. Additions - red
   b. Deletions - green
   c. Comments - blue
   d. Dimensions - black
8. Show the following on the Electrical (E-Series) Record Contract Drawings by dimension from readily obtained base lines:
   a. Exact location, type and function of electrical and instrumentation equipment and devices.
   b. Precise routing and locations of underground conduits, pullboxes, junction boxes, and appurtenances that make-up the raceway system.
   c. Show the dimensions, location and routing of electrical work, which will become permanently concealed.
   d. Show complete routing and sizing of any significant revisions to the systems shown.
9. Prior to acceptance of the work, the Contractor shall deliver to the Engineer one set of record full size drawings neatly marked accurately showing the information required above.

1.07 COORDINATION

A. The Contractor shall coordinate the electrical work with the other trades, code authorities, utilities, and the Engineer; with due regard to their work, towards promotion of a rapid completion of the project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provisions, then the Contractor shall bear expense of such changes as necessary to be made in the work of others.

B. Manufacturer’s directions and instructions shall be followed in all cases where such is not shown on the Contract Drawings or herein specified.

C. The electrical and instrumentation modifications and additions are to be made at facilities that need to remain powered at all times. The Contractor shall schedule all the required work with the Owner, including each shutdown period. Each shutdown shall be implemented to minimize disruption of the existing operations. Shutdowns may be required outside of normal working hours when necessary. The work to be provided under this Contract shall not disrupt any of the existing operations without prior approval.

1. The Contractor shall limit all scheduled shutdown periods to less than 2 hours (120 minutes) and only with prior approval of the Owner.
2. Carry out scheduled shut downs only after the time, date, and sequence of work proposed to be accomplished during shutdown has been favorably reviewed by the Owner. Submit shutdown schedule and plans at least 10 working days in advance of when the scheduled shutdown is to occur.
3. Contractor shall make provisions for portable generators and automatic transfer switches when facilities will be without power.
4. The Owner reserves the right to delay, change, or modify any shutdown at any time, at no additional cost to the Owner, when the risk of such a shutdown would jeopardize the operation of system.
5. Contractor is advised that during change out of existing MCCs, meter/main, pumps, demolition of existing conduits, installation of new conduits, etc., Contractor is responsible to keep equipment running for all necessary station operation. The Contractor shall install temporary generators, motor controls, panelboards, power panelboards, wiring, etc. to keep all facility equipment powered and automatic controls functional.

D. Contractor shall be responsible for obtaining utility Engineered Drawings for service conductor conduits, pull boxes, wire size requirements, pull rope requirements, etc. Conflicts between the Contract Drawings and the utility engineered drawings shall be brought to the attention of the Engineer.

E. The Contractor shall cease work at any particular point, temporarily, and transfer his operations to such portions of work as directed, when in the judgment of the Owner it is necessary to do so.

F. Prior to commencing construction, the General Contractor shall arrange a conference with the General Contractor, Electrical Contractor, System Supplier, Resident Engineer & Owner as well as all equipment and system suppliers vital to the current phase of work. During the meeting, the equipment supplier shall verify types, sizes, locations, installation requirements, controls and diagrams of all equipment furnished. The Equipment and System Suppliers shall, in writing, inform the Engineer that all phases of coordination of this equipment have been covered and if there are any unusual conditions, they shall be enumerated at this time.

G. It is the responsibility of the Contractor to make all equipment approval arrangements and scheduling with the power utility company connected with this project. Schedule within 30 days after award of contract all service installations and connections with the power and telephone utility. Lack of effort by the Contractor to properly schedule Utility service will not be considered valid justification for delays in project completion and no extension in contract time will be given.

H. The Contractor shall coordinate with Owner, witnessing Engineer and System Supplier to test the entire system.

1. No passwords shall be enabled on software or hardware developed for this project. All electronic disk copies provided to Owner shall not have any password protection enabled on them or the software. Software submitted with password protection will be removed by Owner and the Contractor will be back-charged for the cost thereof.

1.08 SUBMITTAL AND DRAWING REQUIREMENTS

A. General:

1. Submit shop documents and drawings for approval in accordance with this subsection and Section 01300.

2. Electrical submittals shall be submitted for favorable review by the Owner or Engineer per this subsection. They shall be complete giving all details of connections, wiring, instruments, enclosures, materials and dimensions. Standard sales literature will not be acceptable.

3. A copy of the appropriate Division Specification Sections, with addendum updates included and with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

a. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the Contractor, each deviation shall be underlined and denoted by a unique number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications.

b. The submittal shall be accompanied by a detailed, written justification for each numbered item explaining variance or non-compliance with specifications.

c. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no review.

4. The Contractor shall coordinate submittals and required meetings with the work, panel fabrication and factory tests so that project will not be delayed. This coordination shall include scheduling the different categories of submittal, so that one will not be delayed for lack of coordination with another.

5. No material or equipment shall be allowed at the job site until the submittal for such items has been reviewed by the Engineer and marked "No Exceptions Taken" or "Make Corrections Noted."

6. The equipment specifications have prepared on the basis of the equipment first named in the Specifications. The Supplier shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional design, options, or modifications may be required, at no additional cost, to meet Specifications.

7. The decision of the Engineer governs what is acceptable as a substitution. If the Engineer considers it necessary, tests to determine equality of the proposed substitution shall be made, at the Contractor's expense, by an unbiased laboratory that is satisfactory to the Engineer.

8. The Contractor shall cease work at any particular point, temporarily, and transfer his operations to such portions of work as directed, when in the judgment of the Engineer it is necessary to do so.

9. No submittal documents shall be labeled as proprietary. Labeling documents as proprietary will be sufficient cause for rejection of entire submittal. The Owner reserves the right to copy or duplicate any and all portions of the documents provided for the project including copyrighted documents as desired.

10. Approval of submittals shall not relieve Contractor of their obligation to perform the work in strict accordance with this Contract and the Contract Documents or of their responsibility to provide a complete and reliable system.

11. Identify all submittals by submittal number on letter of transmittal. Submittals shall be numbered consecutively and resubmittals shall have a letter suffix. For example:

    a. 1st submittal: 1
    b. 1st resubmittal: 1A
    c. 2nd resubmittal: 1B, etc.

B. The electrical submittals shall include but not be limited to data sheets and drawings for each product together with the technical bulletin or brochure. No FAX copies of documents are allowed. Color copies shall be provided when black and white copies do not show adequate clarity. The electrical submittals shall include:

1. Product (item) name used herein and on the Contract Drawings.

2. The manufacturer's model or other designation.

3. Tag name/number per the P&ID drawings, schedules, and indexes.

4. Index Binder Tab Dividers.

5. Detailed electrical one line, elementary control diagrams and interconnection diagrams showing all wiring requirements for each system.

6. Complete documentation with full description of operation.
7. Complete catalog cuts with full description of equipment. General sales literature will not be acceptable. The part or model number with options to be provided shall be clearly identified. Where more than one item or catalog number appears on a catalog cut, the specific item(s) or catalog numbers(s) proposed shall be clearly identified.
8. Location of assembly at which it is installed.
9. Input-output characteristics.
10. Range, size and graduations as required.
11. Physical size with dimensions and mounting details. System Supplier submit a letter listing all instrumentation pipe sizes, pipe connections, flange types, and ANSI ratings signed by Contractor and System Supplier to certify coordination for proper installation prior to flow elements being purchased.
12. Enclosure fabrication and color.
13. Enclosure layout and elevation drawings to scale.
14. Quantity and quality requirements for electric power.
15. Materials of construction of components.
16. Nameplate schedule.
17. Interconnection diagrams.
18. Failure to provide submittals with heavy duty permanent plastic labeled index tabs may be grounds for immediate rejection without review.
19. Bill of Materials: A complete Bill of Materials list shall be provided at the inside of the front cover. The Contractor shall provide Bill of Material for electrical components formatted as shown in Appendix "A". A separate set of Material Listing forms shall be provided for the MCC, spare parts, and another listing all field equipment. Generic names or part numbers used by a distributor or Systems House are not acceptable; originating manufacturer’s name and part number shall be listed.
20. A separate instrument data sheet shall be provided for each instrument per ISA S20 standards or approved equal. Data sheets shall be printed on blue or pink paper. Provide an index with proper identification and cross-referencing of each data sheet.
21. Submit USB electronic copies of all submitted drawing in AutoCAD format.
22. For each resubmittal, provide a copy of submittal comments and a separate letter, on Company letterhead, identifying how each submittal comment has been addressed in the resubmittal.

23. Electronic PDF version of submittals shall follow hard copy format of submittal and shall be "bookmarked" at each index, subtab, copy of appropriate check-marked Specification Section, bill of materials, copy of submittal comments (for resubmittals), Contractor's response to submittal comments (for resubmittals), drawings, etc. Failure to bookmark PDF may be grounds for immediate rejection without review.

24. Submittal Drawings shall be provided in 11 inch by 17 inch hardcopy format.

25. Electronic submissions of submittals may be provided for submittals less than 80 pages and without drawings. Submittals equal to or over 80 pages or those that contain drawings shall be provided in a hardcopy format. Drawings shall be printed at 11 inches by 17 inches. Hardcopy submittals shall be provided in binders as specified herein. The Owner reserves the right to reject submittals that fail to be organized as described herein.

C. All drawings shall be generated with a computer utilizing the AutoCAD drafting package. Standard preprinted drawings simply marked to indicate applicability to the Contract will not be acceptable. Drawings shall be prepared in a professional manner and shall have borders and a title block identifying the project, system, drawing number, drawing title, AutoCAD file name, project engineer, date, revisions, and type of drawing. Drawings shall be no smaller than 11" x 17" and printed with a laser jet printer or plotted in ink on vellum. The lettering shall be legible and no smaller than 0.075 inch in height. Diagrams shall carry a uniform and coordinated set of wire colors, wire numbers, and terminal block numbers. A Drawing Index shall be provided that lists each Drawing title and drawing number. Each Drawing title and number shall be unique. The index shall not include drawings listed as "This Page Intentionally Left Blank". The shop drawings shall include:

1. Electrical one or three line diagrams detailing all devices associated with the power distribution system. The following applicable information or data shall be shown on the one- or three- line diagram: location, size and amperage rating of bus; size and amperage rating of wire or cable; breaker ratings, number of poles, and frame sizes; generator; automatic transfer switch; utility metering; voltage; amperage; number of wires and phases; fault interrupt ratings; ground size and connections; neutral size and connections; power fail and other protective devices; fuse size and type; panelboard; starters; contactor size and overload range; motor full load amperage of submitted motor and horsepower; rating for miscellaneous loads; etc. Submit equipment motor voltage, phase and full load amps provided for this project for verification of accuracy of submitted one line drawings.

2. Elementary diagrams shall be provided for all relay logic, power supplies, PLC I/O and other wiring. All elementary diagrams shall be drawn in JIC EMP/EGP format and standards similar to those shown on the E-series

elementary diagrams showing ladder rung numbers and coil and contact cross referencing numbers.

3. Enclosure and Elevation layout diagrams shall be provided to show all deadfront, front panel and backpan devices drawn to scale. Show fabrication methods and details; including material of construction, paint color, support and latching mechanisms, fans and ventilation system, and conduit entrance areas.

4. Interconnection diagrams shall show for each piece of equipment all wiring between all devices, panels, cabinets, terminal boxes, control equipment, motor control centers and any other devices and equipment. An interconnection diagram shall be furnished for each electrical and instrumentation system, even if one was not shown explicitly on the Contract Drawings. Interconnection diagrams shall be prepared for all conduits listed in the Conduit and Wire Routing Schedule. Each interconnection diagram shall show the following as a minimum:

   a. Interconnect drawings shall be prepared for all equipment by the System Supplier.

   b. The diagrams shall be utilized by the electrician during all phases of installation and connection of all conductors to ensure coordination of equipment interconnect.

   c. The diagrams shall show wiring as field labeled at the end of the project when as-builts are submitted.

   d. Each wire labeling code as actually installed shall be shown. The wiring labeling code for each end of the same wire must be identical.

   e. All devices and equipment labeling codes shall be shown.

   f. All Interconnection wires listed in the Conduit and Wire Routing Schedule for each conduit shall be shown only on one interconnect drawing. Interconnection diagrams shall be of the continuous line type with identified lines. Diagrams of the wireless or wire schedule type are not acceptable. Bundled wires shall be shown as a single line with the direction of entry/exit of individual wires clearly shown.

   g. All terminations points on the diagram shall be shown with the actual equipment identification terminal number or letter. This identification of terminations includes terminal blocks, junction boxes, all devices, computer I/O points, etc. “??” in lieu of terminal number is unacceptable.

   h. Diagrams shall include raceway numbers, raceway size, raceway type, cable numbers, wire color code, and wire numbers.

   i. Each wire size, and cable size and color code shall be shown. Each conduit with the conduit label and conduit size and wire fill shall be shown. Wire and cable routing through conduits, wireways, manholes, handholes, junction boxes, terminal boxes and other

electrical enclosures shall be shown with the appropriate equipment labels. All spare wires, cable, and termination points shall be shown. Cable shields shall be shown.

j. Labeling codes for terminal blocks, terminals, wires, cables, panels, cabinets, instruments, devices, and equipment shall be shown. Place "øA," "øB," and "øC" label next to each breaker to identify phase connected to.

k. Schematic symbols shall be used for field devices, showing electrical contacts. Signal and DC circuit polarities shall be shown.

l. The diagrams shall show all other Contract and Supplier drawing numbers, for reference, that are associated with each device that is interconnected. Attached to each interconnect, a copy of all the support documents used in preparing interconnects shall be submitted. This includes current issues of panel schematics, elementary diagrams, panelboard schedules, conduit schedules, one-line diagrams, connection diagrams, terminal block diagrams, submittals, contract drawings, vendor drawings and all other data used to develop the interconnection diagram as noted in the "Reference Documents" corner of Interconnect Drawings.

m. Interconnects shall include list of all applicable reference drawings, request for clarifications, field instructions and change orders. All deletions and additions of equipment, wire and cables shall be clearly shown.

n. Field wiring shall not start before the Interconnection Drawing has been submitted by the Contractor and approved by the Owner.

o. Do not show the same wires or jumpers, or panel wiring on both the connection and interconnection diagrams. All jumper, shielding, and grounding termination details not shown on the connection diagrams shall be shown on the interconnection diagrams.

p. Interconnection diagrams shall be submitted and approved by Owner for each electrical and instrumentation system. The Contractor shall not pull in any wires into conduits that do not have approved interconnects. If the Contractor pulls in wire without Owner approval of associated Interconnect Drawings, the Contractor will not be reimbursed for labor for re-pulling in wires even if there was an error in wire fill or sizing. Also, if the Contractor pulls in wire without Owner approval of associated Interconnect Drawings, then all progress payments related to field wiring for that particular area of work will be withheld until approved Interconnect Drawings are in use.

q. All interconnection diagrams shall be prepared by a System Supplier under the supervision of or by a State of California Registered Electrical Engineer and shall bear that Engineer's professional

stamp and signature for all Interconnection Drawings submitted for approval including as-builts and those used in the field installation.

r. Example format of Interconnection diagram is shown on Contract "E" Series Drawings or may be obtained from the Engineer.

s. Interconnect drawings submitted with wiring of a single conduit run separated onto multiple interconnect drawings will be rejected without review. A single conduit run with wiring shown on separate interconnect drawings will be allowed only after written approval is given by the Engineer for each conduit run prior to submitting the associated interconnect drawings.

t. Only field wiring between MCC, Panelboards, Control Panels, and other electrical and instrumentation devices or equipment shall be shown on interconnection drawings. No internal panel wiring shall be shown on interconnect drawings except jumper or other wiring to be installed in field by Electrical Contractor.

u. Interconnect Drawings along with the corresponding support documents shall be submitted in a separate submittal package. Interconnect drawings submitted with non-interconnect drawing packages will be rejected.

v. Interconnect drawings shall be prepared for all equipment by the System Supplier with the exception of the Telephone System and Security Alarm System who shall produce their own interconnect drawings.

w. Provide a notes section on each interconnect drawing. In the note section, list any variances from the Contract conduit schedule necessary for completing the interconnections. Change orders regarding wire fill, conduit schedule and errors in plans regarding conduits and wires will not be processed until interconnect drawings have been received for such work.

x. The field electrician shall mark-up all interconnection diagrams during installation to show accurate as-built wiring, conduits runs, terminations, etc. If interconnection drawings are not properly as-built, the Electrical Contractor will have cost deducted from the Contract for the Owner to field verify and prepare as-built interconnection drawings amount. The amount of the deduction shall be determined on a time and material basis. The cost of such work shall be $120.00 per hour plus expenses.

y. The System Supplier shall be responsible to collect all information necessary to complete each interconnection drawing. This includes making field trips to collect all terminal connection data for new and existing, MCCs, switchboards, panelboards, instruments, equipment and electrical panels.

z. An index of drawings shall be provided with each Interconnection submittal listing the unique drawing number and the description of

the interconnect drawing (e.g. Drawing 4321-IC1004 Pump 1004 Interconnect Drawing).

aa. Provide conduit and interconnect drawing cross reference indexes. Interconnect Conduit Index shall list all conduits listed in the Conduit & Wire Routing schedule and its associated Interconnection Drawing number. An Interconnection Drawing Index shall list all Interconnection drawings and the conduits shown on that specific drawing. These two indexes shall be at the front of all interconnection drawing submittals.

bb. Interconnection submittals that contain more than two motor control panels/centers shall have heavy duty dividers with permanent plastic labeled index tabs separating each group of drawings.

5. Submit full size drawing of all nameplates and tags, as specified herein, to be used on project. The Engineer has the right to adjust nameplate engraving titles during submittals at no additional cost to the Owner. Submittal to include the following:

a. Dimensions of nameplate.

b. Exact lettering and font for each nameplate.

c. Color of nameplate.

d. Color of lettering.

e. Materials of construction.

f. Method and materials for attachment.

g. Drawing showing location of nameplates on each panel and enclosure.

6. Copying contract drawings and providing them as submittals will be considered unresponsive and the submittal will be rejected without review.

D. Each submittal shall be bound in a three ring binder, which is sized such that when all material is inserted the binder is not over 3/4 full. Binder construction shall allow easy removal of any page without complete manual disassembly; spiral ring type binders are not acceptable.

1. Each binder shall be appropriately labeled on the outside spine & front cover with the project name, contract number, equipment supplier's name, specification section(s), and major material contained therein.

2. An index shall be provided at the inside of the front cover. This index shall itemize the contents of each tab and subtab section. Also list the project name, contract number and equipment supplier's name, address, phone number, and contact person on the index page.

3. Field equipment shop documents, panel equipment shop documents, drawings, and bill of materials shall be grouped under separate tabs. Catalog cuts shall be ordered in the same sequence as their corresponding Contract specification subsection.

4. Catalog cuts shall be submitted grouped together by material and not scattered throughout the submittal intermingled with other material cut sheets (i.e. do not submit cut sheet for specific size conduit followed by cut sheet for specific size wire, and then cut sheet for different size conduit and different size wire. Group conduits together, group wires together, etc.)

5. All copies shall be clear and legible. Data sheets shall be provided for each instrument, with an index and proper identification and cross-referencing.

6. Exceptions to the Contract specifications or drawings shall be clearly defined by the equipment supplier.

    a. Data shall contain sufficient details so a proper evaluation may be made by the Engineer. Contractor shall provide separate letter (located in the front of the submittal) detailing specific exceptions to the Contract Specifications or Drawings.

    b. Exceptions that are noted in the marked-up Drawings or Specifications, but not listed on the Exceptions/Clarifications letter, will be considered as non-responsive and not accepted as changes to the Contract Documents.

7. Requests for information (RFIs) shall not be included in submittals. RFIs supplied with submittals will not be answered. RFIs shall be submitted following proper channels.

8. Resubmittals shall be provided with a copy of the previous submittal comments and a separate letter, on company letterhead, identifying how each submittal comment has been addressed in the resubmittal.

