

SECTION 01000

SUMMARY OF WORK

PART 1: GENERAL

1.01 WORK UNDER THIS CONTRACT

The CONTRACTOR shall furnish all labor, materials, equipment and means to construct the project entitled **MPWSP SLANT WELL INTAKE SYSTEM – CIVIL CONSTRUCTION**, as shown on the Drawings and described herein. The work includes, but is not limited to, the following:

Construction and installation of the Monterey Peninsula Water Supply Project (MPWSP) Slant Well Intake System within the CEMEX Sand Mining Site, which includes site grading, feed water pipeline (i.e. ~~PVC C900~~ ~~PVC~~ or ~~HDPE~~ and DI pipe, DI fittings, valves, air/vacuum release valves with enclosure, blow-offs, and related appurtenances, concrete thrust blocks and thrust restraint joints, trench excavation and backfill, etc.), approx. 700 feet of 3642-inch FPVC (C900) pipe installed using Horizontal Directional Drilling (HDD), mechanical piping vaults, mechanical piping (i.e. valves, meters, gauges, etc.), concrete electrical enclosures, electrical, instrumentation, and controls, pump to waste basins, site restoration, and existing utilities abandonment in accordance with the plans and specifications that are part of the contract and bid documents for this project and until satisfactory and final acceptance of the work by the OWNER.

The above general outline of principal features does not in any way limit the responsibility of the CONTRACTOR to perform all work and furnish the required materials, equipment, labor and means as shown or required by the Contract Documents as required to provide a complete and functional project.

Materials, equipment, labor, etc., obviously a part of the work and necessary for the proper operation and installation of same, although not specifically indicated in the Contract Documents, shall be provided as if called for in detail without additional cost to the OWNER.

1.02 LOCATION

All work is to be performed within the CEMEX Sand Mining Site, within the City of Marina, at locations shown in the project drawings and specifications for this project.

1.03 WORK BY OTHERS

Michael Baker International, Inc. is the OWNERS Agent (ENGINEER) and Civil Design Team for the MPWSP Slant Well Intake System (within the CEMEX Sand Mining Site). GEOSCIENCE Support Services Inc. is the Slant Well Designer and Boart Longyear is the Slant Well Drilling and Equipping Contractor.

1.04 OWNER FURNISHED PRODUCTS

GEOSCIENCE Support Services Inc. will purchase the pressure transducers for each slant well and with the assistance of Boart Longyear, install them. CAW will purchase the even (7) slant well intake pumps and they will be installed by Boart Longyear.

1.05 CONTRACTOR USE OF SITE

- A. Access to site: Limited to areas noted on project drawings.
- B. Emergency building exits during construction: Not Applicable
- C. Construction operations: Limited to areas noted on project drawings.
- D. Time restrictions for performing work: Working Hour Restrictions as specified in Supplemental General Conditions.
- E. Utility outages and shutdown: To be coordinated with OWNER, CEMEX, and Pacific Gas and Electric (PG&E) as needed and appropriate.

1.06 FUTURE WORK

Not Applicable

1.07 SEQUENCE OF WORK AND SPECIAL PROJECT REQUIREMENTS

- A. **Shutdowns.** Not Anticipated, pipeline does not connect to an active pipeline. A schedule, including time and duration of any anticipated shutdowns shall be submitted to the OWNER for approval prior to the start of construction.
- B. **Tapping.** Not Applicable
- C. **Schedule.** The CONTRACTOR shall allow for construction and schedule constraints in preparing the construction schedules required under Section 01300: Submittals. The schedule shall include the CONTRACTOR'S activities necessary to satisfy all constraints included and referenced in the contract documents.

- D. **Sequence.** The anticipated construction sequence is as follows:
1. The CONTRACTOR shall be required to coordinate his work plan and schedule with the offsite pipeline work which shall be ongoing during the duration of this project:
 - a. Feed Water Pipeline (from CEMEX Site to Desalination Plant Site).
 2. CONTRACTOR shall coordinate with OWNER and CEMEX to determine location and sequencing for horizontal directional drilling (HDD) pits and operation.
 3. CONTRACTOR shall install the feed water pipeline and medium voltage conduits from Main Switchgear to each medium voltage transformer simultaneously to reduce impact along access roads.
 4. CONTRACTOR shall construct the feed water pipeline with all gate and butterfly valves installed, so that the pipeline can be cleaned, and pressure tested before connecting to each well site conveyance pipeline.
- E. **Alternate Sequence.** The CONTRACTOR shall have the option of submitting an alternate sequence of construction to the OWNER prior to the commencement of work if he/she believes the work can be accomplished in a more efficient manner or logical sequence, and with less impact to CEMEX. The OWNER will review the alternate sequence and provide a final determination as to whether the proposed sequence meets the OWNER's sequencing requirements.
- F. **Traffic Control.** Not Applicable
- G. **Stormwater BMPs.** Contractor shall furnish, install and maintain Stormwater BMPs in accordance with the drawings prepared for this project and in accordance with local, county, and state requirements.

1.08 CHANGE PROCEDURES

- A. The Engineer may issue to CONTRACTOR a Proposal Request which includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Times for executing the change and the period of time during which the requested price will be considered valid. CONTRACTOR will prepare and submit an estimate within 15 working days. The estimate shall contain a detailed breakdown of the labor, equipment, material, subcontract, equipment

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rental, contingencies, overhead, and profit costs associated with the requested change. The estimate shall also include any requested adjustments to Contract Times including the window of time the OWNER has to render a decision on the matter.

1.09 DEFINED TERMS

Terms used in these Specifications which are defined in the General Conditions of the Contract Documents shall have the meanings assigned to them in the General Conditions.

1.10 ABBREVIATIONS

Where any of the following abbreviations are used in the Contract Documents, they shall have the meaning set forth opposite each.

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANS	American National Standard
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers

ASTM	American Society for Testing and Materials
AWPA	American Wood-Preservers' Association
AWWA	American Water Works Association
CS	Commercial Standard
IBR	Institute of Boiler and Raditor Manufacturers
IPS	Iron Pipe Size
JIC	Joint Industry Conference Standards
NBS	National Bureau of Standards
NEC	National Electrical Code; Latest Edition
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
125lb ANS	American National Standard for Cast-Iron Pipe
250lb ANS	Flanges and Flanged Fittings, Designation B16.1-1975, for the appropriate class
AWG	American or Brown and Sharpe Wire Gage
NPT	National Pipe Thread
OS&Y	Outside Screw and Yoke
Stl.WG	U.S. Steel Wire, Washburn and Moen, American Steel and Wire or Roebling Gage
UL	Underwriters' Laboratories
USS Gage	United States Standard Gage
WOG	Water, Oil, Gas

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.01 FIELD SURVEY WORK

- A. Unless otherwise provided in the Supplementary Conditions the ENGINEER shall provide existing engineering control points to establish reference points for construction. Utilizing ENGINEERS's initial control base line, CONTRACTOR shall setup any new control bench marks to be utilized throughout the project. Base line shall be set in accordance with all lines, dimensions, reference points, and elevations given in the Contract Drawings.
- B. Should the CONTRACTOR detect a discrepancy between the information as presented in the Contract Drawings and any existing survey grid-work, bench marks, structures, etc., the CONTRACTOR shall notify the ENGINEER immediately. New construction shall not commence until accurate control base lines and bench marks have been established.
- C. The CONTRACTOR shall throughout the course of the project, set all additional stakes which are needed for offset stakes, reference points, slope stakes, pavement and curb line and grade stakes, stakes for structures, sewers, utilities, roadway drainage, pipe underdrains, paved gutter, fence, culverts, or other structures, supplementary bench marks, and any other horizontal or vertical controls necessary to secure a correct layout and construction of the work. Stakes for line and grade for pavements, curbs, storm drains, sewers, etc., shall be set at twenty-five (25) foot maximum intervals. Base lines shall be staked in such manner as to clearly define them for the project.
- D. It shall be the CONTRACTOR's responsibility that the finished work conform to the lines, grades, elevations and dimensions called for in the Contract Documents. The Work shall be subject to checking by the ENGINEER, but any inspection or checking of CONTRACTOR's layout by the ENGINEER and the acceptance of all or part of it shall not relieve the CONTRACTOR of his responsibility to secure the proper dimensions, grades, elevations and locations on the several parts of the Work. The CONTRACTOR shall exercise care in the preservation of stakes, monuments and bench marks and shall have them reset at his expense when they are lost or displaced.

- E. Prior to the commencement of any Work activity, the CONTRACTOR shall survey and layout the Work to be performed and advise the ENGINEER of any conflicts, obstructions, concerns, etc. which will prevent completion of such work in accordance with the requirements of the Contract Documents. If the CONTRACTOR fails to conduct such survey and layout or if the survey and layout fails to identify a conflict, obstruction, etc., which it reasonably should have, and a conflict, obstruction, concern, etc., is discovered, the CONTRACTOR shall bear the cost of any standby time for labor and/or equipment which occurs pending the ENGINEER's direction and the cost of rework of any Work installed which is affected by the conflict, obstruction, etc.
- F. Where the dimensions and locations of existing structures are of importance in the installation or connection of any part of the Work, the CONTRACTOR shall verify such dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

3.02 COORDINATION AND MEETINGS

- A. The CONTRACTOR will be required to coordinate his work, to phase the construction operations, and provide, install and maintain any temporary connections necessary to prevent interference to operation of OWNER's facilities. Any construction work requiring the shut-down of facilities must be scheduled and performed only at such times as shall be authorized by the ENGINEER and OWNER. Such work must be completed during the specific periods authorized by the OWNER. It may be necessary that work will be performed during several shut-down periods and/or during periods of premium time payment to accomplish the desired construction. All costs to perform the CONTRACTOR's work, including premium time payments, shall be borne by the CONTRACTOR and are included in the Contract price.
- B. In addition to the above, the CONTRACTOR shall:
 - 1. Coordinate scheduling, submittals, and work of the various sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
 - 2. Verify the utility requirement characteristics of operating equipment are compatible with the utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

3. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
4. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
5. Coordinate completion and clean up of Work of separate sections in preparation for substantial completion and for portions of Work designated for OWNER's partial occupancy.
6. After OWNER occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of OWNER's activities.

C. Job Progress Meetings

Progress meetings will generally be held monthly. CONTRACTOR's attendance shall be required.

1. Schedule - The ENGINEER will establish the meeting place, time and date, notify participants and administer the meeting. CONTRACTOR shall notify major subcontractors and suppliers, as appropriate.
2. Attendance
 - a. ENGINEER and/or resident project representative.
 - b. CONTRACTOR's project manager and project superintendent
 - c. OWNER's representative
 - d. Subcontractor, as appropriate to the agenda
 - e. Suppliers, as appropriate to the agenda
 - f. Other parties as determined by ENGINEER and/or OWNER
3. Agenda
 - a. Review minutes of previous meeting.
 - b. Review of work progress since previous meeting.
 - c. Review field observations, problems, conflicts.
 - d. Review problems which impede construction schedules.
 - f. Review of off-site fabrication, delivery schedules.

- g. Review corrective measures and procedures to regain projected schedule.
 - h. Review revisions to construction schedules.
 - i. Review plan progress, schedule, during succeeding work period.
 - j. Review coordination of schedules.
 - k. Review submittal schedules; expedite as required.
 - l. Review maintenance of quality standards.
 - m. Review proposed changes for:
 - effect on construction schedule and on completion date
 - effect on other contracts of the project
 - n. Other business
4. Minutes - ENGINEER will prepare and distribute copies to participants and OWNER for review at the next meeting.

***** END OF SECTION *****

SECTION 01025

MEASUREMENT AND PAYMENT

SCOPE

This section covers methods of measurement and payment for items of Work under this Contract.

GENERAL

The Contract Price shall cover all Work required by the Contract Documents. All costs in connection with the proper and successful completion of the Work, including furnishing ALL materials, equipment, supplies, and appurtenances; providing all construction plant, equipment, and tools; and performing all necessary labor and supervision to fully complete the Work as indicated on the drawings or specified by these specifications and permit requirements, conduct start-up testing, conduct training, and provide operation and maintenance manuals and record drawings shall be included in the unit and lump sum prices bid. All Work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid. This requirement shall include all meetings and permit compliance requirements with affected utility companies and agencies with jurisdiction over the project.

ESTIMATED QUANTITIES

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

BASE BID ITEMS

BID ITEM #1: MOBILIZATION, DEMOLITION, BONDS AND INSURANCE

- A. Measurement and payment of construction of mobilization, limits of construction fencing (i.e. orange barrier fencing), demolition, set-up of office trailers, temporary utilities, sanitary facilities, employee and visitor parking, installation of project signs, bonds, and insurance will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form.
- B. Total amount of premiums, supported with documentation including certified invoices, paid by the Contractor to obtain performance and payment bonds, and

specified insurance shall be paid at one time together with the first progress payment.

- C. Total amount for this bid item will be paid at the lump sum price named in the bid form. The amount paid under this bid item shall not exceed five (5) percent of the Total Bid Price.

BID ITEM #2: MINE SAFETY AND HEALTH ADMIN (MSHA) TRAINING

- A. Measurement and payment of Mine Safety and Health Administration (MSHA) training will be based upon the component parts listed in the approved Schedule of Values. Total payment for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full training completion.
- B. This work includes having ALL contractor personnel who may be working onsite complete MSHA 8-hour new mining training (27 courses). Each personnel can complete training online or Contractor can hire a professional to come to their office and conduct a course. U.S. Dept. of Labor Certificate of Training (MSHA FORM 5000-23) must be provided to the CEMEX front office before personnel can enter the work site.

BID ITEM #3: ENVIRONMENTAL MITIGATION MEASURES

- A. Measurement and payment of environmental mitigation measures pursuant to the Supplemental General Conditions (Section 3), will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and functional erosion control system and all appurtenant work.
- B. Work included in this bid item includes but is not limited to all work related to developing and implementing environmental protection measures, permit compliance measures, associated reporting requirements as described in the Supplemental General Conditions - Section 3, at all times during construction.

BID ITEM #4: STORMWATER BMP INSTALLATION AND MAINTENANCE

- A. Measurement and payment of construction of all erosion control and storm water pollution prevention as it relates to this construction will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and functional erosion control system and all appurtenant work.
- B. Work included in this bid item includes but is not limited to all work related to developing, obtaining applicable permits, and maintaining sufficient erosion control and storm water pollution prevention plan at all times during construction.

BID ITEM #5: ONSITE GRADING

- A. Measurement and payment of onsite access roads and well site working pads will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable tunnel and pipeline and all appurtenant work.
- B. Work included in this bid item involves the grading of ingress/egress site access as shown on Sheet C2 and all site grading at all five (5) well sites. Work includes, but is not limited to, construction staking, site grading, excavation, backfill, compaction, dust control, all equipment, property owner coordination, connecting work to other bid items and all other appurtenant work and materials for a complete and functional access road and well working sites.

BID ITEM #6: 3036" TO 42" FEED WATER PIPELINE

- A. Measurement and payment of construction of all work on the feedwater pipeline between Stations 10+00 and 33+00 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the feedwater pipeline between Stations 10+00 and 33+00, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, and compaction. Work also includes all connections to the well site pipelines, connecting work to other bid items, all pavement removal and road reconstruction, traffic control, structures, valves, labor, equipment, blow-offs, air release, and all other appurtenant work and materials for a complete and functional system as shown in design drawings.

BID ITEM #7: 4236" FEED WATER PIPELINE – HORIZONTAL DIRECTIONAL DRILLING

- A. Measurement and payment of construction of work on the feed water pipeline between Stations ~~30+90~~~~33+00~~ and 37+20, installed using horizontal directional drilling (HDD), will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the feed water pipeline between Stations ~~30+90~~~~33+00~~ and 37+20, including but not limited to the excavation pits, shoring, pipe (fused 4236" PVC (DR-25) ~~or HDPE (DR-17)~~) and

appurtenances installation, backfilling, compaction, pressure and leakage testing, flushing, and cleaning and disinfection of the 3642-inch feed water pipeline. Work also includes connections to the feed water pipeline, connecting work to other bid items, all pavement removal and road reconstruction, traffic control, structures, valves, labor, equipment, blow-offs, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #8: PIPELINE DISINFECTION AND TESTING

- A. Measurement and payment of pipeline disinfection and testing on the feedwater pipeline between Stations 10+00 and 37+20 and all other pipelines will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item, but not limited to, pressure and leakage testing, flushing, cleaning and disinfection of the feedwater pipeline and all other mechanical piping/valves between the well discharge head and the feedwater pipeline connection.

BID ITEM #9: WELL SITE #1 MECHANICAL PIPING (1 WELL)

- A. Measurement and payment of construction of all work on Well Site #1 (one well at site) mechanical piping and valving as shown in Sheet M1 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed concerning Well Site #1 mechanical piping, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction, pipe supports, and cathodic protection. Work also includes pump to waste piping, connecting work to other bid items, structures, labor, equipment, gauges, blow-offs, air release valves, meters, deep well solenoid control valve, and all other valves and appurtenant work and materials for a complete and functional system as shown in the construction drawings.

BID ITEM #10: WELL SITE #2 MECHANICAL PIPING (2 WELLS)

- A. Measurement and payment of construction of all work on Well Site #2 (two wells at the site) mechanical piping and valving as shown in Sheet M2 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.

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- B. Work included in this bid item involves all work to be performed concerning Well Site #3 mechanical piping, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction, pipe supports, and cathodic protection. Work also includes pump to waste piping, connecting work to other bid items, structures, labor, equipment, gauges, blow-offs, air release valves, meters, deep well solenoid control valve, and all other valves and appurtenant work and materials for a complete and functional system as shown in the construction drawings.

BID ITEM #11: WELL SITE #3 MECHANICAL PIPING (1 WELL)

- A. Measurement and payment of construction of all work on Well Site #3 (one well at site) mechanical piping and valving as shown in Sheet M1 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed concerning Well Site #3 mechanical piping, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction, pipe supports, and cathodic protection. Work also includes pump to waste piping, connecting work to other bid items, structures, labor, equipment, gauges, blow-offs, air release valves, meters, deep well solenoid control valve, and all other valves and appurtenant work and materials for a complete and functional system as shown in the construction drawings.

BID ITEM #12: WELL SITE #4 MECHANICAL PIPING (1 WELL)

- A. Measurement and payment of construction of all work on Well Site #4 (one well at site) mechanical piping and valving as shown in Sheet M1 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed concerning Well Site #4 mechanical piping, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction, pipe supports, and cathodic protection. Work also includes pump to waste piping, connecting work to other bid items, structures, labor, equipment, gauges, blow-offs, air release valves, meters, deep well solenoid control valve, and all other valves and appurtenant work and materials for a complete and functional system as shown in the construction drawings.

BID ITEM #13: WELL SITE #5 MECHANICAL PIPING (2 WELLS)

- A. Measurement and payment of construction of all work on Well Site #5 (two wells at the site) mechanical piping and valving as shown in Sheet M2 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed concerning Well Site #5 mechanical piping, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction, pipe supports, and cathodic protection. Work also includes all connections to existing utilities, connecting work to other bid items, structures, labor, equipment, gauges, blow-offs, air release valves, meters, deep well solenoid control valve, and all other valves and appurtenant work and materials for a complete and functional system as shown in the drawings.

BID ITEM #14: PRECAST CONCRETE VAULTS WITH ACCESS HATCH

- A. Measurement and payment of construction of all work to procure and install seven (7) precast concrete vaults for each well, will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item to procure and install seven (7) precast concrete vaults that include an access Hatch, Fiberglass Ladder w/ Stainless Steel Hardware and Bilco Ladder up Safety Post, Link Seals for Pipe Openings. Work also includes but not limited to the excavation, trenching, shoring, link seals and appurtenances installation, geotextile fabric, crushed rock base, embedment, backfilling, compaction, connecting work to other bid items, labor, equipment, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #15: PUMP TO WASTE BASINS

- A. Measurement and payment of construction of all work on five (5) pump to waste will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on each pump to waste basin, including but not limited to construction staking, excavation, rip rap rock class 2, geotextile fabric, and compaction. Work also includes connecting work to other bid items, labor, equipment, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #16: 8' PVC COATED CHAIN-LINK FENCE WITH PRIVACY SLATS

- A. Measurement and payment of construction of all 8' Tall PVC Coated chain link fence and gates, including tan (sand) colored privacy slats will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at unit price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to install chain-link privacy fence, including but not limited to construction staking, excavation, PVC coated chain-link fence, privacy slats, and appurtenances installation, backfilling, compaction, labor, equipment, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #17: 3,000 GALLON SURGE TANK #1

- A. Measurement and payment of construction of all work on the 3,000-gallon surge tank #1 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed for the 3,000-gallon surge tank #1, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction. Work also includes connecting work to other bid items, structures, valves, gauges, labor, equipment, and all other appurtenant work and materials for a complete and functional surge tank system.