9. Drawings shall be submitted in a separate hole-punched binder that covers the entire 11” x 17” length of the Drawing:

    a. Shop Drawings with less than 20 sheets total in the submittal, may be provided in an 11½-inch by 17½-inch reinforced folder.

    b. All Interconnection Drawings or Shop Drawings of 20 sheets or more shall be provided in separate heavy duty three-ring binder to allow drawings to be easily removed. Binder shall be Cardinal D-Ring Easy Open Ledger Binder with locking D-Rings or approved equal.

    c. Failure to provide drawing submittal in correct binder format may be grounds for immediate rejection without review.

    d. Each drawing title block shall contain the English description name for drawing contents (i.e. Lift Pump No. 1 Interconnect Drawing) and drawing number. All pages and drawings in the submittal shall be numbered sequentially (with no number skipped) in lower right hand corner.

    e. Drawings that are "C" or "D" size shall be folded, with the title block visible and placed in reinforced clear plastic pockets.

E. Shop documents and drawings shall be submitted for all devices and components in the electrical system. The Contractor is notified that this is a "Fast Track" project and all electrical & instrumentation drawings shall be submitted in a timely manner as not to delay completion of the project.

1.09 SUPERVISION

A. The Contractor shall schedule all activities, manage all technical aspects of the project and attend all project meetings associated with this Section.

B. The Contractor shall supervise all work in this Division, including the electrical system general construction work, from the beginning to completion and final acceptance.

C. The Contractor shall supervise and coordinate all work in this Division to insure that each phase of the project, submittal, delivery, installation, and acceptance testing, etc., is completed within the allowable scheduled time frames.

D. The Contractor shall be responsible for obtaining, preparing, completing, and furnishing all paper work for this Section, which shall include transmittals, submittal, forms, documents, manuals, instructions, and procedures.

1.10 INSPECTIONS

A. All work or materials covered by the Contract documents shall be subject to inspection at any and all times by the Owner. If any material does not conform to the Contract documents, or does not have an "No Exceptions Taken" or "Make correction Noted" submittal status; then the Contractor shall, within three days after being notified by the Owner, remove the unacceptable material from the premises; and if said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the Contractor.

B. The Contractor shall give the Owner 10 working days' notice of the dates and time for inspection. Date of inspection shall be as agreed upon by both the Contractor and Owner.

C. Work shall not be closed in or covered over before inspection and approval by the Owner. All costs associated with uncovering and making repairs where non-inspected work has been performed shall be borne by the Contractor.

D. The Contractor shall cooperate with the Owner and provide assistance for the inspection of the electrical system under this Contract. The Electrical Contractor shall remove covers, provide access, operate equipment, and perform other reasonable work which, in the opinion of the Engineer, will be necessary to determine the quality and adequacy of the work.

E. Before request for final inspection is made, the Contractor shall submit to the Owner in writing, a statement that the Contractor has made his own thorough inspection of the entire project enumerating punch list items not complete and that the installation and testing is complete and in conformance with the requirements of this Division.

F. The Owner may arrange for a facility inspection by Cal-OSHA Consultation Service at any time. The Contractor shall make the necessary corrections to bring all work in conformance with Cal-OSHA requirements, all at no additional cost to the Owner.

G. Contractor will be Responsible for any Additional Cost for Overtime, Weekend Overtime or Differential Time, Expenses for Inspection of Defective Work that has to be re-inspected.

1.11 JOB CONDITIONS

A. The Contractor shall make all arrangements and pay the costs thereof for temporary services required during construction of the project, such as temporary electrical power and telephone service. Upon completion of the project, remove all temporary services, equipment, material and wiring from each site as the property of the Contractor.

B. The Contractor shall provide adequate protection for all equipment and materials during shipment, storage and construction. Equipment and materials shall be completely covered with two layers of plastic and set on cribbing six inches above grade so that they are protected from weather, wind, dust, water, or construction operations. Equipment shall not be stored outdoors without the approval of the Owner. Where equipment is stored or installed in moist areas, such as unheated buildings, provide an acceptable means to prevent moisture damage, such as a uniformly distributed heat source to prevent condensation.

C. The elevation of the project site is shown on Contract Civil Drawings. All equipment shall be derated, as recommended by the manufacturer or in accordance with ANSI C37.30.

D. The normal outdoor, not in direct sunlight, ambient temperature range of the job site will vary between 0 to 110 degrees Fahrenheit. All equipment shall be rated to operate in these temperature ranges or provisions for adequate heating and cooling shall be installed, at no additional cost to Owner. Provide air conditioning on outdoor electrical panels with heat sensitive equipment to meeting this requirement.

E. The jobsite is prone to vandalism and theft. Contractor shall be responsible for securing all materials and equipment against theft and vandalism for the duration of the project.

F. Contractor & Subcontractors shall utilize temporary services during construction of the project. No Contractors shall utilize building power, receptacles, etc. during construction.

1.12 MEASUREMENT AND PAYMENT

A. No measurement will be made. Full compensation for conforming to these requirements, including all the labor, materials, tools, equipment, incidentals and for doing all the work involved in this section necessary for completion of the work, as shown on the Contract Plans, as specified in the Standard Specifications, these special provisions and as directed by the Engineer, shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed.

1.13 CHANGE ORDER PRICING

A. All change order pricing by Contractor or System Supplier shall be broken out into the following minimum categories:

1. Labor per hour listed per discipline, i.e. Engineer, Drafter, Estimator, Programmer, Secretarial, etc.
2. Materials and equipment itemized per component and quantity.
3. Rentals, travel, per Diem, etc.
4. Tax.
5. Shipping.
6. Overhead and profit.

B. Lump sum change order pricing is not acceptable.

C. If Contractor or System Supplier refuse to provide a change order with broken out pricing, the Engineer reserves the right to obtain independent estimates from other Contractors or System Suppliers. The Contractor or System Supplier who refused to provide the change order with broken out pricing, will be charged for the preparation of the independent estimates.

PART 2 - MATERIALS

2.01 QUALITY

A. It is the intent of the Contract specifications and drawings to secure the highest quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product.

B. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed and braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble free service. Light duty, fragile and competitive grade devices of doubtful durability shall not be used.

C. Products that are specified by manufacturer, trade name or catalog number established a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Engineer prior to installation.

D. Underwriters Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment.

E. When required by the Contract specifications or requested by the Engineer, the Contractor shall submit equipment or material samples for test or evaluation. The samples shall be furnished with information as to their source and prepared in such quantities and sizes as may be required for proper examination and tests, with all freight and charges prepaid. All samples shall be submitted before shipment of the equipment or material to the job site and in ample time to permit the making of proper tests, analyses, examinations, rejections, and resubmissions before incorporated into the work.

F. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting or operator interaction when power is restored.

G. Signal transmission from remote or field electric and electronic devices shall be 4-20 mA, sourced by a 24 VDC loop supply from the panel that is to receive the signal. Nonstandard transmission methods such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted.

H. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission.

I. It is the System Supplier's responsibility to visit jobsite to collect and document existing conditions and equipment device part numbers in order for all similar called out new equipment to match existing.

2.02 NAMEPLATES AND TAGS

A. EQUIPMENT EXTERIOR NAMEPLATES: Nameplate material shall be rigid laminated black phenolic with beveled edges and white lettering, except for caution, warning, and danger nameplates the color shall be red with white lettering. The size of the nameplate shall be as shown on the Drawings. No letters are allowed smaller than 3/16". All phenolic nameplates located outdoors shall be UV resistant. Securely fasten nameplates in place using two 316 stainless steel screws if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable.

1. Each major piece of electrical equipment shall have a manufacturer's nameplate showing the Contract specified name and number designation, the manufacturer's name, model designation, part number, serial number, and pertinent ratings such as voltage, amperage, # of phases, range, calibration, etc.

2. For each device with a specific identity (pushbutton, indicator, field control station, disconnect switches, etc.) mounted on the exterior or deadfront of a piece of equipment, provide a nameplate with the inscription as shown in the Contract Documents. Where no inscription is indicated in the Contract Documents, furnish nameplates with an appropriate inscription providing the name and number of device.

3. For all receptacles and switches (including devices located on Switchboard or MCC), provide a faceplate engraved or stamped with the panelboard and circuit number it is fed from. Also, include on faceplate or on a separate nameplate for each light switch identification use such as "OUTSIDE BUILDING LIGHTS," "PERIMETER LIGHTS," "MCC ROOM," etc.

4. All field instruments and devices shall be labeled with designation shown on P&ID diagrams.

5. All transformers and panelboards shall have nameplates with ½" high letters and be engraved with designations as shown on one-line Drawings.

6. All safety and disconnect switches shall have nameplates with ½" high letters and be engraved with designations as shown on one-line drawings.

7. Underground Pull Box and Vault Cover Identification: Engrave or bead weld pull box covers with minimum 1/4" thickness and 1/2" letters and

covers shall be engraved with designations, as shown on Contract drawings or as directed by Owner.

8. Aboveground Pull Box Cover Identification: 316 stainless steel screws attached stamped 316 stainless steel plate nameplates with 1/2" letters and be engraved with designations as shown on Contract drawings or as directed by Owner.

9. Provide engraved nameplate at service entrance equipment (red with white lettering) indicating type and location of standby generator per NEC 702.7 (A).

10. Provide engraved nameplate at service entrance equipment per NEC 702.7(B).

11. METERING – Service Equipment Label: Per NEC 110.24 (A) Service equipment shall be legibly marked in field with the maximum available fault current. Field marking shall include date the fault current calculation was performed and be weather & UV rated. Service equipment shall not be hand labeled.

12. All subpanels shall be identified with an engraved phenolic label of the power source location feeding it (i.e. MCC-100, Panelboard LP-1, etc.)

13. Specific equipment fed from more than one feeder shall be properly identified ("Fed from Pedestal and the standby generator").

B. EQUIPMENT INTERIOR NAMEPLATES: Nameplate material shall be white plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering.

1. The size of the nameplate tape shall be no smaller than ½" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. Add additional clear adhesive to hold the nameplate securely in place when necessary.

2. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate located above the device with the inscription as shown in the Contract Documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of device used on the Submittal Drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal.

3. Nameplates shall not be attached to wireway covers or to removable devices.

4. For all receptacles and switches (including devices located in Control Panel, provide a faceplate printed with the panelboard and circuit number it is fed from.

C. EQUIPMENT TAGS: The Contractor shall attach a tag to the equipment (including instruments) with the same inscriptions as specified above in paragraph A. The tag shall be made from 316 stainless steel material and the size of the nameplate shall be no smaller than 3/8"h x 2"w with 3/16" machine printed or engraved lettering unless otherwise approved by the Engineer. The tag shall be attached to the equipment with 316 stainless steel wire of the type normally used for this purpose. SST wire must be crimp connected. Twisting ends together is not acceptable.

D. Engrave or machine print the tags with inscriptions as approved by the Engineer in the nameplate submittal.

E. Provide temporary labels for all instruments and devices immediately when installed. Temporary labels shall be provided with ½" letters minimum and labeled with P&ID tag number.

2.03 WIRE

A. This Section applies to all wires or conductors used internal for all electrical equipment or external for field wiring. All wires shall be properly fused or protected by a breaker at the amperage rating allowed by the NEC.

B. Material: Wire shall be new, plainly marked with UL label, gauge, voltage, type of insulation, and manufacturer's name. All wire shall conform to the following:

1. Conductors shall be copper, with a minimum of 97% conductivity.
2. Wire shall be Class B stranded. Solid wire conductor prohibited.
3. ASTM B8, soft drawn copper, maximum 12 months old.
4. Insulation of all conductors and cables shall be rated 600 volt.
5. Insulation type for all conductors shall be moisture and heat resistant thermoplastic NEC Type XHHW-, rated 90 °C in dry locations and 75 °C in wet locations, or approved equal.
6. Field wire minimum AWG sizes
   a. #12 for wires used for individual conductor circuits 480 volt and above. #12 for wires used for individual conductor circuits 100 volt and above, except for PLC I/O which may be #14 AWG.
   b. #14 for wires used for individual conductor circuits below 100 volt.
7. Non-field or panel wire minimum AWG sizes if properly protected by fuse or breaker:
   a. #14 for wires used for individual conductor circuits 100 volt and above.

b. #18 for wires used for individual conductor circuits below 100 volt and above if properly protected by fuse or breaker.

8. Instrument Wiring

a. Field: Instrument cables shall have 600V tray cable rated insulation and 100% individual shielded twisted pair #16 conductors with drain wire. Single twisted shielded pair (T.S.P.R.) Cables shall be Belden, Manhattan, or approved equal.

b. Non-Field: Instrument cables shall have 300V rated insulation and 100% individual shielded twisted pair #18 conductors with drain wire. Single twisted shielded pair (T.S.P.R.) cables shall be Belden, Manhattan, or approved equal.

c. General: Instrument cables shall have 600V rated insulation and 100% individual shielded twisted pair #16 conductors with drain wire. Single twisted shielded pair (T.S.PR.) cables shall be Belden, or approved equal.

C. Wire Marking

1. Wire Identification: All wire terminations including field interconnect as well as wiring interior MCC cubicles, switchboard, panels, equipment, junction panels and boxes shall be identified with machine printed labels. Hand lettered labels are not acceptable and shall be replaced at the Contractor's expense. The wire identification code for all field interconnect and panel interior wiring, shall be similar to the designations shown on the Contract example drawings.

2. Wire Labels: The labels shall be machine printed with indelible ink, heat-shrink type, capable of accepting a minimum of 23 machine printed characters per sleeve, label by Brady "Bradysleeve" or equal. Labeling shall be neatly installed for visibility and shall be clearly legible. Each wire and conductor shall be labeled with wire label, as shown on approved loop, elementary and interconnect Drawings. Labels shall not be wrap-around or Snap-On type.

3. Where there is insufficient space for labels on locally interconnected neutral wires such as jumpers between adjacent auxiliary relay coil neutral terminals, these labels may be omitted. "Locally" is defined as wires no longer than 8".

4. Wire labels for lighting and receptacles shall be installed and consist of the panelboard and circuit number (i.e., Panelboard "LP100," circuit breaker #3 would have wire label line "LP100-L3" and neutral "LP100-N3").

5. All spare wires shall be labeled with equipment number followed by X1, X2, etc. (i.e. P11001-X1 for first spare wire).

6. All control and signal wiring terminations shall have the correct wire label applied prior to making connection.

7. Ethernet patch cables and fiber cables shall be labeled with primary devices it is connected to (i.e. “PLC,” “OI,” “PLC-2,” etc.). Label shall be white plastic with black machine printed lettering as produced by a KROY or similar machine with lettering no smaller than 3/8”. Securely attach to cable with clear tape.

D. Special Purpose Wiring

1. Manufacturer Supplied Cables (MNFR CBL): Cables and wiring for special systems shall be provided by the manufacturer with the equipment and installed per the manufacturer’s recommendations.

2. CAT 6 communication cable in underground (UG) conduit shall meet the following requirements:

   a. TIA/EIA-568-B Category 6E Specifications.
   b. #24 AWG solid bare copper conductor, 4 or 25 pair shielded twisted pair per “Conduit & Wire Routing Schedule”.
   c. Rated for direct burial application.
   d. Insulation: Solid Polyolefin, 600V rated.
   e. Filling compound: 80°C extended thermoplastic rubber.
   f. Outer Jacket: Black, water and UV resistant polyethylene.
   g. Electrically continuous aluminum shield.

3. Indoor CAT 6 communication cable meet the following requirements:

   a. TIA/EIA-568-C.2 Category 6 100 MHz specifications.
   b. #24 AWG solid bare copper conductor, 4 twisted pairs.
   c. Polyolefin insulation.
   d. Shielded bulk cable.
   e. PVC jacket.
   f. Nominal Impedance: 100 ohms.
   g. Nominal capacitance: 15 pf/ft. maximum.
   h. UL listed.
   i. Non-plenum usage rated when routed in conduit.
   j. Plenum usage rated when routed in plenum spaces.
   k. Cable shall be rated for water.

E. Color Code

1. Color code of all wire shall conform with the following table.

WIRES COLOR CODE TABLE

Description	Phase/Code Letter	Field Wire or Tape Color	Non-Field Wire Color
480 V, 3 Phase	A	Brown	Brown
	B	Orange	Orange
	C	Yellow	Yellow
240 V or	A	Black	–
208 V, 3P	B	Red (Orange if high leg)	–
	C	Blue	–
240 / 120 V, 1 P	L1	Black	Black
	L2	Red	–
12 V Positive	12P	Dark Blue	Dark Blue
12 V Negative	12N	Black/Red Stripe	Black/Red Stripe
24 V Positive	24P	Pink	Pink
24 V Negative	24N	Black Stripe	Black Stripe
AC Control		Violet	Red (Yellow for Foreign Circuits)
DC Control		Light Blue	Light Blue
Neutral	N	White	White
Ground	G	Green	Green
Shielded Pair	+	White (Clear)	White (Clear)
	–	Black	Black

2. No other colors shall be used without prior approval of the Owner.

3. The same color shall be connected to the same phase throughout the panel.

4. All wires shall be properly fused or protected by a breaker at the amperage rating allowed by the NEC.

5. Neutral used for AC Control shall be white.

6. Phase color insulation shall be provided for complete length of #8 wire or smaller, colored phase tape is not allowed on #8 and smaller wire.

2.04 TERMINAL BLOCKS & FUSES

A. Control Panel Terminal Blocks:

1. General

a. Terminal blocks to be clamp type, 6mm spacing, 600 volt, minimum rating of 30 amps, and mounted on DIN rail, Phoenix Contact, Entrelec, or approved equal. DIN rail shall be same type as used for the relays. Install an extra DIN rail on each type of terminal strip with 20% spare terminals for future additions.

b. Provide terminal blocks with "follower" plates that compress the wires and have wire guide tangs for ease of maintenance. Terminal blocks that compress the wires with direct screw compression are unacceptable. All power, control and instrument wires entering and leaving a compartment shall terminate on terminal blocks with wire numbers on terminals and on both ends of the wires.

c. Terminal Tags and Markers: Each terminal strip shall have a unique identifying alphanumeric code at one end. Numbers shall be assigned to all blocks except grounding blocks. Fuse blocks shall be assigned unique tag numbers such as FU1, FU2. No two fuses shall be assigned the same tag number. Terminal blocks are to be labeled to match the wire landed.

d. Terminal blocks shall be physically separated into groups by the level of signal and voltage served. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.

e. Provide a ground terminal or connection point for each grounding conductor.

f. Provide a separate terminal block for every two neutral terminations or as coordinated with the interconnect diagrams.

2. MCC – Motor Starter Cubicles Terminal Blocks:

a. MCC cubicle terminal blocks shall be pull-apart as supplied standard by MCC manufacturer.

3. Power Termination Blocks shall be rated for 600V main power connection. The power termination blocks shall be rated to accept Copper or Aluminum cable rated as shown on Contract one-line diagrams. The power termination block shall be capable of being mounted anywhere in a termination box. Each termination block shall be provided with lug shield to prevent contact with power connections. The power termination blocks shall be Connectron or approved equal.

B. Fuses

1. Fuses used in circuits 200 VAC and above shall be time-delay type FNQ or approved equal, 13/32" x 1-1/2", and have an interrupting rating of 42,000 AIC at 500 VAC. Fuse holders shall be of the barrier type and rated 600 VAC.

2. Fuses used in 120 VAC shall be time-delay type MDL or approved equal, 1/4" x 1-1/4", and have a rating of 250 VAC. Fuse-holders shall be of the terminal block type.

3. Fuses used in signal and 24 VDC circuits shall be fast-acting type GMA or approved equal, 5 mm x 20 mm/1/4" x 1-1/4" and have a rating of 250 VAC. Fuse-holders shall be of the terminal-block type.

4. Fuses shall be sized in conformance with the NEC.

2.05 COMPONENTS

A. Switches and Pushbuttons

1. Switches and pushbuttons for general purpose applications shall be water and oil tight as defined by NEMA 4X, corrosion resistant as defined by NEMA ICS 6-110.58, U.L. listed, standard 30 mm diameter, with round plastic clamp ring. Switches shall be Allen-Bradley 800H or approved equal.