BID ITEM #18: 8,000 GALLON SURGE TANK #2

- A. Measurement and payment of construction of all work on the 8,000-gallon surge tank #1 will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed for the 8,000-gallon surge tank #1, including but not limited to construction staking, excavation, trenching, shoring, pipe and appurtenances installation, pipe embedment, backfilling, compaction. Work also includes connecting work to other bid items, structures, valves, gauges, labor, equipment, and all other appurtenant work and materials for a complete and functional surge tank system.

BID ITEM #19: CONCRETE AND REINFORCING STEEL

- A. Measurement and payment of construction of all work related to concrete and reinforcing steel for electrical enclosure pads, surge tank pads, electrical cabinet pads, thrust blocks, valve anchors, etc. will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves but is not limited to all concrete and reinforcing steel for electrical enclosure pads, surge tank pads, electrical cabinet pads, thrust blocks, valve anchors, etc., including but not limited to the excavation, trenching, shoring, appurtenances installation, embedment, backfilling, and compaction. Work also includes connecting work to other bid items, labor, equipment, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #20: WELL SITE #1 ENCLOSURE, ELECTRICAL, CONTROLS, AND HVAC

- A. Measurement and payment of construction of all work related to the electrical components at Well Site #1 based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the electrical components at Well Site #1, including but not limited to construction staking, Fibrebond concrete enclosure, switchboard, VFD, HVAC, excavation, trenching, conduit and appurtenances installation, labor, equipment, and all other appurtenant work/materials for a complete/functional electrical controls system.

BID ITEM #21: WELL SITE #2 ENCLOSURE, ELECTRICAL, CONTROLS, AND HVAC

- A. Measurement and payment of construction of all work related to the electrical components at Well Site #2 based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the electrical components at Well Site #2, including but not limited to construction staking, Fibrebond concrete enclosure, switchboard, VFDs, HVACs, excavation, trenching, conduit and appurtenances installation, labor, equipment, and all other appurtenant work and materials for a complete and functional electrical and controls system.

BID ITEM #22: WELL SITE #3 ENCLOSURE, ELECTRICAL, CONTROLS, AND HVAC

- A. Measurement and payment of construction of all work related to the electrical components at Well Site #3 based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the electrical components at Well Site #3, including but not limited to construction staking, Fibrebond concrete enclosure, switchboard, VFD, HVAC, excavation, trenching, conduit and appurtenances installation, labor, equipment, and all other appurtenant work/materials for a complete/functional electrical controls system.

BID ITEM #23: WELL SITE #4 ENCLOSURE, ELECTRICAL, CONTROLS, AND HVAC

- A. Measurement and payment of construction of all work related to the electrical components at Well Site #4 based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the electrical components at Well Site #4, including but not limited to construction staking, Fibrebond concrete enclosure, switchboard, VFD, HVAC, excavation, trenching, conduit and appurtenances installation, labor, equipment, and all other appurtenant work/materials for a complete/functional electrical controls system stem.

BID ITEM #24: WELL SITE #5 ELECTRICAL, CONTROLS, AND HVAC

- A. Measurement and payment of construction of all work related to the electrical components at Well Site #5 based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the electrical components at Well Site #5, including but not limited to construction staking, Fibrebond concrete enclosure, switchboard, VFDs, HVACs, excavation, trenching, conduit and appurtenances installation, labor, equipment, and all other appurtenant work/materials for a complete/functional electrical controls system.

BID ITEM #25: 1,500 KVA AND 1,000 KVA TRANSFORMERS

- A. Measurement and payment of construction of all work on 1,500 KVA and 1,000 KVA Transformers will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item involves all work to be performed on the 1,500 KVA and 1,000 KVA Transformers (stainless steel skin), including but not limited to construction staking, excavation, trenching, conduit and appurtenances installation, embedment, backfilling, compaction. Work also includes all connections to other bid items, tranfmier slab boxes, structures, labor, equipment, and all other appurtenant work and materials for a complete and functional system.

BID ITEM #26: ADDITIONAL ELECTRICAL EQUIPMENT AND INSTALLATION

- A. Measurement and payment of construction of all additional electrical equipment will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item for additional electrical equipment includes all work for the main switchgear, PG&E slab Box and transformer, conduits, conductors (i.e. power, grounding, control), Pull Boxes, and Programming, including but not limited to construction staking, excavation, trenching, conduit and appurtenances installation, backfilling, compaction, connections to other bid items, labor, equipment, and all other appurtenant work and materials for a complete and functional electrical and controls system.

BID ITEM #27: FIBER OPTIC CONDUIT AND PULL BOXES

- A. Measurement and payment of construction of all work concerning installation of PVC conduit and pull boxes or fiber optic wire will be based upon the component parts listed in the approved Schedule of Values. Total payment for construction for this bid item and all appurtenant work will be made at the lump sum price named in the bid form. Except as otherwise provided under separate bid items, such price names shall constitute full compensation for the construction of a complete and operable systems and all appurtenant work.
- B. Work included in this bid item includes all work for the fiber optic conduit and pull boxes, including but not limited to construction staking, excavation, trenching, conduit and appurtenances installation, backfilling, compaction, connections to other bid items, labor, equipment, and all other appurtenant work and materials for a complete and functional fiber optic conduit wire installation.

****End of Section****

SECTION 02830
CHAIN LINK FENCE

PART 1 – GENERAL

1.1 SUMMARY

- A. Provide all material, labor, equipment and service necessary for the furnishing and installation of chain link fencing and gates, as shown on the Drawings and as specified herein. The work includes, but is not limited to:
 - 1. Polyvinyl Chloride (PVC) coated and galvanized or aluminized chain link fencing, posts, rails, aluminum sliding gate and accessories.
 - 2. Finish hardware
 - 3. Replacement of unsatisfactory materials.

- B. Provide chain link fence complete units controlled by a single source including necessary erection accessories, fittings, and fastenings. The single source installer shall have not less than 5 years of successful experience in installation of chain link fences similar to those required for this project.

- C. Fence shall be erected by skilled craftsperson or tradesperson in accordance with the best practice of the trade and taking into account the recommendation of the fence Manufacturer's Institute.

1.2 RELATED WORK

- A. The WORK of the following Section applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. Section 01300 – Submittals

1.3 SUBMITTALS

- A. Product Data: Submit the following to the Owner Representative for acceptance:
Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, posts, rails, and accessories.

- B. Materials: Submit a two foot square sample evergreen color polyvinyl chloride coating over galvanized coating with a 1-inch mesh fencing fabric and sand colored privacy slat to the ENGINEER for approval.

- C. Shop Drawings: Submit shop drawings indicating thicknesses,

dimensions, fastenings, hinges, and post anchoring method to Owner Representative for review and approval. Provide separate drawings for each of the following:

1. Post layout and fence material.
2. Post anchoring system.
3. Fence layout, include the connection system of the fabric to the top and bottom rail.
4. Gates, including all hardware and appurtenances. Submit Shop drawings and manufacturer's literature (product data) to the ENGINEER for review in accordance with Section 01300 for acceptance.

PART 2 – PRODUCTS

2.1 FENCE FABRIC ~~(IF NEEDED DURING CONSTRUCTION)~~

- A. Chain Link Fence Fabric for perimeter security fences shall be Polyvinyl Chloride (PVC)-Coated ASTM F668 Class 2b over zinc-coated steel wire with minimum coating weight of 2.0 ounces of zinc per square foot of coated surface. Fabric shall be fabricated of 9-gauge wire woven in 24-inch mesh. Fence height shall be 87 feet with top and bottom rails ~~and one foot of barbed wire at top of fence, 8 feet overall height including barbed wire.~~ Chain link fabric for slatted fence must have 3-1/2-inch-vertical and 5-inch-horizontal mesh (27-1/2 diamond count).
- B. Fence fabric shall conform to the following: PVC-coat fabric color shall be tan (sand) ~~evergreen~~ complying with ASTM F 934. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.2 PRIVACY SLATS (FINAL)

- A. Chain Link Fence Privacy Slats shall be made of High Density Polyethylene (HDPE) and have UV inhibitors (UV resistant color concentrates) to add color protection and guard against cracking, chalking, and fading in the sunlight, while also being resistant to severe weather conditions, salt water, sand, alcohol, alkaline, ammonia, petroleum distillates, and common environmental pollutants. 8 feet overall height, sand (tan) color.

2.3 GATES

- A. All gates shall conform to the ASTM F 900 standards per detail. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size shall be (NPS) 1.9 inch and coated with PVC per 2.01B. Gate post diameters shall be as shown on the drawings.

- B. Aluminum sliding gate frame material to be in accordance with ASTM F 1184 Type II Class 2. Grade shall be structural aluminum: 6063-T52 unless otherwise specified. Color shall match with fabric.
- C. Gate Privacy Slats shall be HDPE, color shall be sand tan.
- D. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Gate fabric shall be attached to the gate frame by the method approved by the manufacturer. Welding is prohibited.
- E. Latches, hinges, stops, keepers, rollers, post caps, and other hardware items shall be furnished as required for the operation of the gate and painted evergreen to match fence (2 coats). Latches shall be commercial grade and arranged for padlocking so that the padlock will be accessible from both sides of the gate – except at double gates that require accessibility from the inside part of gate ONLY. Latch holes for the padlocks on vehicle gates shall be of sufficient diameter to accommodate SFPUC padlocks.

2.4 POSTS

- A. Metal Posts for Chain Link Fence: All metal posts for chain link fence shall conform to standard ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B, shall meet the strength and coating requirements of ASTM F 1043. ~~Sizes shall be as shown on the drawings.~~ Line posts (2") -and terminal (corner, gate, and pull) posts (2.5") selected shall be of the same designation throughout the fence. Gatepost shall be for the gate type specified subject to the limitation specified in ASTM F 900. All posts shall be capped and shall have PVC coating per 2.01B.

2.5 BRACES AND RAILS

- A. ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043 and shall have PVC coating per 2.01B.

2.6 ACCESSORIES

- A. All posts shall be capped to prevent rainwater from filling the posts and shall have PVC coating per 2.01B.
- B. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.
- C. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment.

2.7 CONCRETE

- A. ASTM C 94, using 3/4-inch maximum size aggregate, and having minimum compressive strength of 4,000 psi at 28 days. Grout shall consist of one part Portland Cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared per drawings. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts as practical; however, runs between terminal posts shall not exceed 200 feet for security fences. Any damage to galvanized surfaces shall be repaired with paint containing zinc dust in accordance with ASTM A 780.
- B. All fence and gate bolts shall be mounted so that they cannot be easily removed from the unsecured side of the fence or gate.
- C. All fence and gates shall be installed so that the fence or gate cannot be easily climbed from the unsecured side of the fence/gate due to improperly mounted fence rails, fence hardware, or gate hardware.
- D. The gap at the bottom of the fence should be as small as possible to prevent prying. The fence bottom rail should be a maximum of 3 inches from the concrete/asphalt. The fence fabric SHALL extend below the bottom rail so that the maximum gap between the fabric and the concrete/asphalt is 2 inch.