2. Switches and pushbuttons shall have contacts rated 10 amperes continuous and 600 VAC.

3. Manufacturer's standard size legend plates shall be provided and engraved to specify each switch and pushbutton function. The legend plate color shall be black.

4. Selector switch handles and pushbutton caps shall be black.

5. Selector switches for hand-off-auto (HOA) applications shall have the hand position to the left, off in center, and auto in the right position.

6. Potentiometer be 10kohm, manual single turn potentiometer.

7. On/Off selector switches shall have the "ON" position to the right.

8. Lockout stop shall be a pushbutton with red cap and pad locking assembly for pushbutton.

B. Relays and Timers

1. GENERAL: Relays and timers shall be provided with N.O. or N.C. contacts as shown on the Contract drawings. All spare contacts shown shall be provided. Contacts shall be rated 10 amps minimum at 120 VAC, 60 Hz unless otherwise stated. Supply power or coil voltage shall be 120 VAC unless shown otherwise on the Contract drawings. Relays and timers shall

be designed for continuous duty. All relays shall be U.L. listed. The following is a summary of abbreviations associated with relays and timers:

CR	–	Control relay
TR	–	Timing relay
TDOE	–	Time delay on energization
TDOD	–	Time delay on de-energization

2. Control relays (CR) shall be plug-in type with indicating lights and clear see-through sealed or enclosed housing to exclude dust. Sockets for plug-in relays shall be standard industrial blade type with barrier pressure screw terminals. Provide IDEC Type RR, or approved equal. Two form-C contacts (minimum) shall be provided on each relay.

3. Time delay relays (TR) on energization or de-energization shall be solid state plug-in relays with a timer adjustable over the range 1 second to 3 minutes unless other ranges are indicated or required. Provide LED timer energized indicator lamp. Sockets for plug-in timers shall be standard industrial type with barriered pressure screw terminals. Time delay relays shall be IDEC GTS, or approved equal.

C. Indicating Lights

1. Indicating Lights for general purpose applications shall be water and oil tight as defined by NEMA 4X, corrosion resistant as defined by NEMA ICS 6-110.58, U.L. listed, High intensity multi-chip LEDs, full voltage (unless shown otherwise), standard 30 mm diameter, with round plastic lens and miniature bayonet lamp base. Indication lights shall be Allen-Bradley 800H, or approved equal.

2. Manufacturer’s standard size legend plates shall be provided and engraved to specify each light’s function. The legend plate color shall be black.

3. Indicating lights designated "PTT" shall be provided with a push-to-test switch and wiring.

4. Indicating light type and color of lens shall be as shown on the Drawings or specified in the Contract documents. Lamp color will be as follows:

a.	Open/On	Green
b.	Closed/Off	Red
c.	Alarm	Amber
d.	Power On	White

D. Circuit Breakers

1. Circuit breakers shall be of the indicating type, providing ON, OFF and TRIPPED positions of the operating handle. Circuit breakers shall be quick-make, quick-break, with a thermal-magnetic (TM) action or Motor Circuit Protectors (MCP) as shown on One-Line Diagrams. Circuit breakers

feeding Soft Starters or VFDs shall have true adjustable long, short and instantaneous trip units.

2. Main Circuit breakers shall be the bolted on type. The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified are not acceptable. All multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open. Main Circuit breakers and motor circuit protectors shall be manufactured by Eaton, G.E., ITE, or approved equal.

3. Each 480 volt or 240V circuit breaker shall have a minimum interrupting capacity of 35,000 amperes. Each 120 volt breaker shall be rated for a minimum 10,000 amperes interrupting capacity. Breakers shall be sized as shown on Drawings and as necessary for the supplied equipment.

4. Fused disconnects shall not be used in place of breakers.

5. Breakers shall be sized and have a minimum interrupting capacity as shown on Drawings and as required for the supplied equipment.

6. All breakers shall be supplied with the correct sized copper only lugs for wire sizes as listed in “Conduit & Wire Routing Schedule”. Provide larger frame breaker or lug adapters as necessary when connecting to the listed oversized wire.

2.06 CONTROL PANEL

A. Control panel shall consist of the 24VDC power supply, enclosure, and other devices for a complete and operational system.

1. City will obtain new backpan mounted RTU. Backpan spaces shall be made available inside Control Panel for its installation.

   a. Programming, configuration and final terminations will be by Others.

2. Devices:

   a. Lights, switches, pushbuttons, terminal blocks etc. to match those specified under Devices subsection.

   b. DC power supply to be VDC quantity and sizes per Contract drawings, Sola, Phoenix Contact, Power One Linear series, or approved equal.

   c. RFI filter for radio interference protection shall be Corcom 15VK, or approved equal.

B. Provide metal data pocket within each enclosure to hold as-built drawings.

2.07 FIELD DEVICES

A. Level/Pressure Indicating Transmitter (0-30 feet, LIT-151)

1. Transmitter:

   a. The pressure transmitter shall incorporate a high-accuracy capacitance sensor. With this sensor, process pressure is transmitted through the isolating diaphragm and fill fluid to the sensing diaphragm in the center of the capacitance cell. Capacitor plates on both sides of the sensing diaphragm detect its position. The differential capacitance between the sensing diaphragm and the capacitor plates shall be directly proportional to process pressure.

   b. The transmitter shall incorporate a temperature measurement to compensate for thermal effects.

   c. The pressure transmitter electronics shall convert the capacitance and temperature input signals directly into digital format for further processing by the electronics module.

   d. Configuration data shall be stored in nonvolatile EEPROM memory in the electronics module of the transmitter.

2. Software Functionality:

   a. The PC based HART protocol software and cables shall be provided.

   b. Configuration: The transmitter shall be configured by the System Supplier. Configuration shall consist of operational/parameters and informational data.

   c. Test: The pressure transmitter shall perform continuous self-tests.

   d. Format: The format function is used during the initial setup of a transmitter and for maintenance of the digital electronics.

Requirements**:** Range:	0-30 Feet.
Output:	Two-wire 4-20 mA output. Digital process variable superimposed on 4-20 mA signal.
Power Supply:	Loop power supply required.
Indication:	4-digit LCD meter setup with Engineering Units.
Zero Elevation and Suppression:	Anywhere within the sensor limits.
Overpressure Limits:	Limit is 0 psig to 3,626 psig (25 Mpa) without damage to the transmitter.
Temperature Limits:	Process: 0° F to 185°F (-18° C to 85°C). Ambient: -4° F to 175°F (-20° C to 80°C).
Humidity Limits:	0 – 100% relative humidity.
Accuracy:	±0.075% of span for spans from 1:1 to 10:1 of URL.
Stability:	±0.2% of URL for 12 months.

Requirements**:** Range:	0-30 Feet.
Process-Wetted Parts:	Isolating Diaphragms: 316 SST.
	Drain/Vent Valves: 316 SST.
	Flanges: 316 SST.
	Wetted O-rings: Glass-filled TFE.

3. The pressure transmitter shall be Foxboro IGP10-A22D transmitter, to match Owner Standard.

4. CALIBRATION VALVE - Each calibration valve assembly shall have integral 316 stainless steel block and bleed valving. Valve shall have a non-rotating tip stem and a fully back-seated bonnet. Block and bleed valve shall be Hex HB59 (phone 800-543-7311), PBM valve solutions or approved equal.

B. Intrusion Switch

1. Door Intrusion Switch ((ZS-191A, ZS191B) – Each intrusion door switch shall have a wide gap magnetic sensor with S.P.D.T. contacts mounted in a rugged steel housing with a 3 foot stainless steel armored cable for wiring to a junction box. Intrusion door switches shall be Sentrol 2507-A, or approved equal

2. Tank Intrusion switch (ZS-192A, ZS192B) – Each tank intrusion switch shall be pre-wired factory sealed cable of 5 feet for wet applications. Roller level switch shall have 316 stainless steel roller with 5’ long rod lever arm. Switch shall be provided with two circuits with clockwise or counter clockwise lever movement operation. Intrusion switch shall be Allen-Bradley Model 802MC-AY5 with 802MC-W3 lever or approved equal.

2.08 CONDUIT, RACEWAYS AND WIREWAYS

A. General: Conduit, raceways, wireways, wiring methods, materials and installation shall meet all requirements of the NEC, be UL labeled for the application, and meet the minimum following specifications:

1. All wiring shall be installed in conduits, raceways, or wireways when interconnecting equipment and devices.

2. The Contractor shall use special conduit, raceways, wireways, construction methods, and materials as shown on the Contract drawings; which shall take precedence over any general methods and materials specified in this Section.

3. The minimum size conduit shall be ¾-inch unless indicated otherwise on the Drawings or for special connections to equipment.

4. Conduit stubs for future use shall be capped with coupling, nipple, plug, and cap and each end identified with conduit labels.

5. Conduits to be abandoned that protrude above graded shall be cut flush and filled with grout.

6. Conduits shall not be filled to more than 50% of their total cross–sectional area.

7. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG," Appleton "GIB," or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.

B. Conduit Marking

1. All conduits listed in the "Conduit and Wire Routing Schedule" shall have conduit tags at both ends of each conduit segment. This includes all conduits in pullboxes and vaults.

2. Tag material shall be rigid laminated red phenolic with white lettering. The size of the tag shall be 2" diameter. No letters are allowed smaller than 7/16". Securely fasten tags in place using 316 stainless steel 0.048 inch diameter wire of the type normally used for this purpose (catalog cut sheet shall be submitted). Stainless steel wire shall be crimp connected. Twisting ends together is not acceptable. Engrave the tags, on both sides, with the conduit number as listed in the Conduit and Wire Routing Schedule on the Contract "E"-series Drawings. Labeling shall be neatly installed for visibility and shall be clearly legible. Conduit tags shall be Brady Custom B-1, or approved equal.

3. Prior to encasement, concealment, backfilling of conduits, temporary conduit labels shall be provided at each end of conduit. Temporary conduit labels shall have ½-inch (minimum) lettering at all transition points. After encasement and concealment temporary conduit labels shall be placed at each exposed end.

4. Warning Tapes:

a. Bury detectable warning tapes approximately 12 inches above all underground conduit runs of two or more outside of building. Align parallel to and within 3 inches of the centerline of the conduit or duct bank.

b. Plastic tape shall be colored for particular underground service, 3-inch minimum width, utilize tape made of material resistant to corrosive soil. Tape shall have aluminum backing to facilitate locating it underground using a non-ferrous locator. Use red tape for "Electric" service and orange tape for "Communication" service. Use tape with printed wording listing type of service. Manufacturers and types: Seton, Blackburn, Griffolyn Co., Terra-Tape, Brady or equivalent.

C. Galvanized Rigid Steel Conduit (GRS)

1. Rigid steel conduit, couplings, bends and nipples shall be in accordance with ANSI C80.1 and UL-6.
2. Hotdip galvanized inside and outside after fabrication and then coated with a zinc bichromate finish.
3. Minimum trade size – three-quarters inch (¾") unless otherwise shown on Contract Drawings.
4. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG", Appleton "GIB", or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.
5. Galvanized rigid steel factory elbows for indoor 90 degree transitions.
6. EMT or IMC is not considered an equivalent to GRS.
7. GRS conduit is allowed only when specifically called out in the "Conduit and Wire Routing Schedule".

D. Galvanized Rigid Steel Conduit – PVC Coated (GRS-PVC)

1. Standard weight, galvanized conduit with a 40-mil thick polyvinylchloride coating bonded to both the outside and urethane interior coating. Conduit shall be hot-dip galvanized conforming to NEMA RN 1. GRS-PVC conduit to be Robroy Plasti-bond Red, Perma-Cote, or approved equal.
2. Provide PVC coated galvanized rigid steel factory elbows for 90 degree transitions.
3. Fittings shall be hot dipped galvanized steel or galvanized cast ferrous metal with a PVC 40 mils thick coating. Provide threaded-type fittings, couplings, and connectors; set-screw type and compression-type are not acceptable. Fittings shall be Robroy Liquitite coated fittings or approved equal.
4. All junction boxes shall be galvanized with exterior surfaces PVC coated to 40 mils thickness except where 316 stainless steel boxes are called out.
5. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG", Appleton "GIB", or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.
6. Support channel and pipe straps shall be PVC coated. Exposed metal/nuts, all-thread rod shall be 316 stainless steel.
7. PVC coating patching material shall be as provided by the manufacturer.
8. PVC coated Aluminum conduit is not acceptable.

E. PVC Conduit (PVC-40 OR PVC-80)

1. Shall be high impact polyvinylchloride suitable for use underground, direct burial and for use with 90 C wires, and shall conform to UL 651. PVC conduits shall be UL listed and labeled for “direct” burial.
2. A copper bonding conductor shall be pulled in each raceway and bonded to equipment at each end with approved lugs.
3. Bends, elbows, and risers shall be made with PVC coated galvanized rigid steel (GRS-PVC) conduit using threaded adapters. Bond each metallic portion to each other and to equipment connected at each end of conduit run.
4. Risers shall be made with PVC coated galvanized rigid steel (GRS-PVC) conduit using threaded adapters. Bond each metallic portion to each other and to equipment connected at each end of conduit run.
5. PVC fittings shall have watertight solvent-weld-type conduit connections.
6. PVC conduit shall be stored on a flat surface and shielded from the sun.
7. PVC conduit shall not be used above grade.
8. PVC coated Aluminum conduit is not acceptable.

F. Liquid Tight Flexible Metal Conduit (FLEX)

1. Minimum trade size one-half inch (1/2").
2. All flex conduits shall be metallic with water tight outer jackets.
3. Connectors:
   a. NON-NEMA 12 AREA: PVC coated metallic with insulated bushings.
   b. NEMA 12 AREA: Metallic with insulated bushings.
4. Final connections to vibrating equipment such as motors and fans shall be made with flexible conduits.
5. Flexible conduit lengths shall not be greater than 36 inches.
6. Flexible metallic conduit shall not be considered as a ground conductor, install a separate wire for equipment bonding.
7. Flexible conduit shall only be installed in exposed or accessible locations.
8. Flexible conduits shall be used for conduit coupling to all vibrating and shifting equipment.

2.09 WIRING DEVICES

A. Boxes

1. Device boxes shall be of zinc-galvanized steel type with shape and size best suited for the particular application, rated for the location installed, and shall be supported directly to structure by means of screws, anchors, or bolts.

2. Box dimensions shall be in accordance with size, quantity of conductors, and conduit clearances per NEC articles 314 requirements.

3. Non-Weatherproof Boxes - Surface boxes shall be cast ferrous, deep FD type with threaded hubs.

4. Weatherproof (WP) Boxes - PVC-coated cast ferrous boxes may be used in place of 316 stainless steel boxes, except where boxes contain devices on cover. Boxes shall be deep, FD type with threaded hubs or stainless steel with watertight Myers hubs. Single gang boxes shall have cast hubs.

B. Switches

1. General purpose switches shall be manufactured in accordance with UL 20. Switches shall be one pole rated, 20 amps, at 277 VAC. Bodies shall be of ivory phenolic compound supported by mounting strap having plaster ears. Switches shall have copper alloy contact arm with silver cadmium oxide contacts. Switches shall have slotted terminal screws and a separate green grounding screw. Furnish Hubbell 1221, Leviton 1221, or approved equal.

C. Receptacles

1. General purpose receptacles shall be duplex and rated 20 amps, 120 VAC, 2 pole, 3 wire grounding, NEMA 5-20R configuration, specification grade, and side wired to screw terminals. Face color shall be white or ivory. General purpose receptacles shall be Leviton 5362, Bryant, Hubbell, or approved equal.

2. GFI (ground fault circuit interrupting) receptacles shall be used in all boxes shown as weatherproof. GFI receptacles shall be duplex, 20A, 120V, with “test” and “reset” buttons with shallow design for mounting and standard screw terminals for direct wiring. Receptacles shall be designed, manufactured, and tested to prevent nuisance tripping from voltage spikes, RFI, EMI, or electronic component failures. Chaining multiple receptacles from one GFI unit is not acceptable. GFI receptacles shall be Leviton 6899, Arrow-Hart or approved equal.

D. Device Plates and Covers

1. General purpose device plates and covers shall be 316 stainless steel. Plates or covers shall be attached with 316 stainless steel screws. Circuit breaker number and panelboard name shall be stamped on each cover.

2. PVC coated device boxes shall have PVC-coated gasketed covers.

3. Weatherproof switch, outlet, and receptacle boxes shall be fitted with gasketed covers rated for wet locations in accordance with NEC 404.4.

4. Weatherproof switch, outlet, and receptacle boxes shall be fitted with cast aluminum gasketed cover rated for wet locations. Each receptacle access cover shall have a gasketed spring door to maintain the weatherproof integrity with plug inserted in accordance with NEC 406.9 for unattended locations. Final decision of type of access cover for specific location shall be per Engineer. Screws and hinge springs shall be 316 stainless steel. Receptacles located outside shall have tumbler key lock.

5. Weatherproof access covers shall be Hubbell, Crouse-Hinds, or TayMac Safety Outlet Enclosures, or approved equal.

6. Receptacle & light switch plates shall be stamped or engraved as specified in section Nameplates and Tags.

2.10 GROUNDING SYSTEM

A. Ground clamps shall be bolt-on type as manufactured by ILSCO type AGC, O-Z Gedney Type GRC, Burndy Type GAR or GP or approved equal.

B. All ground rod, pipe, and steel plate and buried bond connections shall be made by welding process equal to Cadweld.

C. Ground buses shall be provided in all electrical enclosures. Each ground bus shall be sized as shown on the Contract drawings or specified herein. The ground bus shall be adequately sized for the connection of all grounding conductors required per NEC. Screw type lugs shall be provided on all ground busses for connection of grounding conductors.

D. Each ground bus shall be copper. Screw type fasteners shall be provided on all ground busses for connection of grounding conductors. Ground bus shall be a Challenger GB series, ILSCO D-167 series or approved equal.

E. Attachment of the grounding conductor to equipment or enclosures shall be by connectors specifically provided for grounding. Mounting, support, or bracing bolts shall not be used as an attachment point for ground conductors.

F. All raceway systems, supports, enclosures, panels, and equipment housings shall be permanently and effectively grounded.

G. One side of the secondary on all transformers shall be grounded.

H. The system neutral (grounded conductor) shall be connected to the system's grounding conductor at only a single point in the system. This connection shall be made by a removable bonding jumper sized in accordance with the applicable

provisions of the National Electrical Code if the size is not shown on the Drawings. The grounding of the system neutral shall be in the enclosure that houses the service entrance main over-current protection.

I. The system neutral conductor and all equipment and devices required to be grounded by the National Electrical Code shall be grounded in a manner that satisfies the requirements of the National Code.

J. Grounding conductors shall be sized as shown on the Plans or in accordance with NEC Table 250.122, whichever is larger.

K. Grounding and bonding wires shall be installed on all conduits with grounding bushings, expansion joints and for continuity of raceways transitions. Bonding wires at endpoints shall be connected to enclosure ground bus or equipment grounding lug.

L. Conduit grounding bushings shall be installed on all metallic conduits. Conduit grounding bushings shall be set screw locking type electra-galvanized malleable iron with insulation collar and shall be provided with a feed through compression lug for securing the ground bonding wire. Ground bonding wire shall be bare wire and shall be sized per NEC.

M. All receptacles shall have their grounding contact connected to a grounding conductor.

N. Branch circuit grounding conductors for receptacles, or other electrical loads shall be arranged such that the removal of a lighting fixture, receptacle, or other load does not interrupt the ground continuity to any other part of the circuit.

O. Negative side of all VDC power supplies shall be grounded.

2.11 MANUAL TRANSFER SWITCH

A. Provide manual transfer switch (MTS) with two 20A, 120VAC breakers; one for utility (UPS Power), one for generator. MTS shall have outdoor rated stainless steel cabinet with lockable cover. MTS shall be provided with built-in 120VAC receptacle. MTS shall be Reliance Controls Easy Tran CSR201 Series or approved equal.