3.2 EXCAVATION

- A. Postholes shall be cleared of loose material. Waste material shall be spread as directed by the Owner Representative. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a minimum clearance between the bottom rail and finish grade, asphalt, or concrete curb. For over excavated area, fill area with concrete or asphalt with strength similar to the concrete post.

3.3 POST INSTALLATION

- A. Post installation and footing as indicated on Drawings.
 - 1. Concrete and grout shall be thoroughly consolidated around each post, shall be

free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts.

2. Line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set.
3. Fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground; post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.4 RAILS

- A. Top and bottom rails shall be installed as indicated on Drawings. Field verify all horizontal and vertical angles and custom fabricate brackets as needed. Submit to Owner Representative for review.

3.5 CHAIN LINK PRIVACY SLATS

- A. Chain link privacy slats shall be installed based on manufactures recommendation.

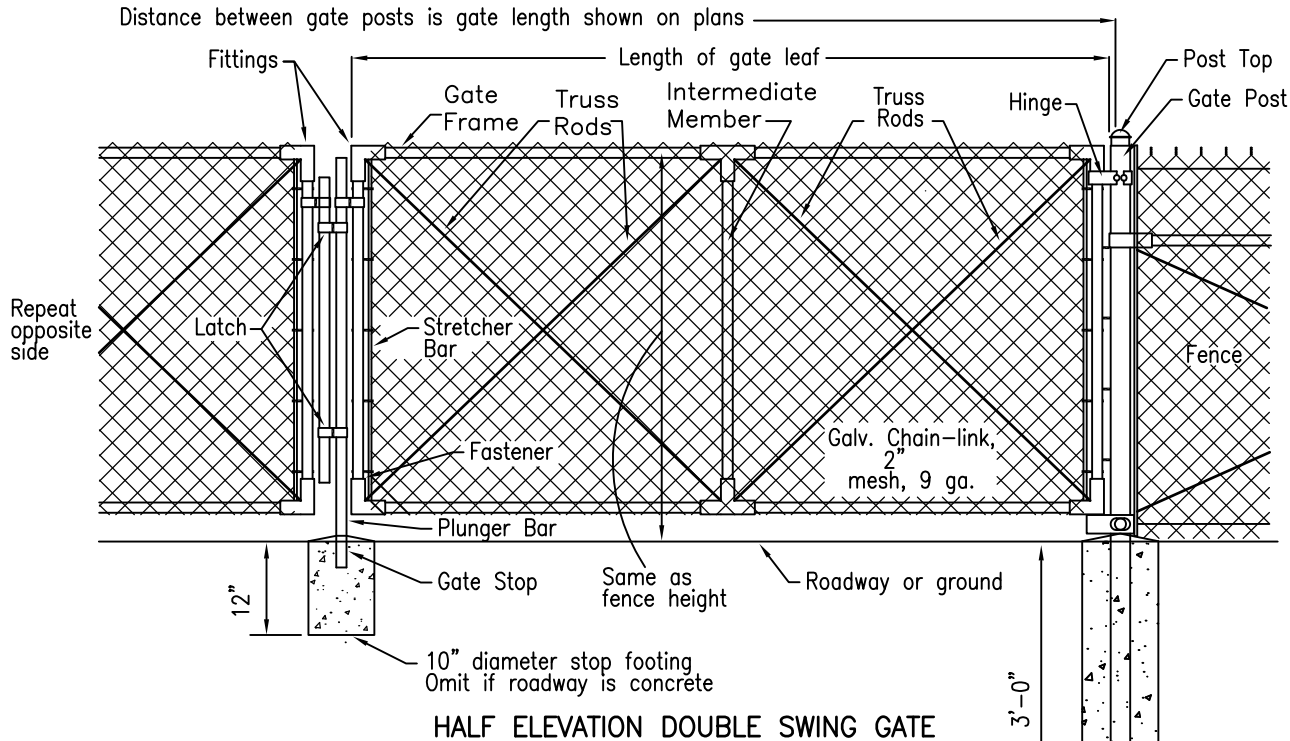
3.6 GATE INSTALLATION

- A. Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal. Gates shall be constructed in such a manner as to prevent the ability of a person from climbing over the secured site of an unopened gate.

3.7 GROUNDING

- A. Pedestrian gates at fences shall be grounded as shown on the Drawings. See Electrical Drawings.

****END OF SECTION****

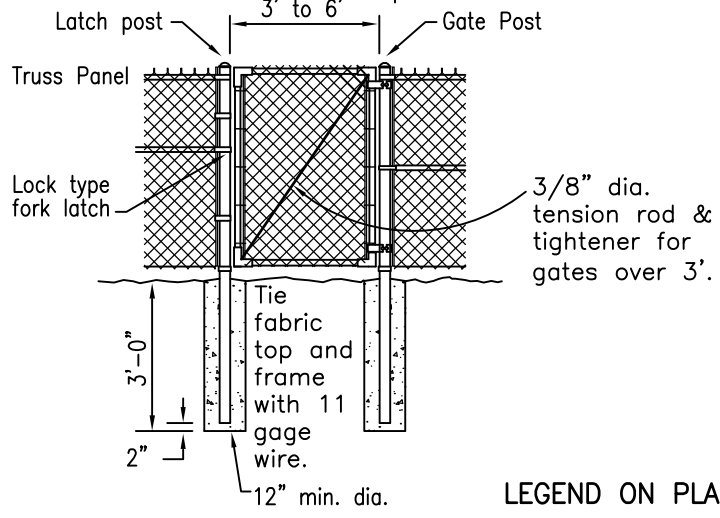
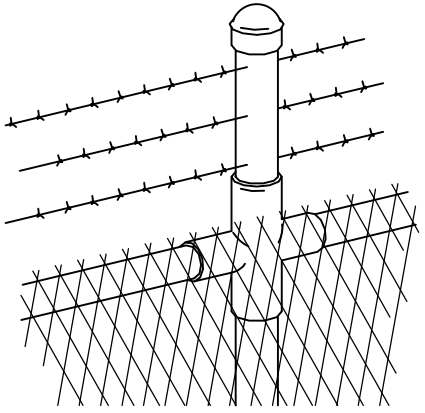


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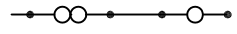
1. All footings shall be 520-C-2500 concrete.
2. The following items shall be furnished and installed only when shown on the plans and/or called for in the special provisions:
 - a. Barbed wire
 - b. Extension post
3. Chain link fence shall conform to Section 206-6 of the Standard Specification for Public Works Construction unless specifically noted on this drawing.

Diameter of footing = 4 times outside diameter of post.

Clear opening shown on plans.



LEGEND ON PLANS



Revision	By	Approved	Date
ORIGINAL		A.Kercheval	12/75
Delete	Metric	D. Gerschoffer	05/12
Reviewed		D. Gerschoffer	12/15
Reviewed		D. Gerschoffer	10/18

SAN DIEGO REGIONAL STANDARD DRAWING

RECOMMENDED BY THE SAN DIEGO REGIONAL STANDARDS COMMITTEE

CHAIN LINK GATE

M. Stanton 10/25/2018
Chairperson R.C.E. 19246 Date

DRAWING NUMBER **M-05**

SECTION 13321

FIBER OPTIC CABLING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work of this Section includes providing a fiber optic communications infrastructure including, but not limited to, fiber optic cable (FOC), patch panels, terminations, testing, and implementation.
- B. The Work includes testing individual fiber cables installed under this Contract and testing a completed fiber optic communications network.

1.02 RELATED WORK

- A. Delivery, Storage and Handling in Section 01600.
- B. Process Instrumentation and Control System in Section 13300 "IC - General Provisions."

1.03 SUBMITTALS

- A. Submit following to the Engineer, in accordance with Sections 01300 and 01730:
 - 1. Catalog Data: Catalog data on fiber-optic cable, termination devices, patch panels, breakout enclosures, splice kits, pigtails, and fan-outs where applicable. Product data sheets shall include the manufacturer's name and catalog number for each item, the manufacturer's descriptive literature, catalog cuts, and any power supply requirements.
 - 2. Certification of compliance in writing stating the fiber optic cable, anticipated layout, and components are compatible, acceptable for use, and in compliance with these specifications.
 - 3. Detailed bill of materials for fiber-optic cable, terminations, patch panels, breakout enclosures, splice kits, connectors, pigtails, and fan-outs.
 - 4. Drawings indicating the locations of all patch panels, termination points, or breakout enclosures.
 - 5. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.
- B. Provide four samples of each type of cable, splice, and connector termination kit. Four samples of a completed example of each type of splice and connector termination shall be submitted.
- C. The Fiber Optic System Supplier shall provide a fiber optic power budget for each cable run in excess of 1000 feet. The budget shall include transmitter power, receiver sensitivity, connector losses, cable losses, and a 3db-aging margin. Fiber optic transmission line shall maintain a minimum of 10db safety margin.
- D. Training plan and schedule for fiber optic cable termination training.
- E. Test reports.

- F. O&M manuals.

1.04 REFERENCE STANDARDS

- A. The optical fiber cable shall conform to the latest issue of the following standards documents, which are incorporated by reference into this Section:
 - 1. EIA-455: Standard Fiber Optic Test Procedures (FOTPs) Devices.
 - 2. EIA-598-A: Standard Colors for Color Identification and Coding.
 - 3. MIL-202: Test Methods for Electronic and Electrical Component Parts.
 - 4. MIL-454: Standard General Requirements for Electronic Equipment.
 - 5. MIL-810: Environmental Test Methods and Engineering Guidelines.
 - 6. EIA-568-B.3: Commercial Building Telecommunications Cabling Standard: Optical Fiber Cabling Components.
 - 7. ICEA 5-83-696: Fiber Optic Premises Distribution Cable (Indoor/Outdoor).
 - 8. National Electrical Code (NEC) Article 770.
 - 9. UL 1581 VW-1 - Vertical Tray Cable Flame Test.
 - 10. UL 1666 - UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts.
 - 11. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use IN Air-Handling Spaces.
 - 12. IEEE Standard 383 - Flame Retardancy.
 - 13. DOD-STD-1678.
 - 14. National Electrical Manufacturers Association (NEMA).
 - 15. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- B. All fiber optical cables shall be constructed in accordance with EIA-455, and 100 percent of all optical fibers and jacketing shall meet or exceed the requirements contained in this specification.

1.05 QUALITY ASSURANCE

- A. The cable manufacturer shall be ISO9001 certified and registered.
- B. The fiber optic cabling system materials furnished under this Section shall be provided by Fiber Optic Suppliers who have been providing these types of materials for the past three years. The Fiber Optic Suppliers shall provide personnel capable of providing technical assistance during installation.

- C. The installation of fiber optic cabling system materials furnished under this Section shall be performed by an installation Contractor who has been installing these types of materials and systems for the past three years.
- D. Supplier shall furnish five working installation references.
- E. The Engineer shall determine whether a product is an equal based upon the information listed herein and the manufacturer's data sheets regarding the models specified. Alternate equipment shall meet the criteria listed herein and all additional information in the manufacturer's data sheets in order to be accepted as an equal.

1.06 SYSTEM DESCRIPTION

- A. N/A

1.07 DELIVERY, STORAGE AND HANDLING

- A. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
- B. When the length of an order requires a large wooden reel, the cable will be covered with a three-layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.
- C. Test tails shall be at least two meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and fiber.
- D. Wooden reels shall be plainly marked to indicate the direction in which it shall be rolled to prevent loosening of the cable on the reel.
- E. All fiber optic cables shall be attenuated tested. The attenuation of each fiber shall be provided with each cable reel by the manufacturer.
- F. The attenuation shall be measured at 850nm and 1300nm for multimode fiber cables after received on site. The manufacturer shall submit the test results prior to installation of the cable.
- G. Packaging:
 - 1. The completed cable shall be packaged for shipment on non-returnable wooden reels. It is the responsibility of the Contractor to determine all required cable lengths.
 - 2. Top and bottom ends of the cable shall be available for testing.
 - 3. Both ends of the cable shall be sealed to prevent the ingress of moisture.
 - 4. Each reel shall have a weatherproof reel tag attached identifying the reel and cable. The reel tag shall include the following information:
 - a. Cable Number Gross Weight.
 - b. Shipped Cable Length in Meters.
 - c. Product Number.

- d. Date Cable was Tested.
 - e. Cable Length Markings Item Number.
- H. Each cable shall be accompanied by a cable data sheet.

1.08 SPARE PARTS AND TEST EQUIPMENT

A. Spare Parts:

1. Provide a minimum five percent spares of LC connectors and dust covers, but not less than 20 spare LC style connectors and 40 dust covers.
2. Provide a minimum five percent spare 36" spare multimode patch cables with connectors (both ends) terminated, but not less than ten 36" spare multimode patch cables with connectors (both ends) terminated.

B. Test Equipment and Tools:

1. One complete fiber optic connector termination tool kit. The kit shall be the CTS version with VFL, Model TKT-UNICAM-CTS by Corning Cable Systems, or equal.
2. Optical power source and test meter shall be a combination type unit in a single handheld device.
 - a. Optical source shall provide stable transmission of plus or minus 0.1dB at 23 degrees C for eight hours with accurate wavelengths. Sources shall be 850/1300nm multimode (LED) and 1310/1550nm (multimode) or combined quad wavelength source. Provide with visual fault locator (VFL).
 - b. Test meter utilizes InGaAs wide area detector calibrated for 850, 1300, 1550, and 1625nm wavelengths. Provide fiber identification by audible detection of 2 kHz tone.
 - c. Provide data storage: Windows-based PC software and cabling for reports, printing, viewing, and export.
 - d. Power source/meter shall include jumpers, sleeves, cleaning kit, and transit case and shall be Corning Cable Systems Express Series Model No. OTS-3MDS-D-KIT, or equal.

PART 2 PRODUCTS

2.01 GENERAL MATERIALS

- A. Cabinets: cabinets shall be provided as indicated on the Contract Drawings.
- B. Provide tight buffered cables that are not gel filled and are suitable for indoor/outdoor applications. These cables shall be flame retardant for indoor applications and water and fungus resistant for outdoor applications.
- C. Optical Fiber Characteristics:
1. All fibers in the cable shall be usable fibers and meet required specifications.
 2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.
 3. Multi-mode: Provide multimode, optical glass fiber compatible with LED or laser based transmission systems with the following fiber types:

D. Manufacturers:

1. Corning Cable Systems Corp.
2. CommScope.
3. Belden Cable.
4. Or equal.

2.02 STANDARD 50/125 μM FIBER

A. The multimode fiber utilized in the optical fiber cable shall meet EIA/TIA-492AAAB, "Detail Specification for 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers".

1. Geometry:

Core Diameter (μm)	50.0 ± 3.0
Core Non-Circularity	≤ 5 %
Cladding Diameter (μm)	125.0 ± 2.0
Cladding Non-Circularity	≤ 1.0 %
Core-to-Cladding Concentricity (μm)	≤ 1.5
Coating Diameter (μm)	245 ± 5
Colored Fiber Nominal Diameter (μm)	253 - 259

2. Optical:

Cabled Fiber Attenuation (dB/km) 850 nm 1300 nm	≤ 3.5 ≤ 1.5
Point discontinuity (dB) 850 nm 1300 nm	≤ 0.2 ≤ 0.2
Cabled Effective Modal Bandwidth ¹⁾ (MHz•km) 850 nm	≥ 510
IEEE 802.3 GbE Distance (m) 1000BASE-SX Window (850 nm) 1000BASE-LX Window (1300 nm)	up to 600 up to 600
OFL Bandwidth (MHz•km) 850 nm 1300 nm	≥ 500 ≥ 500
Numerical Aperture	0.200 ± 0.015

¹⁾As predicted by RML BW, per TIA/EIA 455-204 and IEC 60793-1-41, for intermediate performance laser based systems (up to 1 Gb/s).

2.03

2.03 FIBER OPTIC DISTRIBUTION CABLE

A. Multi-fiber cables utilizing 900 micron tight-buffered fibers surrounded by dielectric strength members and a flame-retardant outer jacket. Cables shall meet the application requirements of the National Electric Code® (NEC®) Article 770 and shall be listed accordingly:

1. Non-Plenum Applications - Applicable Flame Tests: UL 1666. Cables shall be listed OFNR (OFCR)
 2. Plenum Applications - Applicable Flame Test: NFPA 262. Cables shall be listed OFNP (OFCP)
- B. Cable Specifications:
1. Fiber Count: 12 Strand.
 2. Maximum Tensile Load Short-Term: 148 lbf (660 N)
 3. Maximum Tensile Load Long Term: 45 lbf (198 N)
 4. Minimum Crush Resistance: 57 lbf/in (100 N/cm)
 5. Operating Temperature: -20 to +70 degrees C (OFNR, OFCR) 0 to +70 degrees C (OFNP, OFCP)

2.04 FIBER OPTIC INTERCONNECT CABLE

- A. Tight-Buffered fiber surrounded by aramid yarn strength members and flame-retardant jacket.
- B. Cable Specifications:
1. Fiber Count: Single or duplex type as required.
 2. National Electric Code OFNR designation.
 3. Crush Resistance: 20 lbf/in (35 N/cm).
 4. Operating Temperature: -20 to +70 degrees C.
- C. Fiber Specification Parameters:
1. Required Fiber Grade - Maximum Individual Fiber Attenuation.
 2. The fiber manufacturer shall proof-test 100 percent of the optical fiber to a minimum load of 100 kpsi.

2.05 LOOSE TUBE FIBER OPTIC CABLE (INDOOR/OUTDOOR)

- A. Cable shall be flame-retardant, UV stabilized, fully water blocked with dielectric central member for use in indoor/outdoor applications. The buffer tubes shall be gel-free. Each buffer tube shall contain a water-swallowable yarn for water-blocking protection. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes.
- B. Optical fibers shall be placed inside a buffer tube.

- C. Each buffer tube shall contain up to 12 fibers.
- D. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
- E. Buffer tubes shall be kink-resistant within the specified minimum bend radius.
- F. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
- G. The central anti-buckling member shall consist of a glass-reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
- H. The cable core shall contain a water-blocking material. The water-blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. Cable shall contain water-blocking threads between tubes.
- I. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
- J. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns.
- K. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
- L. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene (MDPE). The minimum normal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water-blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

2.06 ARMOR JACKETED MULTI FIBER CABLE

- A. Rugged armored cable with polyethylene inner jacket, steel tape armor and a medium density, water and UV stabilized polyethylene outer jacket, suitable for duct or direct-buried installation. Cable shall be listed with Rural Utilities Service (RUS) 7 CFR 1755.900 and be fully compliant with ICEA S 87 640. Optional Nylon over jacket shall be available for resistance to hydrocarbons, including jet fuel, when required.
- B. Cable Specifications:
 - 1. Fiber Count: as indicated
 - 2. Maximum Tensile Load Short-Term: 600 lbf (2700 N)
 - 3. Maximum Tensile Load Long Term: 200 lbf (890 N)
 - 4. Minimum Crush Resistance: 125 lbf/in (220 N/cm)
 - 5. Operating Temperature: -40 to +70 degrees, C
 - 6. Outside diameter: 1.03 inch (26.1 mm) (maximum)

- C. The jacket or sheath shall be free of holes, splits, and blisters.
- D. The cable jacket shall contain no metal elements and shall be of a consistent thickness.
- E. Cable jackets shall be marked with manufacturer's name, sequential meter or foot markings, the year of manufacture, and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NEC). The actual length of the cable shall be within "one percent of the length markings. The marking shall be in contrasting color with the cable jacket. The height of the marking shall be approximately 2.5 mm.
- F. The maximum pulling tension shall be 2700 N (608 lbf) during installation (short-term) and 600 N (135 lbf) long-term installed.
- G. The shipping, storage, and operating temperature range of the cable shall be minus 40 degrees C to plus 70 degrees C. The installation temperature range of the cable shall be minus 30 degrees C to plus 70 degrees C.
- H. The cable shall be the FREEDM Series as manufactured by Corning Cable Systems, or equal.

2.07 CABLE CONSTRUCTION

A. Riser Cables:

1. Riser cables up to 24 fibers: In cables with more than one fiber, the fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
2. Riser cables with more than 24 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

B. Plenum Cables:

1. Plenum cables up to 24 fibers: The fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
2. Plenum cables with 24 to 72 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

3. Plenum cables with more than 72 fibers: The buffered fibers shall be grouped into twelve fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.
- C. The strength member shall be a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.
- D. Cable Jacket:
1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
 2. The cable and subunit jacket color shall be orange for cables containing multimode fibers.
 3. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. Non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.
 4. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, low smoke, and environmental test requirements of this document over the life of the cable.
- E. The cable shall be all-dielectric.

2.08 CABLE IDENTIFICATION

- A. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered in the unit jacket for identification. The number shall be repeated at regular intervals.
- B. The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The markings shall be in contrasting color to the cable jacket.