B. Provide adaptor plugs for City to plug in portable 120VAC generator.

2.12 ELECTRICAL ENCLOSURES AND BOXES

A. Enclosures and boxes to be wall mounted, minimum 14 gauge, type 316 stainless steel with seams continuously welded & ground smooth, and fast access door

latches. Outer door shall have provisions for locking enclosure with standard padlock. Provide white backpan in box.

B. Provide accessories consisting of breaker to disconnect incoming power, heater, fan, removable metal louvers, and thermostats, where shown on Contract drawings.

C. Provide larger enclosure as required to accommodate the supplied equipment at no additional cost to the Owner.

D. A copper ground bus shall be provided in the enclosure. Each ground bus shall be copper and UL recognized. Screw type fasteners shall be provided on all ground buses for connection of grounding conductors. Ground bus shall have a minimum of 10 taps, and be rated for copper conductors. Ground bus shall be an ILSCO D-167 Series, or approved equal

E. Provide metal data pocket within each enclosure and box to hold as-built drawings.

F. All panel doors shall be installed with ground straps.

G. Panels shall be provided with engraved nameplate identifying name of panel, voltage and location of power source feeding it (i.e. MCC-100, Panelboard LP-1, etc.).

H. Top of operator interface (pilot devices / breaker) to be maximum 66” above finished floor.

I. Enclosure shall be Hoffman, Tesco, Circle AW or approved equal.

PART 3 - MATERIALS

3.01 ELECTRICAL WORKMANSHIP

A. All work in this Section shall conform to the codes and standards outlined herein.

B. The Electrical Contractor shall employ personnel that are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct improper installations at no additional expense to the Owner.

E. The Engineer reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

3.02 ELECTRICAL CONSTRUCTION METHODS, GENERAL

A. All wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by round-head 316 stainless screw attached retainer. Where space is available, such as in electrical cabinets, all wiring shall be run in slotted plastic wireways or channels with dust covers. Wireways or channels shall be sized such that the wire fill does not exceed 50%. Wires carrying 100 volts and above shall be physically separated from lower voltage wiring by using separate bundles or wireways with sufficient distance to minimize the introduction of noise, crossing only at 90 degree angles. Tie-wraps shall be T & B TY-RAP’s or approved equal.

B. Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by plastic spiral wrap. The hinge loop shall be of sufficient length to permit opening and closing the door without stressing any of the terminations or connections.

C. All devices shall be permanently labeled and secured in accordance with subsections labeled “NAMEPLATES AND TAGS”.

D. All field wires and panel wires have wire markers as specified in the “WIRE” subsection.

E. All components associated with a particular compartment’s or enclosure’s function shall be mounted in that compartment or enclosure.

F. Spacing and clearance of components shall be in accordance with UL, JIC and NEC standards.

G. Wires shall not be spliced except where shown. Devices with pigtails, except lighting fixtures, shall be connected at terminal blocks. Equipment delivered with spliced wires shall be rejected and the Contractor required to replace all such wiring, at no additional cost to the Owner.

H. No wires shall be spliced without prior approval by the Engineer.

I. Where splices are allowed or approved by the Engineer they shall conform with the following:

1. Splices of #10 and smaller, including fixture taps, shall be made with see-thru nylon self-insulated twist on wire joints; T & B "Piggys", Ideal "Wing Nut", or approved equal.
2. Splices of #8 and larger shall be double crimped splices, or approved equal, insulated with heat shrink tubing, or approved equal.
3. Splices in underground pullboxes shall be insulated and moisture sealed with 3M "Scotchcast" cast resin splice kits and shall have a date marking for shelf life. Do not use splice kits with a date marking for shelf life that has expired.
4. Wire splicing devices shall be sized according to manufacturer's recommendations.
5. Tape on splices shall not be allowed.
6. Splices for motor leads shall be made with T&B MSC series splice kit, or approved equal.

J. Tapes shall conform to the requirements of UL 510 and be rated: 105 degrees C, 600V, flame retardant, hot and cold weather resistant. Vinyl plastic electrical tape shall be 7 mil black. Phase tape shall be 7 mil vinyl plastic, color coded as specified. Electrical insulation putty shall be rubber based, elastic putty in tape form. Varnished cambric shall not be used.

K. Connections to terminals shall be as follows:

1. Use connector or socket type terminals furnished with component.
2. Connections to binding post screw, stud or bolt use:
    a. For #10 and smaller wire, T & B "Sta-Kon", Buchanan "Termend" or approved equal, self-insulated locking forked tongue lug.
    b. For #8 to #4/0 wire, T & B "Locktite", Burndy QA or approved equal lug of shape best suited.
3. Use ratchet type crimping tool which does not release until proper crimp pressure has been applied.
4. Connections to terminals shall be as follows:
    a. Use connector or socket type terminals furnished with component.

b. Connections to binding post screw, stud, or bolt use:

1) For #10 and smaller wire, T & B "Sta-Kon", Buchanan "Termend", or approved equal, self-insulated locking forked tongue lug.

2) For #8 to #4/0 wire, T & B "Locktite", Burndy QA, or approved equal, lug of shape best suited.

c. Use ratchet type crimping tool which does not release until proper crimp pressure has been applied.

d. Connections for all terminals shall be made with insulation stripped per manufacturer's instructions.

L. Equipment shall be wired and piped by the manufacturer or supplier. Major field modifications or changes are not allowed without the written “change order” authority by the Engineer. When field changes are made, the components, materials, wiring, labeling, and construction methods shall be identical to that of the original supplied equipment. Contractor’s cost to replace or rework the equipment to match original manufacturer or supplier methods shall be done at no additional cost to the Owner.

M. Mating fittings, bulkhead fittings, plugs, lugs, connectors, etc. required to field interface to the equipment and panels shall be provided by the supplier when the equipment is delivered.

N. All electrical and instrumentation factory as-built drawings associated with the equipment shall be provided with the equipment when it is delivered to the job site. Drawings for each piece of equipment shall be placed in clear plastic packets of sufficient strength that will not tear or stretch from drawing removal and insertion.

3.03 ELECTRICAL EQUIPMENT FABRICATION, GENERAL

A. Panel cutouts for devices (i.e. indicating lights, switches) shall be cut, punched, or drilled and smoothly finished with rounded edges. Exposed metal from cutouts that are made after the final paint finish has been applied shall be touched up with a matching paint prior to installing device. Do not paint nameplates, labels, tags, switches, receptacles, conductors, etc.

B. All doors shall be fully gasketed, with non-shrinkable water and flame resistant material.

C. Bolts and screws for mounting devices on doors shall be as specified by the manufacturer, otherwise they shall have a 316 stainless steel flush head which blends into the device or door surface. No bolt or screw holding nuts shall be used on the external surface of the door.

D. No fastening devices shall project through the outer surfaces of equipment.

E. Each component within the equipment shall be securely mounted on an interior subpanel or backpan and arranged for easy servicing, such that all adjustments and component removal can be accomplished without removing or disturbing other components. Mounting bolts and screws shall be front located for easy access and removal without special tools. Access behind the sub panel or backpan shall not be required for removing any component.

F. HARNESS: Where space is available, all wiring shall be run in slotted plastic wire ways or channels with dust covers. If space is not available for wireways, then all wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by 316 stainless steel screw attached retainer. Wire ways or channels shall be sized such that the wire fill does not exceed 50%. Tie-wraps shall be T&B TY-RAP, or approved equal.

G. HINGE LOOPS: Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by clear nylon spiral wrap. The hinge loop shall be of sufficient length to permit opening and closing the door without stressing any of the terminations or connections. Spiral wrap shall be Graybar T25N, or approved equal.

H. RETAINERS: Wire ways, retainers, and other devices shall be screw mounted with round-head 316 stainless steel screws or mechanically mounted by push-in or snap-in attachments. Glue or sticky back attachment of any type or style shall not be used. Retainers shall be Panduit High Bond Adhesive back mounts SGABM series, or approved equal.

I. ROUTING: Wires shall be routed in slotted plastic wire-ways with snap covers.

1. Wires carrying 120 VAC shall be separated as much as possible from other low voltage wires and signal cables, and shall be routed only in ducts for 120 VAC. If the power wiring has to cross the signal wiring, the crossing shall be as close to a right angle as possible.

2. Ducts for 24 VDC wiring shall be used for all other wires and cables. Routing of 120 VAC in combined ducts is not allowed without prior written approval of the Owner.

3. Wires and cable shall be routed along the shortest route between termination points, excepting routes which would result in routing 120 VAC and other wires and cables in the same duct. Wires and cables shall have sufficient length to allow slack and to avoid any strain or tension in the wire or cable.

4. Wires and cables shall be placed in the ducts in a straight, neat and organized fashion and shall not be kinked, tangled or twisted together. Additional wire ducting shall be provided for use by the electrical subcontractor for routing field wires to their landing points in the each electrical and instrumentation panel.

5. Wiring not routed in duct work shall be neatly bundled, treed, and laced with plastic ties. Wiring across door hinges shall be carefully made up and supported to avoid straining and chafing of the conductors or from putting any strain on their terminals.

J. TERMINATIONS: Single wire and cable conductors shall be terminated according to the requirements of the terminal device. All terminations must be made at terminals or terminal blocks. Use of spring or buttsplice connectors are not allowed.

1. Provide 2" minimum separation between wireway and terminal blocks. Installation of wireways too close to terminal blocks will be required to be completely reworked to the satisfaction of the Owner.

2. For captive screw pressure plate type terminals, the insulation shall be removed from the last 0.25 inches of the conductor. The conductors shall be inserted under the pressure plate to full length of the bare portion of the conductor and the pressure plate tightened without excess force. No more than two conductors shall be installed in a single terminal. All strands of the conductor shall be captured under the pressure plate.

3. Terminal blocks and same equipment type termination wiring shall have all wiring terminated with appropriate sized ferrules with insulation collars. Ferrule crimping (full ratcheting) tool with proper sized jigs shall be used per manufacturer's recommendations.

4. For screw terminals, appropriately sized locking forked spade lugs shall be used. Lugs shall be crimp on type that form gas tight connections. All crimping shall be done using a calibrated crimping tool made specifically for the lug type and size being crimped.

5. On shielded cables, the drain wire shall be covered with insulating tubing along its full bare length between the cable jacket and the terminal lug or terminal pressure plate.

6. For screwless terminals, wire shall be stripped back and inserted per the manufacturer's instructions. When stripping insulation from conductors, do not score or otherwise damage conductor.

7. Heat shrink shall be placed on ends of shielded cable to cover foil.

8. Additional condulets with terminal blocks shall be supplied for wire termination to devices with leads instead of terminals. (i.e., solenoid valves, level probe, etc.).

9. Terminate all status, control, and analog I/O wiring on terminal blocks, including spares. Provide additional relay, DIN rails, terminal blocks and side panels as required.

K. A ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall

be sized as shown on plans or in accordance with NEC Table 250.122, whichever is larger.

L. Minimum wire bending space at terminals and minimum width of wiring gutters shall comply with NEC Tables 373.6(A) & (B).

M. Wire sizes shall not be installed smaller than those shown in NEC Article 310 for each circuit amperage rating.

N. Future device and component mounting space shall be provided on the door, backpan, and subpanel where detailed on the Drawings. Where no detail is shown, provide a minimum of 15 percent usable future space.

O. Doors shall swing freely a minimum of 90º and close with proper alignment.

P. Provide larger motor termination boxes as required to accommodate conduit and wires.

3.04 DELIVERY

A. Contractor shall inspect each electrical and instrumentation item delivered to the jobsite.

B. Contractor shall unpack each item for inspection within two (2) days of arrival.

C. Complete written inventory shall be produced by Contractor and submitted to Owner within (2) days after arrival on jobsite for record keeping prior to any payment for the item.

D. All panels and enclosures be delivered with as-built drawings in clear plastic packets within each panel and enclosure.

3.05 DAMAGED PRODUCTS

A. Damaged products will not be accepted. All damaged products shall be replaced with new products at no additional cost to the Owner.

3.06 FASTENERS & LUGS

A. Fasteners for securing equipment shall be 316 stainless steel. The fastener size shall match equipment mounting holes. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads required.

B. All wire & cable lugs shall be copper; aluminum or aluminum alloy lugs shall not be used. The Electrical Contractor shall supply all lugs to match the quantity & size of wire listed in the Conduit & Wire Routing Schedule.

C. Anchor Methods:

1. Hollow Masonry: Sleeve-type anchors.
2. Solid Masonry: Sleeve-type anchors or epoxy anchor bolts.
3. Metal Surfaces: Machine screws, bolts or welded studs.
4. Concrete Surfaces: Wedge or expansion 316 stainless steel anchors.
5. Structural Steel: Right angle, parallel and edge type rigid metal clamps. Do not weld or drill structural steel.

D. Equipment Mounting:

1. The Electrical Contractor shall be responsible for furnishing and setting all anchor bolts required to install his equipment.
2. Electrical equipment shall be unistrut "stand off" mounted a minimum of ½ - inch from the wall in a manner so that the rear of the equipment is freely exposed to air circulation. Unistrut material shall be 316 stainless steel in NEMA 4X areas and galvanized in non-NEMA 4X areas unless called out specifically in details.
3. All equipment enclosures shall be of the NEMA classification noted on the electrical plan Drawings for the area in which the device will be mounted.
4. Reinforced concrete pad with 316 stainless steel anchor bolts shall be provided for each electrical freestanding equipment.

E. Dissimilar metals such as aluminum, stainless steel, steel, galvanized steel between enclosures, devices, etc. and mounting surfaces shall be isolated from each other using insulated tape or nonmetal spacers. Tape and spacers used shall be specifically manufactured for this application.

3.07 INSTALLATION, GENERAL

A. System

1. Install all products per manufacturer's recommendations and the Drawings.
2. Contract Drawings are intended to show the basic functional requirements of the electrical system and instrumentation system and do not relieve the Contractor from the responsibility to provide a complete and functioning system.
3. Keep a copy of the manufacturer's installation instructions on the jobsite available for review at all times prior to and during the installation of the associated equipment.

B. Provide all necessary hardware, conduit, terminal blocks, wiring, fittings, and devices to connect the electrical equipment provided under other Sections. The following shall be done by the Contractor at no additional cost to the Owner:

1. Provide additional devices, wiring, terminal block, conduits, relays, signal converters, isolators, boosters, and other miscellaneous devices as required to complete interfaces of the electrical and instrumentation system.
2. Changing normally open contacts to normally closed contacts or vice versa.
3. Adding additional relays to provide more contacts as necessary.
4. Provide larger circuit breakers, conduit and wire as required for the horsepower of the supplied equipment when the supplied equipment is larger than that specified, at no additional cost to the Owner. Provide lug adapters as necessary when connecting to the wires listed in the Conduit and Wire routing schedule.
5. Installing additional terminal blocks to land wires.

C. All programmable devices, shall be programmed, set-up and tested by the Contractor prior to start of witness testing. This includes UPS, and instrumentation. Programming and set-up parameters shall be adjusted or changed as directed by the Owner or Engineer during start-up and throughout the warranty period, at no additional cost to the Owner. Coordinate with the Owner and setup all alarm, process, time delays and operation setpoints.

D. Coordinate with the Owner and setup all alarm, process, and operation setpoints.

E. Panels and Enclosures

1. Install panels and enclosures at the location shown on the Plans or approved by the Engineer.
2. Install level and plumb.
3. Clearance about electrical equipment shall meet the minimum requirements of NEC 110.66.
4. Box supports shall be located and oriented as directed in field by Owner.
5. Seal all enclosure openings, including bottom edge of all pad mounted enclosures to prevent entrance of insects, rodents, dirt, debris, etc.
6. All conduits entering outdoor panels and enclosures shall use watertight hubs. These hubs shall be located on sides or bottom only. Top entry of outdoor panels or enclosures is not allowed unless specifically shown on plans.
7. Additional condulets with terminal blocks shall be supplied for wire termination to devices with leads instead of terminals. (i.e. solenoid valves, level probe, etc.)

8. Terminate all status, control and analog I/O wiring on terminal blocks, including spares. Provide additional relay, DIN rails, terminal blocks and side panels as required.

9. All panels and enclosures be delivered with as-built drawings in clear plastic packets within each panel and enclosure.

10. Provide larger motor termination boxes as required to accommodate conduit and wires.

F. Conduits and Ducts

1. Care shall be exercised to avoid interference with the work of other trades. This work shall be planned and coordinated with the other trades to prevent such interference. Pipes shall have precedence over conduits for space requirements. Exposed conduits shall be neatly arranged with runs perpendicular or level and parallel to walls. Bends shall be concentric.

2. Exposed conduits runs shall not be run directly on the ground. Secure conduits to 316 stainless steel unistrut.

3. Install conduit free from dents and bruises.

4. All conduits shall be labeled with conduit tags on all ends; at junction boxes, pull boxes, enclosures, stub-outs, or other terminations. All spare conduits shall be labeled.

5. A maximum of three equivalent 90 degree elbows are allowed in any continuous runs. Install pull boxes where required to limit bends in conduit runs to not more than 270 degrees or where pulling tension would exceed the maximum allowable for the cable.

6. Route all above grade outdoor conduits or conduits in rated areas parallel or perpendicular to structure lines and/or piping.

7. Conduits installed outdoor or in NEMA 4X rated areas above grade shall be braced in place with 316 stainless steel Unistrut stanchions or PVC coated clamps with backplates.

8. Conduit entrances: Seal each conduit entrance from below grade into the panels, and other electrical enclosures with plugging compound sealant to prevent the entrance of insects and rodents.

9. Special “Soft–Jaw” type pipe clamps shall be used to prevent damage to PVC-coated conduits while field threading, cutting to length, and coupling sections.

10. Conduits shall be painted to match the color of surface attached to as directed by Owner.

11. Prior to encasement, concealment, backfilling of conduits, temporary conduit labels shall be provided at each end of conduit. Temporary conduit labels shall have ½-inch (minimum) lettering at all transition points. After

encasement and concealment, temporary conduit labels shall be placed at each exposed end.

12. Spare or Future Conduits:

    a. All spares conduits shall be labeled; the conduits shall be mandrelled and have pull ropes (pull tapes) installed.

    b. Pull rope shall be ½" wide, polyester, rated 1250 pounds tensile strength. Provide a waterproof label on each end of the pull rope to indicate the destination of the other end. Pull tape shall be printed with sequential footage. Pull tape shall be Neptco Muletape WP1250P or approved equal.

    c. Provide caps on conduit ends to prevent entrance of dirt or insects.

13. Conduits shall be painted to match the color of surface attached to as directed by Owner.

14. All existing conduits that are reused shall have a mandrel or conduit piston pulled through the entire conduit run to prove the length contains no blockages or obstructions. Mandrelling shall be witness by the Owner.

15. Install new conduit tags for reused conduits at all transition boxes and endpoints. Conduit & Wire Routing Schedule shall be updated as these modifications take place.

G. Conduit and Wire Routing Schedule

1. Conduit material, wire size, and quantity listed in schedule take precedence over Division 16 Specifications.

2. All of the entries for each line in the conduit schedule apply to each conduit when multiple quantity of conduits multiple quantity of conduits (quantity of which are indicated by number entered in conduit no. column in schedule) are listed in the schedule.

3. Wire sizes listed are in AWG or Kcmil and are copper conductors.

4. Extra wire was intentionally placed in the "Conduit & Wire Routing Schedule" which shall be labeled on both ends with a unique wire label.

5. Contractor to supply and install all conduits and wiring as shown on Utility Engineered Design drawings. Utility primary and secondary conduit and wiring shown in "Conduit and Wire Routing Schedule" is for bid purposes only. A credit or add-on will be provided by Contractor based on the actual work performed by Contractor for the Utility service.

6. All control and signal wiring terminations shall have the correct wire label applied prior to making connection.

7. Conduit entries listed as "GRS-PVC" in the Conduit & Wire Routing Schedule are to be "Galvanized Rigid Conduits with PVC coating" the entire length.

8. Vertical offsets and sloping of conduits are not detailed on plans, the Electrical Contractor shall include in his bid the price for the complete conduit run utilizing the civil & mechanical plans to measure vertical & slope distances.