2.09 CABLE TESTING REQUIREMENTS

- A. Fiber cables shall be tested in accordance with the following industry standard (EIA-455) tests:
1. FOTP-41, Compressive Loading Resistance Test.
 2. FOTP-104, Fiber Optic Cable Cyclic Flexing Test.

3. FOTP-25, Repeated Impact Testing.
 4. FOTP-33, Fiber Optic Cable Tensile Loading and Bending Test.
 5. FOTP-85, Fiber Optic Cable Twist Test.
 6. FOTP-181, Lightning Damage Susceptibility Test.
 7. FOTP-3, Procedure to Measure Temperature Cycling Effects on Optical Fibers, Cables, and other Passive Fiber Optic Components.
 8. FOTP-82, Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable.
 9. FOTP-37, Low or High Temperature Bend Test for Fiber Optic Cable.
 10. FOTP-98, External Freezing Test.
 11. FOTP-27, Fiber Diameter Measurements.
 12. FOTP-28, Measurement of Dynamic Tensile Strength.
 13. FOTP-34, Interconnection Device Insertion Loss Test.
 14. FOTP-89, Cable Jacket Elongation and Tensile Strength Test.
- B. Submit laboratory test reports on representative samples of similar cable design to demonstrate compliance prior to cable installation.

2.10 FIBER CABLE TERMINATIONS, CONNECTORS, AND CABLE ASSEMBLIES

- A. Pigtail Splicing:
1. For termination of fiber cables at a termination or connector panel (patch panel), with one end of a piece of cable pre-connected and the other end unterminated for splicing to the cable that needs to be terminated. Splicing and connectors shall meet the requirements listed in this Section.
 2. A splice/termination tray shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure. Splice tray shall be compatible with the selected patch panel and installed for easy access to the spliced cable sections.
 3. Pigtail assemblies shall match fiber cable type and model and shall be as manufactured by Corning Cable Systems or equal.
- B. Buffer Tube Fan-Out Kits:
1. Individual fibers within a loose tube cable with 250 μ m coated fibers shall use a fan-out kit to maintain flexibility and ease of handling fibers within a termination cabinet. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices.

2. The tight-buffered pigtails shall be factory pre-connected with STTM connectors as specified.
- C. Connectors (Cable Assemblies):
1. The fiber optic communications system shall utilize connector type LC, which is complying with TIA-604-10-B. The connectors shall be designed for use with 50/62.5/125/250 micron cable. Each connector shall cause a maximum signal attenuation of 0,75 dB.
 2. Field-Installed Connectors: Type LC design with ceramic or polymer ferrule and strain relief boot. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 µm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall contain a mechanical splice and have a tool kit available to aid in assembly. The installation tools used to terminate the connector shall be able to terminate other small-form-factor and single-fiber UniCam connector designs. The connector shall not require end-face polishing in the field. The connector shall have a factory polished optical fiber stub in the connector ferrule that is bonded in the ferrule micro hole. Ferrule material shall be available in ceramic or polymer. Connector specifications shall be as follows:
 - a. Insertion loss (typical): 0.3 dB.
 - b. Durability (mating cycles): 500 (minimum).
 - c. Repeatability: Less than 0.2 dB.
 - d. Operating Temperature: 0 to plus 60 degrees C.
 3. After termination with connectors, the fiber ends shall be visually inspected at a magnification of not less than 100 power for multimode to check for cracks or pits in the end face of the fiber.
 4. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; dry interfaces only.
 5. Each connector shall be of the industry standard; designed for multimode tolerances; shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34; and shall be capable of 100 repeated ratings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a Zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials such as nickel-plated zinc, designed to operate in humid environments without degradation of surface finishes. Connectors shall be capable of operating in a range of -40 to 80 degrees C.
 6. Manufacturers:
 - a. Corning Cable Systems, Hickory, NC.
 - b. AMP, Inc., Harrisburg, PA.
 - c. 3M Telecom Systems Group, Austin, TX or equal.
- D. Fiber Optic Patch Cables:
1. Fiber optic patch cable shall be two-fiber zip cord 50/62.5/125 core/clad micron multimode riser rated cable.
 2. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

2.11 FIBER OPTIC TERMINATION PATCH PANELS

A. General:

1. Patch panels shall be suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors, and ground lugs as indicated. Panels shall be NEMA 4X, Type 316 stainless steel construction for outdoors; and NEMA 12, Type 316 stainless steel or fiberglass for indoor use. Patch panels shall be suitable for multimode system operation at 800 and 1300 nanometers. Patch panels shall be suitable for ST or LC connectors. The patch panels shall be sized to handle the number of fibers as required. All fibers shall be terminated in the patch panel.
2. Where shown on the plans or in the related specification sections, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the exposed buffer tube shall be terminated with fan-out kits with pre-connected pigtails. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.
3. Unused buffer tubes shall be uncut and looped within the patch panel for continuous routing of the fiber buffer tube within the cable assembly.
4. Patch panels shall be designed for either rack mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain "ST" type bayonet or LC couplings. All unused couplings shall have protective dust covers. All panels shall be furnished with locking doors.
5. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.
6. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors to prevent damage to fibers and connectors during all regular operation and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be greater than four inches at all times to ensure optical and mechanical integrity of the optical fibers.
7. Termination panels shall be equipped with splice trays (where applicable) and holders for pigtail and through fiber splicing.
8. Termination panels shall be provided with all hardware, options, and accessories to provide for a complete installation of the fiber optic system.
9. Panels shall be as manufactured by Corning Cable Systems LANscape or equal.

B. Rack Mount Fiber Distribution Center (FDC) Splice Housing:

1. A rack-mountable Fiber Distribution Center splice housing shall be provided for pigtail splicing and through fiber splicing equipment.
2. The splice housing shall be compatible with the FDC for interconnection of the splicing equipment with the fiber cable management, termination, and distribution rack equipment.
3. Splice trays shall be provided for pigtail splicing.

4. The splice housing shall be sized and equipped with sufficient capacity to terminate and feed through all required fiber cable, plus an additional 20 percent.
 5. Provide one spare splice tray.
 6. Splice housing shall be Corning Cable Systems LANscape CSH series.
- C. Rack Mount Fiber Distribution Center (FDC):
1. The Fiber/Network equipment rack shall be supplied with two rack-mountable Fiber Distribution Centers (FDCs) capable of 48 ST fiber termination points each. The connector center shall be 19" rack-mountable and provide for internal fan-out, splicing, and connection of the fiber optic cable to front panel ST connection patch panel.
 2. The FDC shall provide backbone and intermediate connects and cable strain relief for a maximum of five fiber cable systems. The front shall be swing open construction with keyed latch mechanism.
 3. The FDC shall be compatible for interconnection with the FDC Splice Housing and provide space and support the addition of fiber cable splice trays for future cable connection and termination.
 4. The Fiber Connection Center shall be Corning Cable Systems LANscape CCH series.
- D. Wall/Panel Mount Fiber Distribution Center (WDC):
1. The field-mounted fiber termination enclosures shall be supplied with a Wall Mount Fiber Distribution Center (WDC) capable of 48 ST fiber termination points. The distribution center shall be panel-mounted and provide for internal fan-out, splicing, and connection of the fiber optic cable to the patch panel assemblies.
 2. Splice trays shall be provided for pigtail splicing. The WDC shall be provided with pass-thru splice trays for continuation of the fiber cable system to additional sites.
 3. Provide one spare splice tray.
 4. The WDC shall provide space and support the addition of future fiber cable splice trays.
 5. The Wall Mount Fiber Distribution Center shall be Corning Cable Systems LANscape (WCH) series.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide all material, equipment, and labor to test and integrate the fiber optic system as indicated and as specified.
- B. Installation shall comply with EIA/TIA Standards 568 and 569.
- C. Fiber optic cables shall be continuous from component to component. Intermediate fiber splices shall not be allowed.

- D. Provide delivery, storage and handling of materials and equipment in accordance with Section 01600.

3.02 IDENTIFICATION

- A. Label each termination point.
- B. Label each cable, buffer tube, and fiber with permanent waterproof typewritten tags.

3.03 PHYSICAL CHECKOUT

- A. General Procedures:
 - 1. Conduct physical checkout of the fiber optic data highway network.
 - 2. Physical checkout shall be performed prior to functional testing.
- B. Check Procedures:
 - 1. Verify that fiber optic cable reels have been off-loaded from truck carefully and not damaged.
 - 2. Submit to the Engineer all test data provided by the fiber manufacturer.
 - 3. Verify that the optical fibers of the cable assembly are the type and quantity as specified and as recommended by the Instrumentation System Supplier.
 - 4. Verify that cable construction is the type specified.
 - 5. Verify that fiber optic patch panels have been installed plumb and level at locations indicated.
 - 6. Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer's recommendations.

3.04 FIBER OPTIC CABLE TESTING

- A. General: The Contractor shall perform pre-installation and post-installation FOC tests. The Engineer shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to NIST standards.
- B. Test equipment: The Contractor shall use the following to perform pre-installation and post-installation FOC tests:
 - 1. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision, and be able to test multimode systems with a visual fault locator. The OTDR shall be as manufactured by Corning, Agilent Technologies, Fluke Networks, or equal.
- C. Pre-installation Tests:
 - 1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications; is free of defects, breaks, and damages by transportation and manufacturing processes; and to provide baseline readings in dB.

2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the Contractor using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.
 3. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the Contractor and manufacturer. In all cases, all fibers shall meet the optical attenuation specifications prior to cable installation.
 4. Perform tests on all reels of cable. The Engineer shall be notified a minimum of 15 days prior to any test.
 5. Document each test and submit the report to the Engineer for review. Documentation shall consist of both hard copy and 3.5 inch electronic disk complete with all application software.
 6. Cable shall not be installed until the Engineer has reviewed the test report.
- D. Post-installation tests: After FOC has been installed and connected, the following tests shall be performed:
1. Visually inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 200X (minimum) inspection microscope.
 2. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.
 3. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.
 4. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.
 5. Hard and electronic copies of test documentation shall be submitted to the Engineer. The documentation shall include:
 - a. The trace plot.
 - b. Index.
 - c. dB/km loss.
 - d. Cable length.
 - e. Date and time of test.
 - f. Wavelength.
 - g. Pulse width.
 - h. The test site.
 - i. Cable ID.
 - j. Fiber number and type.
 - k. Operator's initials.
 - l. Compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the Engineer shall be notified in writing by the

Contractor, and the cable shall be removed and replaced at no additional cost to the Owner.