9. Exposed conduits runs shall not be run directly on the ground or roof. Secure conduits to stainless steel unistrut.

10. Duct-taping conduits together is not acceptable. Conduits, installed into concrete pads, shall be installed with a minimum of 2" distance between conduits to allow installation of bushings.

11. Seals

    a. Seal around all conduits, wires, and cables penetrating between panels, walls, ceilings, and floors in all buildings with a fire stop material. Seal shall be made at both ends of the conduit with a fire stop putty. Seal shall have a minimum two hour rating. Fire stop sealing shall be International Protective Coatings Flamesafe, or approved equal.

    b. Seal around conduits entering outside to inside structures and around bottom of free standing enclosures to maintain watertight integrity of structure.

    c. Place conduit seal inside each underground conduit riser into panels and enclosures to prevent entrance of insects and rodents.

    d. Seal conduits entering any electrical instrument and install conduit drains as necessary to prevent corrosion from water condensation.

    e. Conduit entrances: Seal each conduit entrance from below grade into the MCC and other electrical enclosures with plugging compound sealant to prevent the entrance of insects and rodents. Conduits between the enclosures shall be sealed with plugging compound sealant on each end. Plugging compound sealant shall be PRC-DeSoto (formerly Courtaulds) Aerospace Semco PR-868 or approved equal.

H. Excavation and Back Filling

1. The Electrical Contractor shall provide the excavation for equipment foundations, and trenches for conduits or buried cables.

2. Underground conduits outside of structures shall have a minimum cover of 24 inches except for utility conduits depth shall be as required by the governing utility requirements. Back filling shall be done only after conduits have been inspected.

3. Trenches for all underground utility lines shall be excavated to the required depths.

4. Repave any area that was paved prior to excavation. Backfill and surface all areas as shown on the Drawings or where not shown to the original condition that was present prior to the excavation.

5. Contractor shall uncover any uninspected covered conduit trenches, at no additional cost to Owner, to verify proper installation.

6. Excavation and back fill conduit trenches shall conform to the requirements of the Earthwork Section of these Specifications, unless modified on plans, and to other entities as required. Backfill shall consist of 3/4 inch class 2 aggregate base material, unless otherwise noted.

7. At all times during the installation of the electrical distribution system, the Contractor shall provide barricades, fences, guard rails, etc., to safeguard all personnel, including small children, from excavated trenches.

I. Wiring, Grounding and Shielding

1. It is important to observe good grounding and shielding practices in the generally noisy environment in this application. The shield of shielded cables shall be terminated to ground at one end only (source end), the shield at the other end (receive end) shall be encased in an insulated material to isolate it from ground.

2. Special cables shall be provided when required by manufacturer or necessary to correct noise or distortion interference at no additional cost to Owner.

3. Field wiring shall not begin until interconnection drawings have been submitted by the Contractor and approved by the Engineer.

J. Cutting and Patching: The Contractor shall do all cutting and patching required to install his work. Any cutting which may impair the structure shall require prior approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching. Paint patched surfaces to match the original color.

K. Housekeeping Pads:

1. Concrete housekeeping pads are required for all free standing electrical equipment. Housekeeping pads shall be 3-1/2” inches above surrounding finished floor or grade unless otherwise shown and shall be 4 inches (minimum) larger in width on all sides of equipment. The depth of housekeeping pads shall be 18 inches (minimum).

2. Housekeeping pads shall be installed for future units as shown on the Contract Drawings.

3. Housekeeping pad shall be Class “A” concrete with rebar crossway network. The minimum size rebar allowed is #3. Concrete shall be precisely leveled so that equipment set in place will not require shimming.

L. Cleaning and Touch Up

1. Prior to startup and at completion of the work prior to final acceptance, all parts of the installation, including all equipment, exposed conduit, devices, and fittings shall be cleaned and given touch up by Contractor as follows:

a. Remove all grease and metal cuttings.

b. Any discoloration or other damage to parts of the building, the finish, or the furnishings, shall be repaired.

c. Thoroughly clean any of his exposed work requiring same.

d. Vacuum and clean the inside of all MCC and electrical and instrumentation enclosures.

e. Clean all above and below ground pull boxes, junction boxes, and vaults from all foreign debris prior to final acceptance.

f. Paint all scratched or blemished surfaces with the necessary coats of quick drying paint to match adjacent color, texture, and thickness. This shall include all prime painted electrical equipment, including enclosures, panels, poles, boxes, devices, etc.

g. Remove all decals and lettering from both sides of support plates.

h. Repair damage to factory finishes with repair products recommended by Manufacturer.

i. Repair damage to PVC or paint finishes with matching touchup coating recommended by Manufacturer.

3.08 ELECTRICAL TESTING

A. General Requirements

1. It is the intent of these tests to assure that all equipment is operational within industry and manufacturer’s tolerances and is installed in accordance with design plans and specifications.

2. All equipment setup and assembled by the Contractor shall be in accordance with the design plans and Drawings and the manufacturer's recommendations and instructions and shall operate to the Engineer's satisfaction.

a. Follow all manufacturer's instructions for handling, receiving, installation, and pre-check requirements prior to energization.

b. After energization, follow manufacturer’s instructions for programming, set-up and calibration of equipment.

c. The Contractor shall be responsible for, and shall correct by repair or replacement, at his own expense, equipment which, in the opinion of the Engineer, has been caused by faulty mechanical or electrical assembly by the Contractor.

d. Necessary tests to demonstrate that the electrical and mechanical operation of the equipment is satisfactory and meets the requirements of these Specifications shall be made by the Contractor at no additional cost to the Owner.

3. The testing shall not be started until the manufacturer has completed fabrication, wiring, setup, and programming; performed satisfactory checks and adjustments; factory testing sheets approved by Owner; and can demonstrate the system is complete and operational.

4. Factory Test Scheduling:

   a. The testing shall not be started until:

      1) The Manufacturer has completed fabrication, wiring, and setup; performed satisfactory checks and adjustments; and can demonstrate the system is complete and operational.

      2) Submittals associated with the equipment have been approved by the Engineer

      3) PLC Design review meetings have taken place to the satisfaction of the Owner.

      4) Certification of completion of Contractor's in-house tests shall be submitted prior to scheduling of factory testing.

   b. If factory test equipment is significantly different from submittal drawings, this shall be grounds for cancellation and rescheduling of factory tests at no additional costs to Owner or extension of Contract time.

5. The first Pre-Energization tests shall be performed to determine the suitability for energization and shall be completed with all power turned off and complete prior to the start of any of the Post-Energization Tests. The Electrical Contractor shall have qualified personnel on the job site for all Pre-Energization and Post-Energization tests.

6. Testing Sheets and Procedures:

   a. The supplier shall submit for approval, the proposed factory & field testing sheets at least two weeks prior to the start of the tests. Each testing sheet shall have a title giving the type of test and entry spaces for the name of the person who performed the test, name of the person who witnessed the test, and the date.

   b. Separate test procedures in separate binders shall be submitted for approval for the Factory and Field Tests. Testing shall not commence until the test procedures have been reviewed and approved by the Owner. Tests forms shall be similar to those shown on Appendix "A".

7. All tests shall be witnessed by the Engineer and/or Owner personnel. The test forms shall be completed by the testing person for field checkout, testing, and calibration of all equipment and instruments.

   a. All filled in test forms shall be given to the Engineer and/or Owner the day of the test. Fill in two sets of test forms if Contractor wants to keep a copy.

   b. All tests shall be documented in writing by the supplier and signed by the Engineer as satisfactory completed. The supplier shall keep a detailed log of all tests that failed or did not meet specifications, including date of occurrence and correction.

   c. Completed forms with proper signatures and dates shall be included and become a component of the Operations and Maintenance Manual for each of the respective systems.

   d. The Contractor shall notify the Owner and the Engineer of the Supplier's readiness to begin all factory and field tests in writing (a minimum of ten working days prior to start), and shall schedule system checkout on dates agreed to by the Owner and the Engineer in order that the testing be scheduled and witnessed.

   e. The Contractor shall fill in & submit for approval the "Scheduled Test Request Form" located in Appendix "A" for each requested inspection, factory and field test.

B. FAILURE-TO-MEET TEST:

1. Any system material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer. The Contractor shall replace the defective material or equipment and have tests repeated until test proves satisfactory to the Engineer without additional cost to the Owner.

2. If the results of any of tests are unacceptable to the Engineer, the Contractor shall make corrections and perform the tests again until they are acceptable to the Engineer; these additional tests shall be done at no additional cost to the Owner.

3. If testing, installation or configuration work performed is deemed inadequate by Owner or Engineer, then the Contractor shall provide a qualified technician to meet these requirements. No extension of Contract time will be allowed.

4. If Owner Representative determines that the System Set-up is not ready for testing, the Owner Representative reserves the right to cancel the Factory Test as the equipment is found to be not fully and completely ready for factory testing. The Contractor shall be responsible for paying for the Owner and Engineer to return for the factory testing when it has been cancelled.

C. SAFETY

1. Testing shall conform to the respective manufacturer's recommendations. All manufacturer's safety precautions shall be followed.
2. The procedures stated herein are guidelines for the intended tests, the Contractor shall be responsible to modify these tests to fit the particular application and ensure personnel safety. Absolutely no tests shall be performed that endanger personal safety.
3. The Contractor shall have two or more personnel present at all tests.
4. Two non-licensed portable radios are to be made available by the Contractor for the testing organization to conduct tests.
5. California Electrical Safety Orders (ESO) and Occupational Safety and Health Act (OSHA): The Contractor is cautioned that testing and equipment shall comply with ESO and OSHA as to safety, clearances, padlocks and barriers around electrical equipment energized during testing.
6. Vacuum and clean the inside of all MCC and electrical and instrumentation enclosures prior to any factory and field testing.
7. Field inspections and pre-energization tests shall be completed prior to applying power to equipment.

D. ELECTRICAL FACTORY TEST

1. The System supplier shall conduct a thorough and complete factory test by qualified factory-trained personnel witnessed by Owner per the criteria specified herein. Factory test shall be held within 150 miles of project location.
2. The "System set-up" for factory testing shall consist of, but is not limited to:
   a. Electrical Cabinet
   b. Control Panel
   c. Manual Transfer Switch
   d. Any miscellaneous associated electrical equipment or panels
3. Temporary wiring and equipment shall be setup during these tests to simulate the complete assembled system.
4. The length of the factory testing for the "System setup" shall be a minimum of one (1) working day. If, in the opinion of the Owner or Engineer, the factory testing is not completed at the end of the working day, the testing shall be extended, at no additional cost to the Owner or extension in Contract time. The Contractor shall agree that the sum set forth hereafter is a reasonable amount to be charged as liquidated damages; and it is therefore agreed that the Contractor will pay the Owner the sum of one thousand five hundred dollars ($1,500.00) in liquidated damages for each and every calendar day beyond the time prescribed above for the completion of factory

testing for the System set-up. Liquidated damages will be assessed to the Contractor each and every day past the time allotted for factory testing.

5. All factory tests shall be conducted at the Supplier's facility. All factory tests shall be completed prior to shipment of any of the "System set-up" to the jobsite. The "System set-up" shall be fully assembled, programmed, and connected as it will be installed in the final configuration. If the "System set-up" is found to be not fully and completely ready for factory testing, the Contractor shall be responsible for paying for the Owner and Engineer to return for the factory testing. Factory testing is to ensure that there are no defects. The hardware and software shall be tested for compliance with the plans and Specifications included herein and for the ability to perform the control functions.

6. All components of the system setup shall be completely assembled and thoroughly pre-tested by the supplier or manufacturer before start of factory test.

7. Provide a complete clean copy of System Supplier drawings for Owner and Engineer's use during Factory Test prior to starting the tests. These drawings shall reflect the equipment being tested.

    a. If Owner Representative determines that these drawings do not adequately reflect the actual equipment being tested or differs substantially from the approved equipment submittal, the Owner Representative reserves the right to cancel the Factory Test as the equipment is found to be not fully and completely ready for factory testing.

    b. Equipment that differs substantially from the approved equipment submittal shall be resubmitted. Factory test will be rescheduled after revised submittals have been reviewed by the Engineer and marked "No Exceptions Taken" or "Make Corrections Noted".

    c. No extension of Contract time will be allowed. Cancellation and rescheduling of factory tests shall occur at no additional costs to Owner

    d. The Contractor shall be responsible for paying for the Owner and Engineer to return for the factory testing when it has been cancelled.

8. The associated factory tests for each of the factory testing sheets that are to be performed by the supplier and witnessed by the Owner/Engineer shall include the following for the "System set-up" as a minimum:

    a. Inspections of the panels as follows:

        1) Visual and Mechanical:

            a) Inspect for physical damage, proper support, and wiring.

            b) Check all starters, breakers, and other components for proper sizes.

2) The Contractor shall fill in test form TF4, located in Appendix "A".

b. Testing of the Equipment as follows:

1) Each line of control logic on the elementary or loop diagrams shall be checked. After a line of control logic is tested, the person performing test shall initial or highlight the corresponding line on the elementary diagram. When the complete elementary diagram has been checked, it shall be signed and dated by testing person and person witnessing test.

2) I/O points to terminal blocks shall be simulated for the complete checkout of PLC interfaces.

3) The tests, as a minimum, shall simulate all operating conditions including steady state, transients, upsets, startup, shutdown, power failure, and equipment failure conditions (for control logic).

4) The Contractor shall complete each test and fill in the I/O test form TF13 located in Appendix "A".

c. Testing of Control as follows:

1) To facilitate testing and system simulation of the "System Set-up", the Supplier shall connect a separate toggle two position on-off switch to each status and alarm digital input. Three digital multi-meters (minimum +/- 0.2% accuracy) with clip-on leads shall be supplied and utilized during testing for measurement of digital and analog outputs. The supplier shall use simulated input signals to replicate varying field device signals during the factory tests in order to verify the proper functioning of hardware and software.

d. The structured factory tests to be performed by the System Supplier and witnessed by the Owner shall include the following as a minimum:

1) Control Checkout Tests: Simulate the digital or analog signals (or combination thereof) at the panel field terminals using the test hardware to verify that each control is functional and properly configured. Verify that all parameters (i.e., relay logic operations, relay timing, controller setpoints, etc.) of the control system are defined and operate according to the design documents.

2) Alarm Checkout Tests: Simulate the digital or analog signals (or combination thereof) at the panels using the test hardware to verify that each I/O point is functional and properly configured. Verify that all parameters (i.e., description, engineering units, span, enable/disable, setpoints, runtimes, totalization, logic type, etc.) of the

alarms are defined and operate according to the Specifications.

e. Unstructured factory tests are required as part of the factory testing phase. These additional tests shall include any and all unstructured tests as directed by the Owner or Engineer. The various unstructured tests shall include, but are not limited to, the following:

1) Verify the correct inventory of hardware, etc. All spare parts shall be included in the inventory.

2) The factory tests, as a minimum, shall simulate all normal and abnormal operating conditions including steady state, change of state, variable changes, fluctuations, transients, upsets, start-up, shutdown, power failure, and equipment failure conditions.

9. The factory test will be considered complete only when the integrated system has successfully passed all tests to the satisfaction of the Owner or Engineer and the Factory Test checkout form TF11 has been signed & dated by Owner. No electrical equipment shall be shipped to jobsite without authorization from the Owner or Engineer that the factory test has been completed. Equipment that were shipped to the jobsite without authorization shall be shipped back to the System Supplier for witness testing at no additional cost to Owner.

10. Acceptance and witnessing of the factory tests does not relieve or exclude the Contractor from conforming to the requirements of the Contract Documents.

11. The testing personnel shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.

12. During the testing period, under the supervision of the supplier, the Engineer and other Owner personnel shall have unlimited and unrestricted access to the usage and testing of all hardware and software in the system.

13. Spare parts, including spare I/O for the system shall also be tested during this test period. The supplier shall prove by temporarily connecting the spare hardware to the system that any or all of the spare parts function in a manner equivalent to the original equipment under test.

14. The Contractor shall pay all expenses incurred by his personnel which includes labor, material, transportation, lodging, daily subsistence, and other associated incidental costs during the factory testing.

15. Faulty and/or incorrect hardware operation of major portions of the system may, at the discretion of the Owner Engineer, be cause for suspension or restarting of the entire factory test, at no additional cost to the Owner or extension in contract time.

16. The factory test will be considered complete only when the system setup has successfully passed all tests both structured and unstructured to the

satisfaction of the Owner Engineer. No equipment shall be installed without authorization from the Owner Engineer that the factory test has been completed.

17. All modifications to drawings and documentation as a result of the factory tests shall be corrected and completed before shipment of drawings with equipment and the submittal and delivery of "operation and maintenance" manuals.

18. Copies of the completed, signed, and witnessed factory testing forms shall be placed in the Operation and Maintenance Manual.

E. Electrical Field Tests

1. The Contractor shall engage and pay for the services of an approved qualified testing company for the purpose of performing inspections and tests as herein specified. The testing company shall provide all material, equipment, labor and technical supervision to perform such tests and inspections. The Electrical Contractor shall be present on site for all field tests.

2. Prior to start of any field testing, the Field Test Procedures, Interconnection Drawings and Preliminary Operation and Maintenance Manuals shall have been submitted by the Contractor and approved by the Engineer. Also, prior to start of field testing of equipment, correct machine printed wire labels shall be in place on all wires associated with that equipment.

3. The Electrical Contractor shall complete and submit "Schedule Test Request Form" as illustrated in Appendix "A" for each electrical field test.

4. The Electrical Contractor shall be at the jobsite to assist with all Electrical Field Tests.

5. Pre-Energization Tests: These tests shall be completed prior to applying power to any equipment.

   a. Inspections:

      1) Visual and mechanical inspections:

         a) Inspect for physical damage, proper anchorage and grounding.

         b) Compare equipment nameplate data with design plans and starter schedule.

         c) Compare overload setting with motor full load current for proper size.

      2) Performed NETA acceptance testing for each piece of equipment.

      3) The Testing Company shall compile, by visual inspection a record of all motor nameplate data, the following minimum

data shall be neatly tabulated in spreadsheet form and submitted to Owner:

a) Manufacturer
b) Part and model number
c) Equipment driven
d) Motor horsepower
e) Nameplate amperes, volts and phase
f) Service factor
g) Temperature ratings
h) Overload catalog number
i) Overload current range and setting
j) Circuit breaker rating
k) Circuit breaker trip setting, for magnetic only circuit breakers.

4) The Contractor shall fill in, for each piece of equipment, Test Form TF4 located in Appendix "A".

b. Torque Connections:

1) All electrical, mechanical and structural threaded connections inside equipment shall be tightened in the field after all wiring connections have been completed. Every worker tightening screwed or bolted connections shall be required to have and utilize a torque screwdriver/wrench at all times. Torque connections to the value recommended by the equipment manufacturer. If they are not available, use NEC Annex I for torque values as guidelines.

c. Wire Insulation & Continuity Tests:

1) All devices that are not rated to withstand the 500V megger potential shall be disconnected prior to the megger tests.

2) Megger insulation resistances of all 600 volt insulated conductors using a 500 volt megger for 10 seconds. Make tests with circuits installed in conduit and isolated from source and load. Each field conductor shall be meggered conductor to conductor and conductor to ground. These tests shall be made on cable after installation with all splices made up and terminators installed but not connected to the equipment.

3) Each megger reading shall not be less than 10 Meg-ohms resistive. Corrective action shall be taken if values are recorded less than 10 Meg-ohms. Values of different phases of conductors in the same conduit run showing substantially different Meg-ohm values, even if showing above 10 Meg-ohms shall be replaced.

4) Each instrumentation conductor twisted shielded pair shall have the conductor and shield continuity measured with an ohmmeter. Conductors with high ohm values, that do not match similar lengths of conductors the same size, shall be replaced at no additional cost to the Owner.

5) The Contractor shall fill in test forms Power and Control Conductor Test Form TF1 and Instrumentation Conductor Test Form TF2 located in Appendix "A".

d. Grounding System Tests:

1) Visual and Mechanical Inspection:

a) Verify ground system is in compliance with Drawings and Specifications.

2) Electrical Tests:

a) Before backfilling trenches, and placement of sidewalks, landscape and paving, measure the resistance of each electrode to ground using a ground resistance tester. Perform the test not less than two days after the most recent rainfall and in the afternoon after any ground condensation (dew) has evaporated.

b) After all individual ground electrode readings have been made, interconnect as required and measure the system's ground resistance.

c) The grounding test shall be in conformance with IEEE Standard 81.

d) The current reference rod shall be driven at least 100 feet from the system under test.

e) Measurements shall be made at 10 feet intervals beginning 25 feet from the test electrode and ending 75 feet from it in a direct line between the system being tested and the test electrode.

f) Point-to-Point: Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3) Test Values:

a) The resistance between the main grounding electrode and equipment ground shall be no greater than five ohms per IEEE Standard 142.

b) Investigate point-to-point resistance values that exceed 0.5 ohms.

c) The Contractor shall fill in Grounding System Test Form TF3 located in Section 26 00 00 Appendix "A".

d) Plots of ground resistance shall be made and submitted to the Engineer for approval.

e. Panelboard Tests

1) Visual and Mechanical Inspection:

a) Inspect for physical damage, proper anchorage and grounding.

b) Compare equipment nameplate data with design plans and panelboard schedules.

c) Compare breaker legend for accuracy.

d) Check torque of bolted connections.

2) The Contractor shall fill in Panelboard Test Form TF5 located in Appendix “A”.

6. Post Energization Tests

a. Panels and Enclosure Tests:

1) During these tests, test all local and remote control operations and interlocks.

2) Electrical Tests:

a) Perform operational tests by initiating control devices to affect proper operation.

b. Instrumentation Tests

1) The Contractor shall provide a minimum of two (2) hours of field acceptance testing for each instrument. If any instrument has not been fully tested during its allotted time, the Contractor shall provide additional hours for finishing testing of the instrument, to be paid by the Contractor.

2) The overall accuracy of each instrument loop shall be checked to ensure that it is within acceptable tolerance.

a) As a minimum, all the tests indicated/specified on the test form TF14 in Appendix "A" shall be performed by the Contractor for each of the instruments provided.

3) Test equipment used for testing shall be of suitable quality so as not to mask performance deficiencies. All test equipment shall be traceable to National Bureau of Standards and have been calibrated within six months of test date.

4) Testing shall be accomplished using simulated inputs only with prior written approval of the Owner.

5) Calibration stickers shall be supplied for all equipment and instruments. Calibration stickers shall list the following information:

a) Tag number.

b) Calibrated by who (name), firm, city and telephone number.

c) Date calibrated.

d) Calibration range.

e) Comments.

c. Control System Tests: The following tests shall be performed for all MCCs and for the control panels listed in Section 26 00 00 Appendix "B", including all non-Division 16 Control Panels.

1) Component Tests:

a) Measure insulation resistance of starter phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable values shall conform to NETA Section 3 "Test Values." Measure insulation resistance of each control circuit with respect to ground.

b) Motor overload units shall be tested by injecting primary current through overload unit and monitoring trip time.

c) Test the motor circuit protectors and thermal breakers as specified herein.

2) Control Tests:

a) Remove motor overload heaters from each motor starter or disconnect pump/motor coupling. In case the motor overload heaters are fed by current transformers, the motor conductors shall be removed and insulated away from the load lugs of the motor starter.

b) Verify the pump control circuits are wired and operate as shown on the elementary diagrams. Check the indicator lights, alarm lights, local & remote selector switches, alarm contacts, power fail relays, overloads, etc., for proper operation.

c) Reinstall all heaters and all wiring removed for this test.

d. PLC Control System Tests:

1) All the I/O points for the PLC shall be tested by the system supplier in the field for proper operation of alarms, status, analog, control, display functions. Where practical, the final

element shall be used, i.e. trip the intrusion switch or change levels. Testing shall be accomplished using simulated inputs only when necessary.

2) During this task the System supplier shall have:

a) Qualified field technician with experience in the startup of similar systems with PLC controls, and other field devices.

b) Test instruments as required.

c) A pair of radios for communication.

3) Contractor to fill in "I/O Point Checkout Sheet" TF13 located in Appendix "A".

e. Trial Operations: The entire electrical installation shall be either tested or trial operated to verify Contract compliance. That is, controls, heaters, fans, light switches, convenience receptacles, lights, etc. shall be trial operated. Contractor shall conduct trial operations in the presence of the Engineer and Operations and Maintenance personnel.

F. Operational Testing:

1. After all the previous tests in this subsection 3.07 and 3.08 are complete, the Contractor shall conduct operational testing.

2. The Contractor shall demonstrate the operation of each part of the control and instrumentation system to the satisfaction of the Owner and/or Engineer. Tests shall be repeated by the Contractor at no additional cost to the Owner and at the discretion of the Owner and/or Engineer to resolve whether the system has demonstrated that it will operate under all modes of operations and varying conditions.

3. For the operational testing the new equipment shall be activated to automatically run for 5 days, 24 hours per day, Monday through Friday. During this five day period, the Owner will run the different combinations of the monitoring options. If equipment failure occurs during the 5 days of operational testing, the Contractor shall repair or replace the defective equipment and shall begin another 5 day operational test, Monday through Friday. This shall be continued until the new equipment functions acceptably for 5 consecutive days.

4. The Electrical Contractor, testing firm and System Supplier shall re-visit the jobsite as often as necessary until all field tests, start-up and operation tests are completed and approved.

3.09 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals covering instruction and maintenance on each type of equipment shall be furnished prior to completion of the project.

B. These instructions shall provide the following as a minimum:

1. Each set bound in a three ring binder and organized as specified herein. Binder shall be sized such that when all material is inserted the binder is not over 3/4 full
2. "As Constructed" set of submittal shop documents, data sheets, and drawings (with all field changes included) for all items in the electrical system.
3. A complete list of items supplied, including serial numbers, ranges, options, and other pertinent data necessary for ordering replacement parts.
4. Full technical specifications on each item.
5. Instrument data sheets for all instruments supplied on the project, clearly identifying the instrument tagname, range, part number, serial number, size, etc.
6. Detailed service, maintenance and operation instructions for each item supplied. Schematic diagrams of all electronic devices shall be included. A complete parts lists with stock numbers shall be provided on the components that make up the assembly.
7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
8. Safety precautions and procedures.
9. Record of the following:
    a. Each motor nameplate data including manufacturer, full part number, size, voltage, amps, service factor, bearings, etc.
    b. Each breaker and overload heater element including manufacturer, full part number, size, setting etc.
    c. Spread sheet listing all setpoints and programmable parameters entered for this project for UPS, etc.
10. No photo copies are allowed of standard published manuals available from manufacturers such as for the PLC. All of the manuals shall be originals, not copies.
11. Include all completed and signed test data and forms from factory and field testing.
12. Warranty certificate with start dates, duration and contact information.
13. Troubleshooting instructions.
14. Record of all settings or parameters for all programmable devices.

C. At the end of the project these manuals shall be updated to show "as-built or as-installed" conditions.

D. Provide to the Owner four (4) sets of USB drives on lanyards and two sets of DVDs (DVDs shall contain all documents in both PDF format and unlocked AutoCAD - DWG format):

1. As-built Contract electrical and instrumentation drawings prepared for this project.

2. As-built set of all required Drawings for the project.

3. Electronic PDF version of O&M manual. Version format shall follow the hard copy submittal of the O&M, including index, equipment record sheet, warranty information, theory of operation, maintenance instruction, etc. PDF shall "bookmarked" at each index, subtab, transmittal letter, equipment record sheet, warranty information, theory of operation, maintenance instruction, etc. Failure to bookmark PDF may be grounds for immediate rejection without review. Bookmarks shall be descriptive of actual document, tab, etc. Bookmarks shall not be out of order; the English description shall match that listed in the Submittal's Table of Contents.

4. These files shall be the property of the Owner, for its use on this and future projects.

5. Label drives with site name using white plastic with black machine printed lettering as produced by a KROY or similar machine. The size of the nameplate tape shall be with 3/8-inch lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on the USB drive using the adhesion of the tape.

3.10 TRAINING

A. All training sessions shall be held on dates and times agreeable to Owner. A total of 5 or fewer Owner personnel shall be trained.

B. After "Operation Testing" has started the Contractor shall provide a period of not less than 8 hours training for instruction of operation and maintenance personnel in the use of all the new electrical and instrumentation systems. The Contractor shall make necessary arrangements with manufacturer's representative. Provide product literature and application guides for user's reference during instruction.

C. Training to include instruction on the use, operation, calibration, programming, and maintenance of the field devices provided.

D. Acceptable Operation and Maintenance Manuals shall be on site and available when training sessions are implemented.

3.11 SPARE PARTS

A. The Contractor shall supply all spare parts prior to start of field tests. All parts shall be sealed in plastic bags and delivered to each site in a heavy duty plastic storage

bag. Bag shall be clearly labeled on the outside with part name and number and the corresponding equipment tagname.

B. The Contractor shall make available any replacement parts that are not manufacturer's normal stock items for immediate service and repair of all the instrumentation equipment throughout the warranty period.

C. The following spare parts shall be provided to the Owner as part of this Contract for each site:

1. Five (5) fuses for each type of fuse.
2. Five (5) lamps for each type of light.
3. Two (2) relays for each type of control, power fail and time delay relay.

D. See other division 16 sections for additional spare parts to be provided.

3.12 WARRANTY

A. The Contractor shall warrant all electrical and instrumentation equipment for a period of one (1) year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer or supplier.

B. The Contractor shall provide all labor and material to troubleshoot, replace, or repair any hardware or software that fails or operates improperly during the warranty period, at no additional cost to the Owner.

C. The System Supplier shall have a staff of experienced personnel available to provide service on 2 working days' notice during the warranty period. Such personnel shall be capable of fully testing and diagnosing the hardware and software and implementing corrective measures.

D. If the System Supplier "fails to respond" in 2 working days, the Owner at its option will proceed to have the warranty work completed by other resources; the total cost (direct and indirect) for these other resources shall be reimbursed in full by the Contractor.

1. "Fail to respond" shall be defined as: The Contractor has not shown a good faith effort and has not expended adequate resources to correct the problem.
2. The use of other resources, as stated above, shall not change or relieve the Contractor from fulfilling the remainder of the warranty requirements.

E. The Contractor shall warrant all electrical and instrumentation equipment for a period of one (1) year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer or supplier.

F. Prior to "final acceptance", the Contractor shall furnish to the Engineer a listing of warranty information for all manufacturers of materials, instruments, and equipment used on the project. The listing shall include the following:

1. Manufacturer's name, service contact person, phone number, and address.

2. Material and equipment description, equipment number, part number, serial number, and model number.

3. Manufacturer's warranty expiration date.

G. The Contractor shall provide all labor and material to troubleshoot, program, replace, or repair any hardware or software that fails or operates unpredictably during the warranty period, at no additional cost to the Owner.

H. Each time the Supplier's repair person responds to a system malfunction during the warranty period, he or she must contact the designated Owner maintenance supervisor for scheduling of the work, access to the jobsite, and permission to make repairs. Operation of facilities necessary to test equipment shall only be performed by or under the direction Owner staff. Owner reserves the right at its sole discretion to deny operations requested by the Supplier. A written description of all warranty work performed shall be documented on a field service report to be given to Owner prior to the repair person leaving job site. This field service report shall detail and clearly state problem, corrective actions taken, additional work that needs to be done, data, repair person name and company.

3.13 FINAL ACCEPTANCE

A. Final acceptance will be given by the Owner after the equipment has passed the "operational testing" trial period, each deficiency has been corrected, final documentation has been provided, and all the requirements of design documents have been fulfilled.

B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Supplier shall:

1. Remove all temporary services, equipment, material and wiring from the site.

2. Verify Service equipment has been legibly marked in field with the maximum available fault current per NEC 110.24 (A). Field marking shall include date the fault current calculation was performed and be weather & UV rated. Service equipment shall not be hand labeled.

3. Two sets of all keys for locks supplied on this project. Submit each key with matching duplicate. Wire all keys for each lock securely together. Tag and plainly mark with lock number or equipment identification, and indicate physical location, such as panel or switch number.

4. Verify that as-installed drawings, in reinforced clear plastic pockets, have been placed in all new or modified panels.

5. Provide the following to the Owner:

    a. Listing of warranty information.

    b. Each "Operation and Maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.

    c. O&M documentation, as specified herein.

APPENDIX "A"

ELECTRICAL & INSTRUMENTATION FORMS

Index of Forms:

BILL OF MATERIAL

PROJECT: ______________________ **DATE** ___/___/___
LOCATION: ______________________ **PAGE** ________

SPECIFICATION SECTION	QTY	DESCRIPTION	MFG.	PART NUMBER	TAG No.

SCHEDULED TEST REQUEST FORM

COMPANY PERFORMING TEST: _____
TESTING PERSONNEL : _____ _____
PHONE NUMBER OF COMPANY: _____
TEST PROCEDURE SUBMITTAL: _____ APPROVED : ___/___/___
SCHEDULED TEST DATE : _____ DATE : ___/___/___

TIME	DESCRIPTION OF TEST
8:00	
9:00	
10:00	
11:00	
12:00	
13:00	
14:00	
15:00	
16:00	

NOTES:

TESTED BY : _____ DATE : ____/____/____
WITNESSED BY: _____

POWER AND CONTROL CONDUCTOR TEST FORM

TEST FORM (TF1)

EQUIPMENT

NAME : _____ LOCATION : _____

CALIBRATION EQUIPMENT DATE: _____

DESCRIPTION _____

CONDUCTOR NUMBER	INSULATION TESTS					
	PHASE TO GROUND			PHASE TO PHASE		
	A	B	C	AB	BC	CA

NOTES:
Record insulation test values in meg-ohms.

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

INSTRUMENTATION CONDUCTOR TEST FORM

TEST FORM (TF2)

EQUIPMENT

NAME : _____ LOCATION : _____

CALIBRATION EQUIPMENT DATE: _____

DESCRIPTION : _____

CONDUCTOR PAIR NUMBER	CONTINUITY TESTS		INSULATION TESTS		
	CONDUCTOR TO CONDUCTOR	CONDUCTOR TO SHIELD	CONDUCTOR TO CONDUCTOR	CONDUCTORS TO GROUND*	SHIELD TO GROUND

NOTES:

Record continuity test values in ohms.

record insulation test values in meg-ohms.

* With both conductors tied together

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

GROUNDING SYSTEM TEST FORM

TEST FORM (TF3)

CALIBRATION EQUIPMENT DESCRIPTION : DATE: _____

FALL IN POTENTIAL TEST

MAIN GROUND LOCATION	APPLIED VOLTAGE V	MEASURED POINT 1 VOLTAGE	MEASURED POINT 2 VOLTAGE	MEASURED POINT 3 VOLTAGE	CALCULATED RESISTANCE OHMS

TWO POINTS TESTS

EQUIPMENT NAME	EQUIPMENT #	CIRCUIT #	APPLIED CURRENT	MEASURED VOLTAGE	CALCULATED RESISTANCE OHMS

NOTES:

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

VISUAL AND MECHANICAL INSPECTION FORM

TEST FORM (TF4)

EQUIPMENT

NAME : _____ LOCATION : _____

NAMEPLATE DATA

MFGR. :	_____	SERIES # :	_____
MODEL # :	_____	U.L. # :	_____
VOLTAGE :	_____	PHASE :	_____
AMPERAGE :	_____	SERVICE :	_____
BUS TYPE :	_____	BUS BRACING:	_____
VERT. BUS :	_____	HORZ. BUS :	_____
GND. BUS :	_____	NEU. BUS :	_____
ENCLOSURE :	_____		_____
	_____		_____

INSPECTION CHECK LIST

ENTER: A-ACCEPTABLE R-NEEDS REPAIR OR REPLACEMENT NA-NOT APPLICABLE

TIGHTEN ALL BOLTS AND SCREWS	_____
TIGHTEN ALL WIRING AND BUS CONNECTIONS	_____
VERIFY ALL BREAKERS AND FUSES HAVE PROPER RATING	_____
CHECK BUS BRACING AND CLEARANCE	_____
CHECK MAIN GROUNDING CONNECTION AND SIZE	_____
INSPECT GROUND BUS BONDING	_____
CHECK EQUIPMENT GROUNDS	_____
CHECK CONDUIT GROUNDS AND BUSHINGS	_____
INSPECT NEUTRAL BUS AND CONNECTIONS	_____
CHECK HEATERS AND THERMOSTATS	_____
CHECK VENTILATION AND FILTERS	_____
CHECK FOR BROKEN OR DAMAGED DEVICES	_____
CHECK DOOR AND PANEL ALIGNMENT	_____
INSPECT ANCHORAGE	_____
CHECK FOR PROPER CLEARANCES AND WORKING SPACE	_____
REMOVE ALL DIRT AND DUST ACCUMULATION	_____
INSPECT ALL PAINT SURFACES	_____
CHECK FOR PROPER WIRE COLOR CODES	_____
INSPECT ALL WIRING FOR WIRE LABELS	_____
CHECK FOR PROPER WIRE TERMINATIONS	_____
CHECK FOR PROPER WIRE SIZES	_____
INSPECT ALL DEVICES FOR NAMEPLATES	_____
CHECK IF DRAWINGS MATCH EQUIPMENT	_____
CHECK ACCURACY OF OPERATION & MAINTENANCE	_____
	_____

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

PANEL-BOARD TEST FORM

TEST FORM (TF5)

PANEL NAME: _____ LOCATION : _____

NAMEPLATE DATA

MFGR. :	_____	SERIES # :	_____
MODEL # :	_____	U.L. # :	_____
VOLTAGE :	_____	PHASE :	_____
AMPERAGE :	_____	SERVICE :	_____
BUS TYPE :	_____	BUS BRACING:	_____
VERT. BUS :	_____	HORZ. BUS :	_____
GND. BUS :	_____	NEU. BUS :	_____
ENCLOSURE :	_____	MAIN BKR :	_____

CALIBRATION EQUIPMENT DATE: _____
DESCRIPTION :

INSULATION RESISTANCE TESTS - MEGOHMS					
A-GND	B-GND	C-GND			

INSPECTION CHECK LIST

ENTER: A-ACCEPTABLE R-NEEDS REPAIR OR REPLACEMENT NA-NOT APPLICABLE

TIGHTEN ALL BOLTS AND SCREWS	_____
TIGHTEN ALL WIRING AND BUS CONNECTIONS	_____
VERIFY ALL BREAKERS AND FUSES HAVE PROPER RATING	_____
CHECK BUS BRACING AND CLEARANCE	_____
CHECK MAIN GROUNDING CONNECTION AND SIZE	_____
INSPECT GROUND BUS BONDING	_____
CHECK EQUIPMENT GROUNDS	_____
CHECK CONDUIT GROUNDS AND BUSHINGS	_____
INSPECT NEUTRAL BUS AND CONNECTIONS	_____
CHECK FOR BROKEN OR DAMAGED DEVICES	_____
CHECK DOOR AND PANEL ALIGNMENT	_____
INSPECT ANCHORAGE	_____
CHECK FOR PROPER CLEARANCES AND WORKING SPACE	_____
REMOVE ALL DIRT AND DUST ACCUMULATION	_____
INSPECT ALL PAINT SURFACES	_____
CHECK FOR PROPER WIRE COLOR CODES	_____
INSPECT ALL WIRING FOR WIRE LABELS	_____
CHECK FOR PROPER WIRE TERMINATIONS	_____
CHECK FOR PROPER WIRE SIZES	_____
INSPECT ALL DEVICES FOR PROPER LEGEND NAMEPLATES	_____
	_____

CALIBRATION TEST EQUIPMENT PART NO.	DATE CALIBRATED:

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

FACTORY TEST
MCC/CONTROL PANEL CHECKOUT FORM (TF11)

Manufacturer: _____ **Location:** _____

Job No.: _____

Tel: _____ **Fax:** _____

MCC / Control Panel: _____ **TEST RESULT**

	Pass	Fail
OVERALL PANEL INSPECTION		
1. All front panel and back panel components mounted securely.....	☐	☐
2. All wiring terminated and labeled correctly.....	☐	☐
3. All components, wiring, and labeling accurately reflected on the drawings..	☐	☐
POWER-UP INSPECTION		
1. Voltage levels on load side of circuit breakers.....	☐	☐
2. Voltage levels at the DC terminals of the power supply.....	☐	☐
3. Voltage levels at the DC power distribution terminals.....	☐	☐
POWER DISTRIBUTION AND GENERAL COMPONENT TESTING		
1. Power distribution to the appropriate components.....	☐	☐
2. Operation of the ancillary components such as receptacles, work lights, etc.	☐	☐
CONTROL COMPONENTS CHECKS		
1. Operators (push buttons, selector switches, pilot lights).....	☐	☐
2. Inputs from External Sources.....	☐	☐
3. Outputs to External Sources.....	☐	☐
4. Relay Logic.....	☐	☐
5. PLC I/O and Program Verification.....	☐	☐
6. O/I Display Verification.....	☐	☐

Notes:

1. For relay logic checks, each rung of the elementary or loop diagram is to be highlighted in yellow as they are verified for correct control functions.
2. For PLC I/O and program verification, the control strategies shall be highlighted in yellow as each logic function is tested.