6. Upon completion of the previous tests, all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.
- E. Certification of completion of pre- and post-fiber installation testing including test results shall be provided to the Engineer. Test results shall be submitted on paper in a binder, including results indicated in tables or a spreadsheet. Test results that exceed specification limits shall be noted. The electronic copy shall be included in the binder.
- F. Required OTDR Trace Information:
1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km), as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace, away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.
 2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the five-point splice loss measurement technique.
 3. The OTDR trace shall also include the following information:
 - a. The date and time of the test.
 - b. The cable ID number.
 - c. The cable segment ID number.
 - d. The fiber color or sub-cable number.
 - e. Launch point connector number.
 - f. The optical wavelength used for the test.
 - g. The refractive index setting of the OTDR.
 - h. The pulse width setting of the OTDR.
 - i. The averaging interval of the test.

3.05 TRAINING

- A. Provide one half-day training on termination techniques and testing for up to three students prior to installation.
- B. Provide training as soon as possible following submittal of proposed fiber optic cable.

3.06 WARRANTY

- A. Refer to Section 13300.
- B. Provide an unconditional warranty on all installed cable for a minimum period of 20 years, commencing at the time of final acceptance by the Owner.

- C. This Section describes the material and installation requirement for the fiber optic cabling system and associated equipment.

END OF SECTION

SECTION 17000: INSTRUMENTATION, CONTROL & MONITORING REQUIREMENTS

PART 1 - GENERAL

1.01 WORK REQUIREMENTS

- A. Instrumentation work shall be provided as indicated, specified and required. The intent of this section is to require that the complete instrumentation, control and monitoring system, including all parts of this section, i.e., primary elements, panel mounted and miscellaneous field instruments, etc. shall be furnished by a single ICM system supplier to assure system uniformity, subsystem compatibility and coordination of all system interfaces. Deviations shall be considered in special circumstances but must be approved by the Owner.
- B. Furnish all equipment, materials, supplies and special tools required for proper installation of the ICM system. Provide all supervision and coordination required by the electrical contractor to ensure conduit runs, signal and power wiring is consistent with the requirements of all equipment as specified in this section. Perform all operational testing of individual systems and the complete start-up of the system as indicated on the Drawings and as specified herein.
- C. Provide all the necessary equipment components and interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, start-up, operation and instruction, to ensure that the Owner receives a completely integrated and operational ICM as herein specified.
- D. The ICM supplier shall provide, install and program the PLC and OIT to operate the facility as stated in Section 17100, General Operations.
- E. The ICM supplier shall provide a written plan to verify that each control/instrumentation component is fully functional and provides the appropriate input to the PLC as stated on the Drawings and is capable of providing the interface with the future City-installed fiber optic system.
- ~~F. Programming shall be provided a District selected vendor, with no equal. The fee for programming services is pre-negotiated as listed in the Bid Schedule.~~

1.02 RELATED WORK NOT INCLUDED IN THIS SECTION

- A. Process piping, installation of in-line instrumentation, i.e., primary elements, items in process pipelines, air compressors, main air supply headers and miscellaneous mechanical work, shall be as specified in other sections, if required.
- B. Electrical power distribution, all conduit, and wire for power and signal distribution shall be provided by the electrical contractor as specified in Division 16. Any special cable required between sensors and transmitters will be provided by the ICM system supplier. All other required wire and conduit will be provided by the electrical contractor. Special cable will be installed by the electrical contractor.

1.03 SYSTEM RESPONSIBILITY

- A. The Contractor's attention is directed to the fact that the ICM system as specified in this section is an integrated system and, therefore, shall be provided by a single competent, qualified instrumentation system supplier (hereinafter in this section referred to as the ICM system supplier), who shall have total responsibility for the work of this section. Entire system including calibration, validation, start-up, operation testing and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar work. The ICM system shall be integrated using the subcontractor's latest, most modern proven design and shall, as far as practical, be of one manufacturer. Overall system performance shall be guaranteed by the specified ICM system supplier.
- B. The Contractor shall select the system supplier to perform the work under this section. The qualified ICM system supplier shall perform said work but it shall be understood that this shall not relieve the Contractor from any responsibility under the Contract. Although many references made herein are to work requirements and responsibilities of the ICM system supplier, such references shall only mean that responsibility shall pass through the ICM system supplier but in the final analysis shall rest with the Contractor.
- C. The ICM system supplier shall be responsible for the correct installation for all hardware and systems specified in this section. Certain primary elements, final control elements, etc., although provided as a part of this section, shall be installed in the process lines under other sections of these Specifications; however, this installation shall be under the *direct supervision* of the ICM contractor.
- D. The ICM system supplier shall be responsible to see that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling and alarming devices and all appurtenances, are completely compatible and shall function as outlined, and he shall furnish such additional equipment, accessories, etc. as are necessary to meet these objectives at no additional cost.

1.04 ICM SYSTEM SUPPLIER

The complete control system shall be furnished by a single supplier who shall assume responsibility for the satisfactory performance of the complete system. The ICM supplier shall provide the following minimum criteria:

- A. Demonstrate the company's ability to successfully complete projects of similar size and nature. Provide references (including contact name and telephone number) for at least three projects where the following tasks were performed by personnel directly employed by your firm as a system supplier, system engineering and documentation including panel assembly, schematics, and wiring diagrams, software configuration and documentation; field testing, calibration and start-up, and operating instructions and maintenance training.
- B. Name the individual persons who will be responsible for office engineering and project management, software configuration, field testing, calibration and start-

up, and operator instruction and maintenance training. References called for in the previous item shall include recent projects of these individual persons.

- C. Document that the company is actively in the business of furnishing integrated instrumentation, telemetry, control and electrical equipment for the water and wastewater industries.
- D. Have a qualified service facility with permanent employees located within 100 miles of the job site. Facility to include all tools, spare parts and test equipment to repair, calibrate, test and start-up the equipment to be provided on this Contract.
- E. Pre-approved ICM system suppliers are listed below.

1. Tak Koo
Telstar Instruments, Inc.
4017 Vista Pat Court
Sacramento, CA 95834
(906) 646-1999
tkoo@Telstarinc.com

2. Bruce Borders
Control Systems West, Inc.
1150 Industrial Ave. Suite F
Petaluma, CA 94952
(707) 763-1108
bruce.borders@controlwest.com

4.3. Jerry Horst
TESCO Controls, Inc.
8440 Florin Road
Sacramento, Ca. 95829-9007
(916) 799-0182
jhorst@tescocontrols.com

2.4. Tom Visosky, P.E.
CDM Smith
600 Wilshire Boulevard, Suite 750
Los Angeles, CA 90017
(213) 457-2133
visoskyta@cdmsmith.com

3.5. Dave Stone
Control Technologies
5726 Corporate Avenue
Cypress, CA 90630
(714) 527-3500
dauids@control-technologies.com

4-6. Norman S. Iseri, P.E.
RKI Engineering LLC
2029 Verdugo Blvd #109
Montrose, CA 91020
(818) 317-3003
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1.05 CERTIFICATION BY SYSTEM SUPPLIER

At the time of quoting to the Contractor prior to bid opening, the prospective system supplier shall execute and submit a written certification of intent to assume full responsibility for the complete requirements of the Contract Documents. A signed copy thereof shall be supplied to each prospective contractor for inclusion by him with his bidding documents. Failure by a bidding system supplier to provide this written certification shall be treated by the Contractor as *NO BID* and that system supplier will not be acceptable. The Contractor shall include with his proposal the certification, required above, only for the system supplier for whom he has inserted a price in the bidding documents. The certification shall be on the named system supplier's letterhead, it shall be signed by his authorized responsible representative, and it shall include the following statements:

- A. (Corporate name of system supplier) hereby certifies intent to assume and execute full responsibility to select, furnish, supervise installation and connection, test and calibrate, place into operation all specified instrumentation, equipment and all assemblies, components, and accessories needed to place into service complete operating instrumentation and control system all in full compliance with the requirements of the contract documents.
- B. In addition, it is certified that drawings and data will be prepared and submitted, specified field services will be performed by qualified personnel, the Owner's operating and maintenance personnel will be instructed, and technical manuals will be prepared and submitted.
- C. Finally, it is certified that the quotation offered provides for full and complete compliance with the requirements of the Contract Documents without exception.

1.06 QUALITY ASSURANCE

A. Qualification and Product

The ICM system supplier shall, in fact, be a recognized supplier of primary elements, panel and field instruments, panels, etc., of the general type specified herein and shall have been regularly engaged in providing this equipment on a single system responsibility basis for municipal water and wastewater treatment processes. Also, the personnel employed for system engineering, supervision, start-up, operational testing and training shall be regularly employed and factory trained by the ICM system supplier. Actual installation may or may not be performed by the ICM system supplier employees, but the ICM system supplier shall be responsible for the technical supervision of the installation to ensure that it is proper in all respects.

B. Standard of Quality

1. The ICM supplier shall furnish equipment of the types and sizes specified which has been demonstrated to operate successfully. Wherever on the drawings and in these Specifications, materials or equipment have been specified by using the name of products or manufacturers, no substitutes will be allowed. Material or equipment, so specified, has been selected as being most suitable. The order of listed manufacturers shall not be construed as a preference or order of quality. Where the manufacturers listed are followed by "or equal," the burden of proof of equivalency in quality and performance shall rest with the ICM system supplier and shall require the Owner's written approval. The procedure for submission of products for approval as equivalent shall be as specified under submittals below.
2. All electrical equipment and materials, including their installation, shall conform to Division 16, unless specified otherwise in this section.

C. Factory Inspection

1. The Owner may inspect fabricated equipment at the factory. Notify the Owner in sufficient time so that factory inspection can be arranged. Factory inspection shall be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations. Approval of equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Owner.
2. The Owner shall indicate on return of the approval submittal each item requiring factory inspection. Lack of such indication by the Owner shall constitute a waiver of factory inspection.

D. Coordination with Electrical

Conduits and wire for instrumentation are supplied under Division 16. Prior to installation of any instrumentation conduit, verify conduit size and conduit runs with the electrical supplier. Notify the Owner of any conflicts or deviations prior to installation.

E. Drawings

1. Information on the Drawings
The following information relative to the work of this section is indicated on the Drawings.
 - a. Location of all primary elements, control panels and final control elements.
 - b. Location of instrumentation power junction boxes for instrument electrical power connection.

- c. Location of all equipment having alarm and equipment status contacts.
- d. General control system and control panel layouts.

2. Information Not Shown on the Drawings

The following information relative to the work of the section may differ from the Drawings, but shall be the responsibility of the ICM system supplier to determine, furnish and coordinate with the applicable other sections, based on the system specified.