Tested by: _____ **Witnessed by:** _____

Date: _____

I/O POINT CHECKOUT TEST FORM

TEST FORM (TF13)

I/O TYPE : _____ LOCATION : _____

TEST EQUIPMENT : _____ CAL. DATE : _____

I/O POINT TAGNAME	I/O POINT ADDRESS	TEST INPUT VALUE %			DISPLAY VALUE %			PLC REGISTER VALUE	TEST RESULT FAIL OR PASS COMMENTS	DATE OF CORRECTIVE ACTION
		0	50	100	0	50	100			

NOTES:

TESTED BY : _____ DATE : ____/____/____

WITNESSED BY: _____

INSTRUMENTATION DATA SHEET AND CALIBRATION RECORD TEST FORM (TF14)

Component Description	Manufacturer	Location
	Name	Site
Component Tag Name	Model	Equip
	Serial #	

	Range	Unit
Indicator Range		
Input Range		
Output Range		

Test Equipent	
Description:	
Calibration Date:	

General Notes

1) Attach Calibration Curves for dp Flowmeters

2) Include mounting elevations for level Instruments

3) All entries within solid box to be typed in prior to start of test

Designed Calibration			Measured Calibration		
Input Signal	Output	Eng. Value	Input	Output	Comments

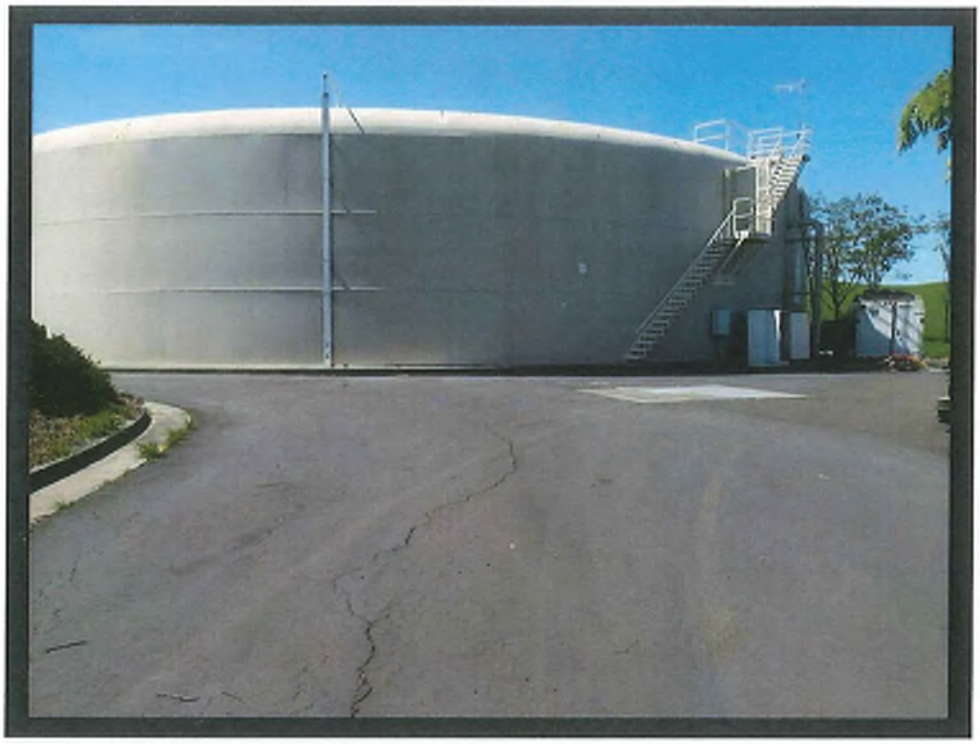
Notes

Tested by (Print Name) Witnessed by (Print Name)

Signature Signature

Date / / Date / /

END OF SECTION



Manor Tank

City Of Petaluma

Report of Findings
From the
Diving Operations
Conducted on

April 9, 2014

By

LiquiVision Technology
DIVING SERVICES

711 Market Street, Klamath Falls, OR 97601, (800) 229-6959 www.divingservices.com

LiquiVision Technology
DIVING SERVICES

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Klamath Falls, OR 97601

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Klamath Falls, OR 97601

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Phone: (541) 883-8473
Fax: (541) 883-1361

www.divingservices.com
liquivision@divingservices.com

Underwater Inspection Of Manor Tank

April 9, 2014

Joe McIntyre
City Of Petaluma
202 N. McDowell Blvd.
Petaluma, CA 94953

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Manor Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is descript and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Manor Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City Of Petaluma	**Tank Name:**	Manor Reservoir
Manager:	Joe McIntyre	Construction:	OG Welded
Job Number:	CA3163813R14T3	Capacity (gal.):	2,000,000
Date of Inspection:	April 9, 2014	Diameter or L x W:	130'
Report Writer:	Cameron Hagerman	Height:	23'
Diver:	Robin Pollock	Floor Square FT:	13272.8
Tender:	Cody Lowe	Date Built:	1991

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

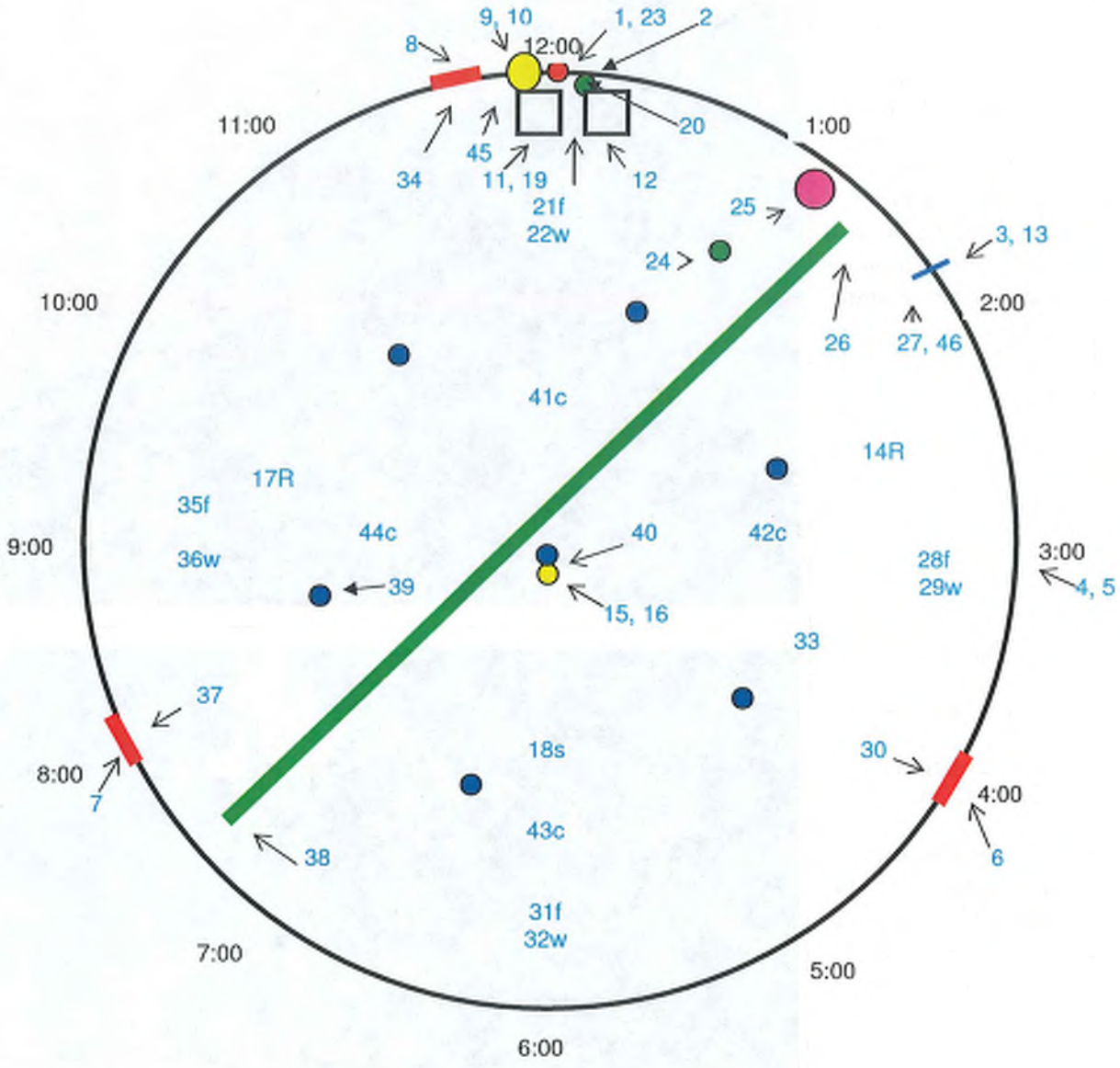
Manor Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Manor Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Sample Port
	Outlet		Liquid Level Indicator		Air Vent
	Cathodic Protection Anode				

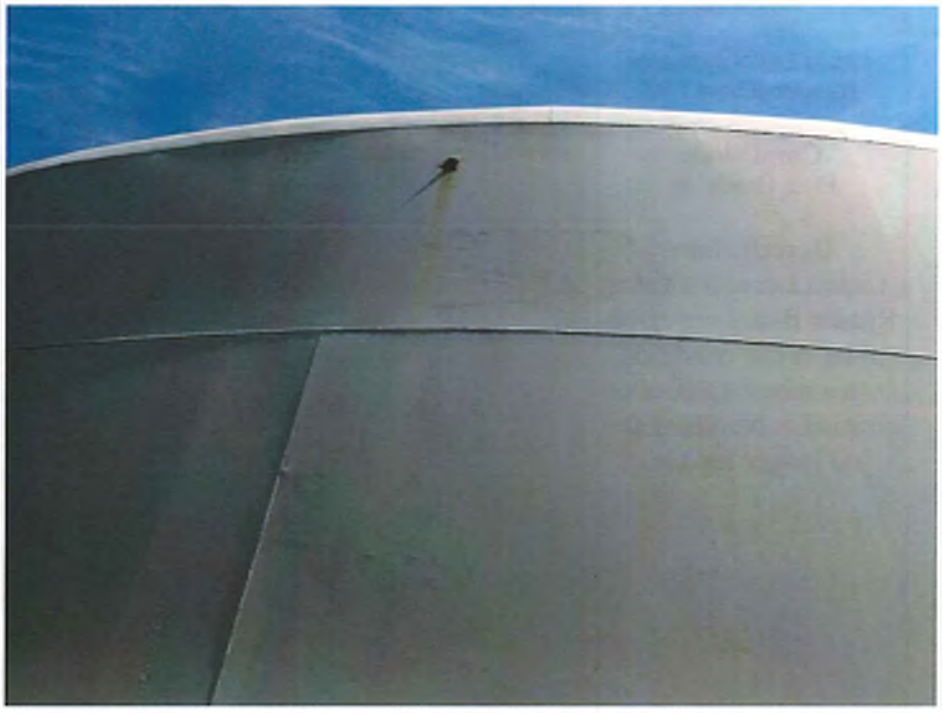
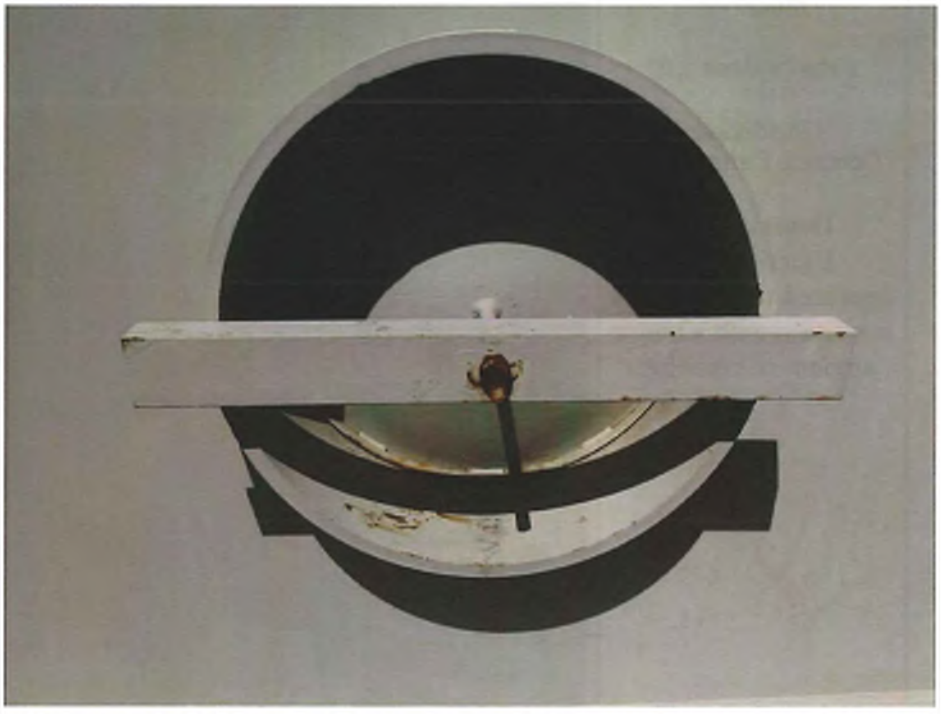
Manor Tank

Image #1 *Sample Port 12:00* **Condition:** Rust Grade[1] **8.** **Description:** 1'' Sample Ports appeared to be in good condition with a minor amount of corrosion.	
Image #2 *Stairs 12:00* **Condition:** Rust Grade[1] **8.** **Description:** Stairs appeared to be in good condition with a minor amount of corrosion.	

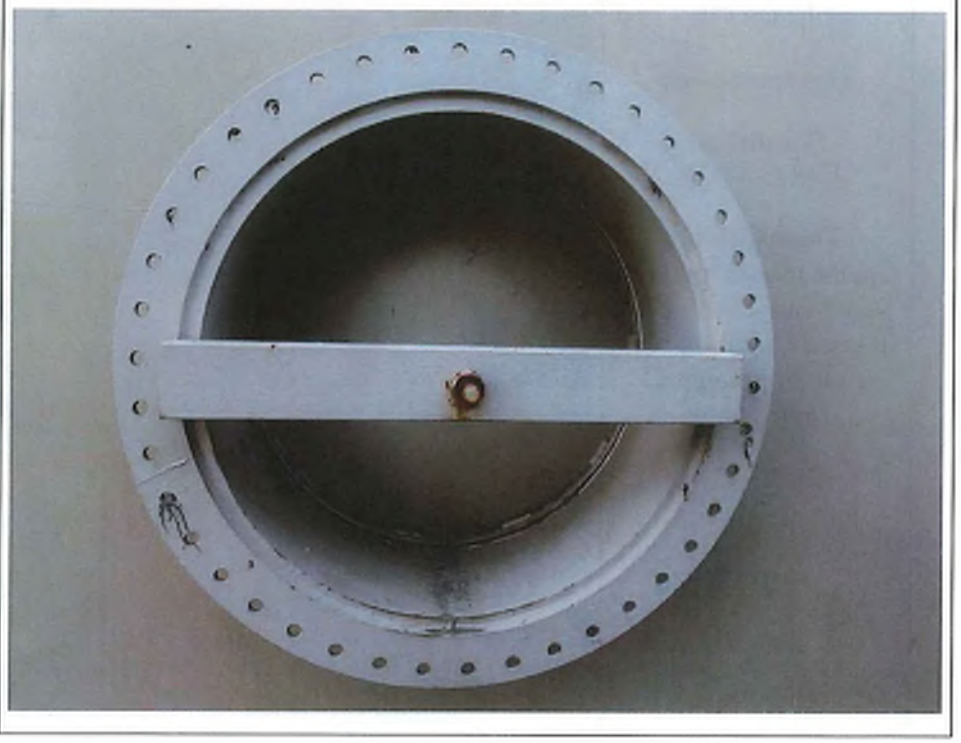
Manor Tank

Image #3 *Liquid Level Indicator Reader Board 1:45* **Condition:** Rust Grade[1] **9.** **Description:** Liquid Level Indicator Reader Board appeared to be in fair condition with a minor amount of corrosion. Numbers are no longer legible.	
Image #4 *Exterior Base 3:00* **Condition:** Concrete Deform[3] **CK.** **Description:** Exterior Base appeared to be in good condition with a minor amount of cracking.	

Manor Tank

Image #5 *Exterior Wall 3:00* **Condition:** Rust Grade[1] **8.** **Description:** Exterior Wall appeared to be in good condition with a minor amount of corrosion and chalking.	
Image #6 *Man Way 4:00* **Condition:** Rust Grade[1] **8.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #7 *Man Way 8:00* **Condition:** Rust Grade[1] **8.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	
Image #8 *Man Way 11:45* **Condition:** Rust Grade[1] **8.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #9 *Overflow 11:45* **Condition:** Rust Grade[1] **7.** **Description:** 10" Overflow appeared to be in good condition with a minor amount of corrosion.	
Image #10 *Overflow Screen* **Condition:** Rust Grade[1] **9.** **Description:** Coarse mesh Overflow Screen appeared to be in good condition with a minor amount of corrosion.	

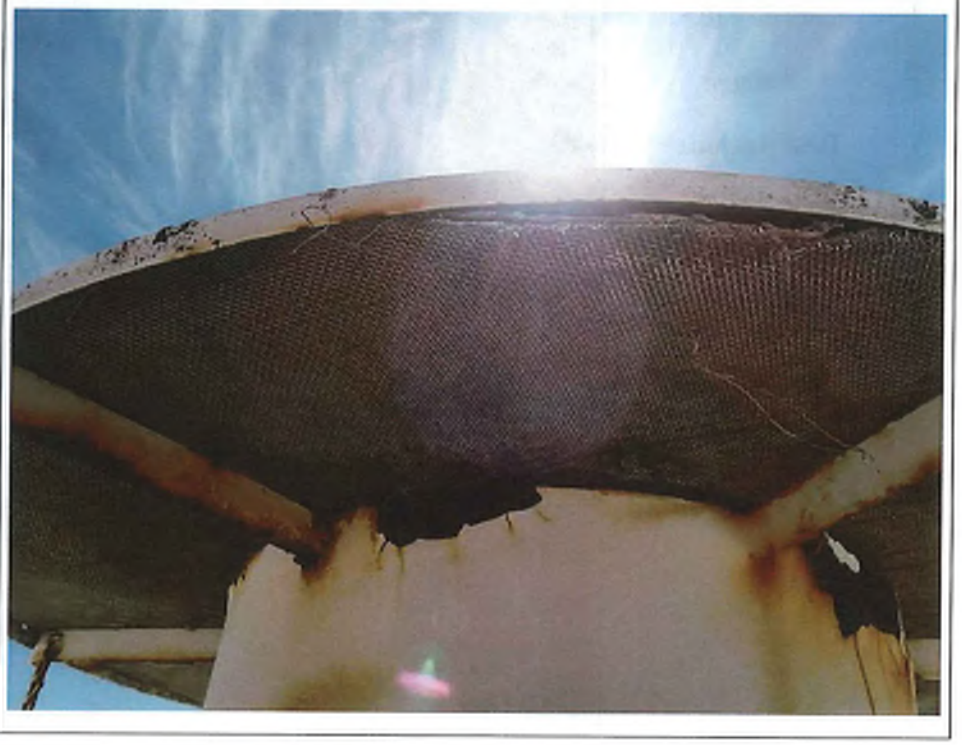
Manor Tank

Image #11 *Entry Hatch 12:00* **Condition:** Rust Grade[1] **4.** **Description:** 36''X36'' Entry Hatch appeared to be in fair condition with a moderate amount of corrosion. No weather stripping was observed.	
Image #12 *Entry Hatch 12:15* **Condition:** Rust Grade[1] **4.** **Description:** 36''X36'' Entry Hatch appeared to be in fair condition with a moderate amount of corrosion. No weather stripping was observed.	

Manor Tank

Image #13 *Liquid Level Indicator Penetration 1:45* **Condition:** Rust Grade[1] **8.** **Description:** Liquid Level Indicator Penetration appeared to be in good condition with a minor amount of corrosion.	
Image #14 *Roof 3:00* **Condition:** Rust Grade[1] **9.** **Description:** Roof appeared to be in good condition with a minor amount of corrosion and organic growth observed.	

Manor Tank

Image #15 *Vent Center* **Condition:** Rust Grade[1] **6.** **Description:** 30" Vent appeared to be in fair condition with a moderate amount of corrosion, organic growth, and delamination observed.	
Image #16 *Vent Screen Center* **Condition:** Rust Grade[1] **6.** **Description:** Fine Mesh Vent Screen appeared to be in fair condition with a moderate amount of corrosion.	

Manor Tank

Image #17

Roof 9:00

Condition:
Rust Grade[1] **9.**

Description:
Roof appeared to be in good condition with a minor amount of corrosion and organic growth observed.

Image #18

Sediment

Description:
1/4" of sediment was removed from reservoir floor.

Manor Tank

Image #19 *Interior Ladder 12:00* **Condition:** Rust Grade[1] **6.** **Description:** Interior Ladder appeared to be in fair condition with a moderate amount of corrosion. Most corrosion observed was near or above water line.	
Image #20 *Reference Cell 12:05* **Condition:** Appeared to be in good condition.	

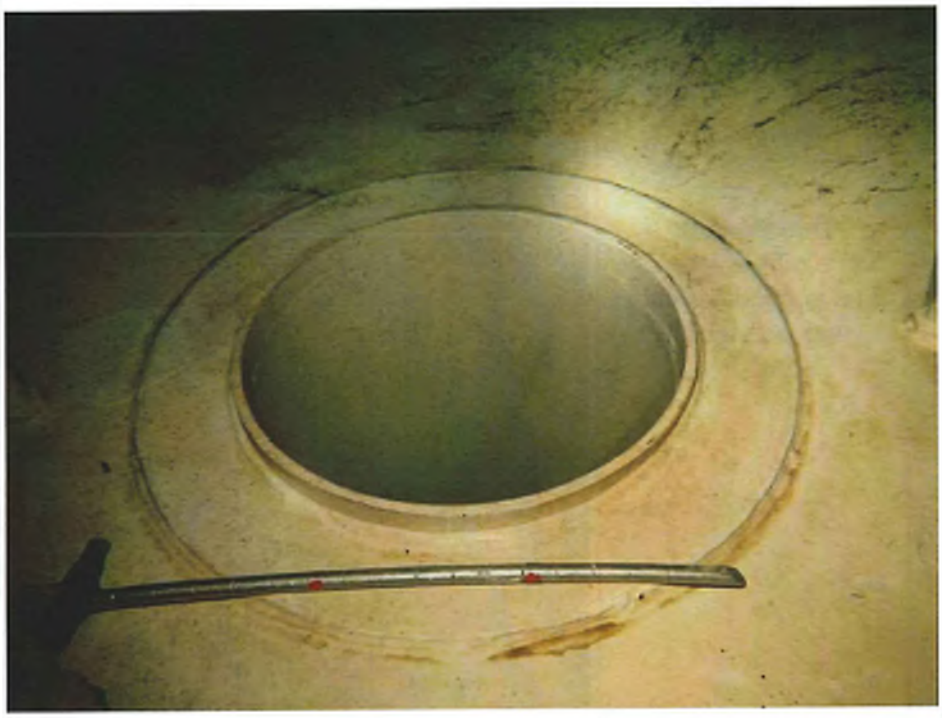
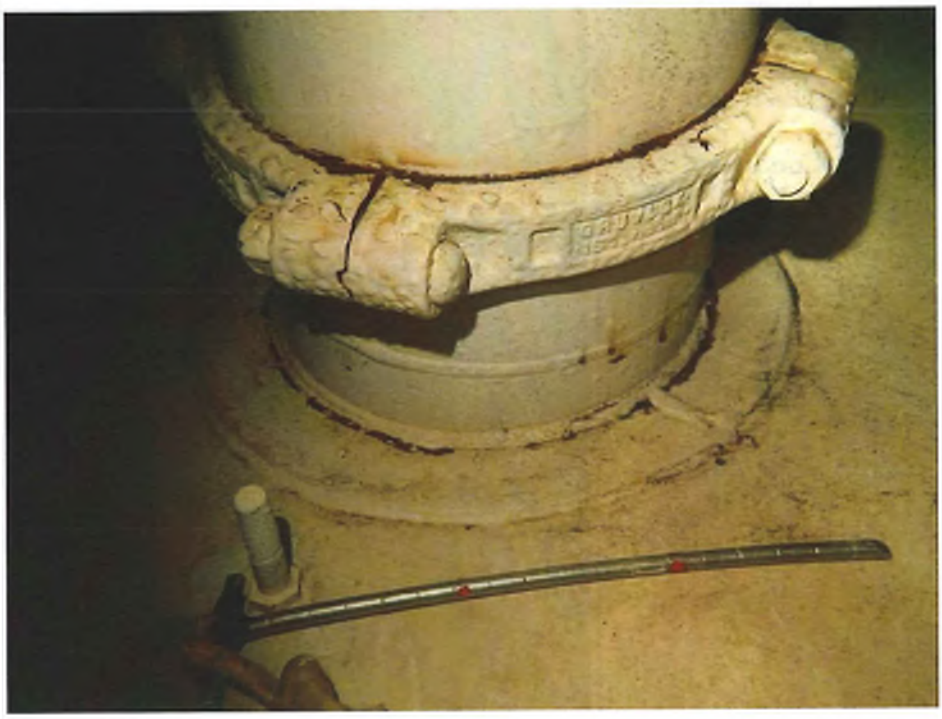
Manor Tank

Image #21 *Floor 12:00* **Condition:** Rust Grade[1] **10.** **Description:** Floor appeared to be in good condition with no signs of corrosion.	
Image #22 *Wall 12:00* **Condition:** Rust Grade[1] **10.** **Description:** Wall appeared to be in good condition with no signs of corrosion.	

Manor Tank

Image #23 *Sample Port 12:15* **Condition:** Rust Grade[1] **10.** **Description:** Sample Port appeared to be in good condition with no signs of corrosion.	
Image #24 *Cathodic Protection Anode 1:00* **Condition:** Appeared to be in good condition.	

Manor Tank

Image #25 *Outlet 1:00* **Condition:** Rust Grade[1] **9.** **Description:** 16" Outlet appeared to be in good condition with a minor amount of corrosion.	
Image #26 *Inlet 1:15* **Condition:** Rust Grade[1] **9.** **Description:** 16" Inlet appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #27

Liquid Level Indicator Base 1:45

Condition:
Rust Grade[1] **9.**

Description:
Liquid Level Indicator Base appeared to be in good condition with a minor amount of corrosion.

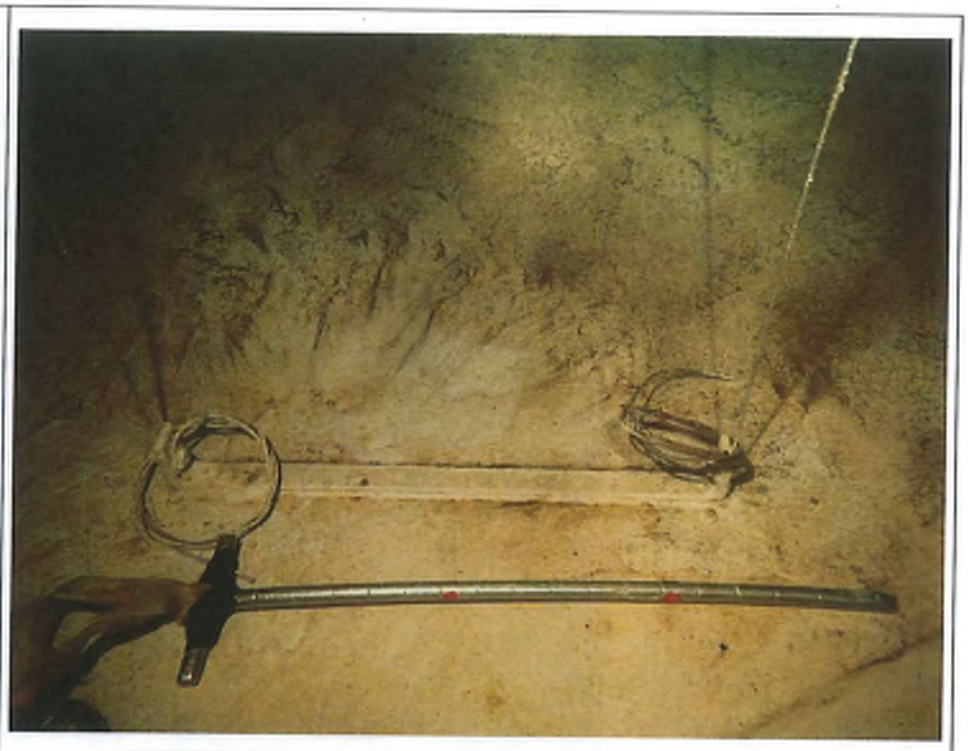


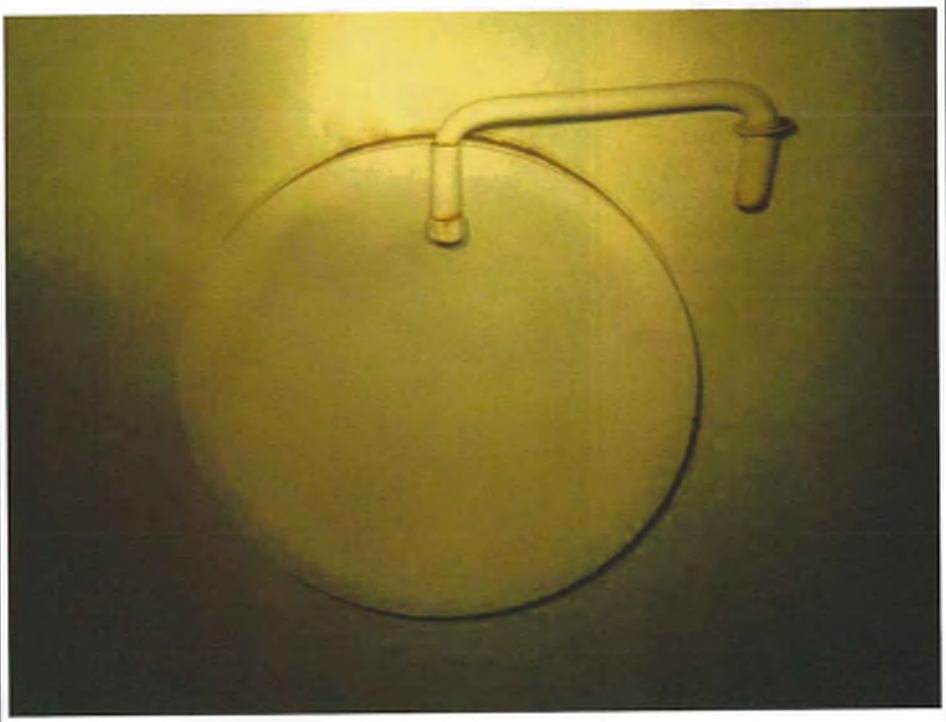
Image #28

Floor 3:00

Condition:
Rust Grade[1] **10.**

Description:
Floor appeared to be in good condition with no signs of corrosion.

Manor Tank

Image #29 *Wall 3:00* **Condition:** Rust Grade[1] **10.** **Description:** Wall appeared to be in good condition with no signs of corrosion.	
Image #30 *Man Way 4:00* **Condition:** Rust Grade[1] **9.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #31 *Floor 6:00* **Condition:** Rust Grade[1] **10.** **Description:** Floor appeared to be in good condition with no signs of corrosion.	
Image #32 *Wall 6:00* **Condition:** Rust Grade[1] **10.** **Description:** Wall appeared to be in good condition with no signs of corrosion.	

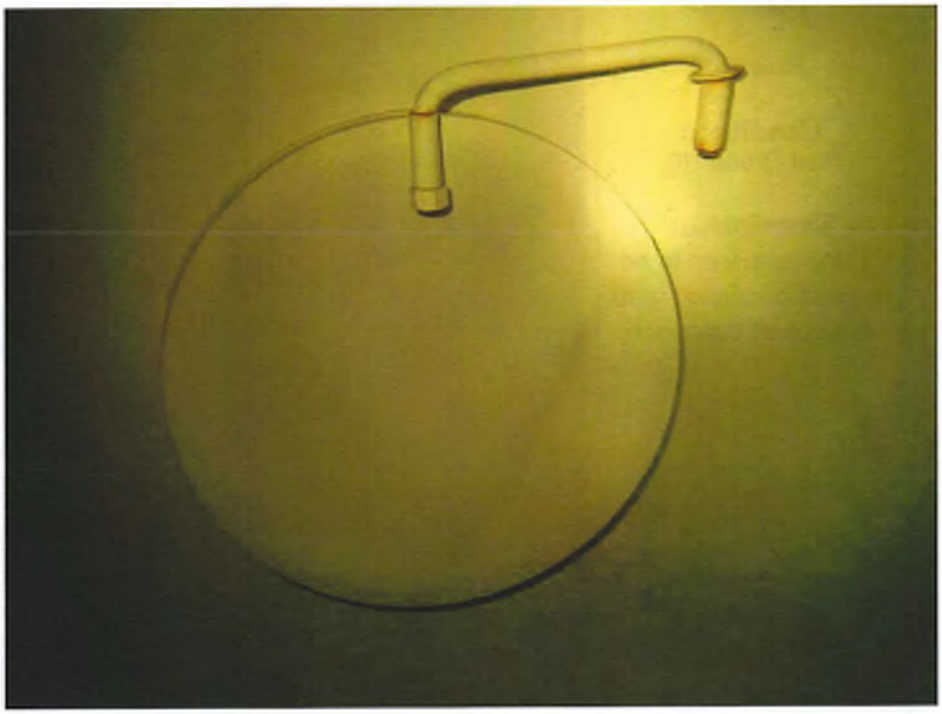
Manor Tank

Image #33 *Column 4:00* **Condition:** Rust Grade[1] **10.** **Description:** 8" Column appeared to be in good condition with no signs of corrosion.	
Image #34 *Man Way 11:45* **Condition:** Rust Grade[1] **8.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #35 *Floor 9:00* **Condition:** Rust Grade[1] **10.** **Description:** Floor appeared to be in good condition with no signs of corrosion.	
Image #36 *Wall 9:00* **Condition:** Rust Grade[1] **10.** **Description:** Wall appeared to be in good condition with no signs of corrosion.	

Manor Tank

Image #37 *Man Way 8:00* **Condition:** Rust Grade[1] **8.** **Description:** 30" Man Way appeared to be in good condition with a minor amount of corrosion.	
Image #38 *Inlet 7:30* **Condition:** Rust Grade[1] **9.** **Description:** 16'' Inlet appeared to be in good condition with a minor amount of corrosion.	

Manor Tank

Image #39 *Column 8:30* **Condition:** Rust Grade[1] **9.** **Description:** 8" Column appeared to be in good condition with a minor amount of corrosion.	
Image #40 *Center Column* **Condition:** Rust Grade[1] **10.** **Description:** 8" Center Column appeared to be in good condition with no signs of corrosion.	

Manor Tank

Image #41 *Ceiling 12:00* **Condition:** Rust Grade[1] 7. **Description:** Ceiling appeared to be in fair condition with a minor amount of corrosion.	
Image #42 *Ceiling 3:00* **Condition:** Rust Grade[1] 7. **Description:** Ceiling appeared to be in fair condition with a minor amount of corrosion.	

Manor Tank

Image #43 *Ceiling 6:00* **Condition:** Rust Grade[1] 7. **Description:** Ceiling appeared to be in fair condition with a minor amount of corrosion.	
Image #44 *Ceiling 9:00* **Condition:** Rust Grade[1] 7. **Description:** Ceiling appeared to be in fair condition with a minor amount of corrosion.	

Manor Tank

Image #45 *Overflow Bell 12:15* **Condition:** Rust Grade[1] **9.** **Description:** 36" Overflow Bell appeared to be in good condition with a minor amount of corrosion.	
Image #46 *Liquid Level Indicator Float 1:45* **Condition:** Rust Grade[1] **9.** **Description:** Liquid Level Indicator Float appeared to be in good condition with a minor amount of corrosion. Recommend lubricating pulleys.	

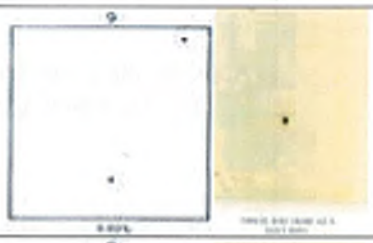
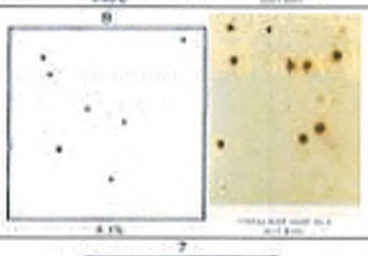
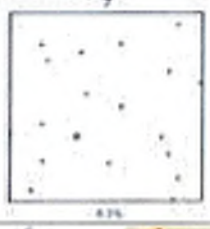
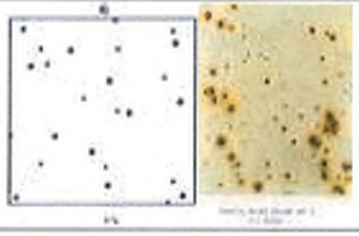
Manor Tank

REFERENCES:

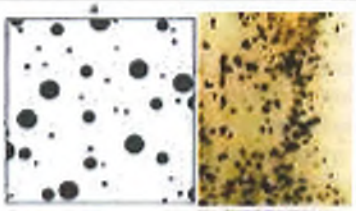
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographical reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Manor Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary

Attendance Sign-up Sheet

MANOR TANK REHABILITATION PROJECT – C67501007

Date: February 9, 2022 (8:00am – 9:00am) – WFO Conference Room 202N. McDowell Blvd. Petaluma, CA 94954)

Sl No.	Name /Title	Representing	Phone	Email	Sign / Initial
1	Dan Herrera Senior Civil Engineer	City of Petaluma	707 778-4589	dherrera@cityofpetaluma.org	
2	George Howard Assistant Civil Engineer	City of Petaluma		ghoward@cityofpetalumal.org	
3	ZAC KOUSSOURIS	EUROSTYLEMANAGM	9163314858	SUPPORT@ESM.CC	
4	Jason Neurenberg	Resource Development CO.	775-552-5280	JasonNeprenberg@resourcedevelopmentco.com	
5	BILL BARZEKD SR PM	VALENTINE CORP	415 7169572	bbarend@valentinecorp.com	
6	Jacob Booth	Booth Electric Inc	707 364 4472	Jacob@booth-electric.com	
7	MARCO LUCICH PRES	CALSIERRA CONSTRUCTION	916-485-3909	MARCO@CALSIERRA.NET	
8	Rodrigo Medina P.M	Top Line Engineers, Inc	510-876-1724	rmedina@toplineengineers.com	
9					
10					