- a. Coordinate with electrical the actual number and size of conduit runs and tubing for power between instrument power junction boxes, signal conduit stub-outs, main headers and control panels, field mounted primary elements, field instruments and final control elements.
- b. Number or sizes of conductors or tubing required for all electric, pneumatic and hydraulic signals.
- c. Point of connection to any hydraulic or pneumatic supply lines.
- d. Detailed control panel layouts.

1.07 SUBMITTALS

A. Refer to Section 01000 for required method of preparation and transmittal, and conform to requirements herein.

B. Presubmittal Conference

- 1. A conference shall be arranged between the ICM system supplier and the Owner or his representative within 60 days after award of the contract for the purpose of informally discussing in detail and verifying the correctness of the ICM system supplier system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by ICM system suppliers, the Engineer and duly authorized representatives of the Contractor and Owner.
- 2. A draft of the submittal for review shall be prepared. The draft shall include the following, as a minimum:

Listing of major items proposed for this section. Identify item tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed.

C. Shop Drawings

1. Before proceeding with any manufacturing, submit shop drawings for review in complete bound sets indexed by specification number. Describe the items being submitted. The manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with tag numbers. Submit fabrication, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing all equipment and tag numbers on all panels. Include space for the City-installed fiber patch panel and Vilink unit. Include material specifications lists where applicable.
2. An "Equipment Specification Data" form shall be submitted for each item of equipment that shall summarize the specification features as called for in these Specifications and include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date.
3. The assigned tag numbers and manufacturer's part numbers shall be included but will not be considered as a substitute for any of the required statement of specifications. More than one tag numbered item may be included on a sheet.

D. Software Documentation Summary

The submittal phase shall also include with the shop drawings as specified in this section, software documentation for the PLC and the proposed screen displays for the operator interface unit. The software documentation shall provide a narrative description of PLC functions including setpoints, adjustable ranges available, control sequences, I/O, and general operation summary. The screen displays shall allow full operator observation of all PLC inputs/outputs as well as the capability of setting local automatic set-points and PLC programming. The portable station programmer shall be utilized for station start-up and it shall also include software documentation.

E. Record Drawings

1. Process and Instrumentation Diagrams
"Record" process and instrumentation diagrams shall be prepared and submitted for all work included in this section.
2. Record Drawings
Without limiting the generality of other requirements of these Specifications, arrange for the submittal, by the subcontractor, of a reproducible Mylar of complete schematics and wiring diagrams or drawings to include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, point to point

diagrams with a cable, wire, tube and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "Record."

F. Instruction Manuals

The ICM supplier shall furnish 10 sets of instruction manuals and parts lists for instrumentation equipment provided under this section. Obtain data from the manufacturers, and format and bind as specified. Obtain distribution method instructions from the Owner or his representative.

1. Schedule

Copies of manuals shall be delivered no later than the equipment shipment date.

2. Contents

Manuals shall include not less than the following final version of information, as applicable, for each instrument, equipment, subsystem and/or control loop.

- a. General, introduction and overall description, purpose, functions, simplified theory of operations, etc.
- b. Specifications (including equipment specification data sheet as described above under shop drawings).
- c. Installation instructions, procedures, sequences, tolerances and precautions.
- d. Operational procedures.
- e. Shut-down procedures.
- f. Maintenance, calibration and repair instructions.
- g. Parts list and spare parts recommendations.
- h. Register bit assignments (Excel format).

G. Format

Drawings and pictorials shall be used to illustrate the text to the extent necessary to ensure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasize applicable portion by heavily weighted arrows, circles or boxes; whichever provides the clearest and neatest presentation.

Manuals shall be grouped by system control panels, including field instrumentation connected or associated with the panel. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, per panel grouping; however, an index by tag number for all instruments shall identify its location in that manual.

Control loop and/or subsystem operational descriptions shall identify the function of each instrument and its reaction to the other instruments in the loop.

H. Binding

Each manual shall be bound in a cover that indicates the panel or process area to which it applies, the manufacturer's name, local address and telephone number, and year of purchase. Punch and bind manuals in standard three-ring binders and include the system name and subcontractor's name on the binding.

I. Accessory and Maintenance Materials

The following items shall be furnished as specified herein and delivered to the Owner, as directed, with an itemized list in a letter of transmittal accompanying each shipment.

1. Special Tools and Accessories

Special tools, instruments and accessories for maintaining instruments and equipment requiring periodic repair and adjustment shall be furnished as specified elsewhere herein. Also, special lifting and handling devices for equipment requiring such devices shall be furnished.

2. Maintenance Materials and Spare Parts

The spare parts and maintenance materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.

Spare parts shall consist of the following basic items:

- a. One minimum of each type of plug-in, etched or printed circuit board assembly. Provide 5 percent spares for boards in multiple use.
- b. Two of each type switch used.
- c. Ten percent but not less than six of each type light bulb and fuse used.

J. ICM System Supplier Certified Reports

The ICM system supplier shall submit a written report for each control panel and associated field instruments certifying that (1) the equipment had been properly coordinated and installed under his supervision, (2) the equipment is in accurate calibration, (3) he was present when the equipment was placed in operation, (4) he has checked, inspected, calibrated and adjusted the equipment as necessary, (5) equipment has been operated under maximum power variation conditions and operated satisfactorily, and (6) the control panel and associated field instruments are fully covered under the terms of the guarantee.

K. Demonstration and Final Operation Test Plans and Results

The ICM supplier shall submit for approval the following:

1. A written plan for demonstrating that each system of equipment provided under this section meets the specified operational requirements.

The written plan shall include a checklist based upon the PLC I/O, OIT, hardwired connection diagrams and field instrumentation components. Each item identified on the checklist shall be signed by the Contractor's system integrator and the Owner's Representative. This checklist shall be submitted to the Owner for approval prior to scheduling the control/instrumentation verification.

Control/instrumentation verification shall be conducted in the presence of the Owner's Representative and other personnel as designated by the Owner.

In general, the control/instrumentation verification procedure shall consist of the following:

- The Contractor to demonstrate that wiring is installed between each instrumentation/control component and the PLC per the plans.
- The Contractor to demonstrate that each PLC I/O is installed per the plans.
- The Contractor shall demonstrate that each I/O point provides the functionality and as required in the contract documents.
- The Contractor shall demonstrate that instrumentation is calibrated at 0 percent, 25 percent, 50 percent, 75 percent and 100 percent of span per the Specifications.
- The Contractor shall demonstrate that hardwired control/instrumentation is installed and operates per the plans and Specifications.
- The Contractor shall demonstrate that the communication link between the PLC and the operator interface terminal (OIT) is properly installed and functional.

2. A written plan for procedures to be used in final operation testing of entire systems including a description for each system of test methods and materials, testing all instruments, a list of the equipment involved with the functional parameters to be recorded on each item, and shop drawings of required temporary by-passes and like facilities.

3. Submit three copies of test results and records for all final operation tests including equipment calibration dates.

L. Screen Displays

The operator interface panel shall display, as a minimum, the following screens:

1. Station alarms.
2. Station graphic showing well pump status, and check and drain valve status. Pump shall be able to be started and stopped from this screen, independent from SCADA control.

1.08 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The ICM system supplier shall box, crate or otherwise enclose and protect instruments and equipment during shipment, handling and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element that could degrade the equipment.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

1.09 JOB CONDITIONS

- A. Drawings are diagrammatic and show the intended arrangement for system operation, piping and appurtenances. Drawings shall be conformed to as closely as possible and care shall be exercised (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to overcome structural interferences. Dimensions and conditions at the place of work shall be verified so that all materials and equipment can be installed in the available spaces.

1.10 GUARANTEE AND WARRANTIES

- A. All work of this section shall be guaranteed in accordance with Section 01000 and Section 16000. With respect to instruments and equipment, guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) leakage, breakage or other failure not caused by Owner misuse. For equipment bearing a manufacturer's warranty in excess of 1 year, a copy of the warranty shall be furnished to the Owner with the Owner named as beneficiary.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and Standard Specifications

Instruments, equipment and materials shall be suitable for service conditions and meeting standard specifications such as ANI, ASTI, IA and SAGA. The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the plant; i.e., all instruments in the plant, supplied by the ICM system supplier, of the same type shall be by the same manufacturer. This allows the stocking of the minimum number of spare parts.

B. Structural Steel Fabrications

All fabrications shall be designed for dynamic and vibratory loadings. Structural steel shapes shall conform to ASTI A36, A440, A500, A501, A570, A618 or equal, as applicable. Welding shall conform to AWS D2.0 Code. Specific items shall be galvanized in accordance with ASTI A123 or A336 as applicable; use galvanized bolts and fasteners with galvanized assemblies. Minimum 1/4-inch thickness steel shall be used for entirely or partially submerged during equipment operation. Design calculations shall be submitted and show adequate structural integrity for the intended purpose.

C. Mountings

Equipment shall be mounted and installed as indicated. Where not shown, field instruments shall be mounted according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with the supplier's recommendation. Where mounted in control panels, mounting shall conform to requirements of that section.

Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting and non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than 3 feet nor higher than 5 feet above walkways, platforms, catwalks, etc. All such equipment shall be weather and splash proof, and electrical equipment shall be in NEMA 4 cases. If mounted in a designated hazardous area, the equipment shall be explosion proof or rated intrinsically safe, whether so specified herein or not. Antenna cables shall enter cabinet from side or bottom to minimize water intrusion damage.

D. Instrument Identification

All major instrumentation and equipment items or systems specified in this section are identified by system and tag numbers. This same number appears in the tag number designations on the drawings and on the schedules of these Specifications. All instrumentation and equipment shall be identified by nameplates or tags. Nameplates for panels and panel mounted equipment shall be as specified in the section for panels and control room hardware. Field equipment shall be tagged with assigned instrumentation tag number. Tags shall be laminated plastic and shall be positioned and lined up to provide a neat appearance. They shall be attached to the cleaned metal surfaces with Type 316 stainless steel screws. For field panel or large equipment cases, use stainless steel screws; however, such permanent attachment shall not be on an ordinarily replaceable part. In all cases the tag shall be plainly visible to a standing observer. In addition to tags, field mounted control stations shall have a nameplate indicating their function and the variable controlled. The nameplate shall be attached by one of the above methods.

E. Electronic Equipment

If the equipment is electronic in nature, provide solid-state equipment to the extent practicable. Select components of construction for their suitability and reliability. Employ adequate components de-rating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Design units or operation without forced cooling, unless such cooling is an integral part of the device.

F. Equipment Operating Conditions

All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

1. Electrical

120 volts AC ± 10 percent, 60 Hz ± 1 -Hz single-phase, except where specifically stated otherwise on the Drawings or in the Specifications.

2. Air
20 psig, ± 1 psig.
3. Field Instruments
 - a. Outdoor Areas
Ambient Temperature: 15°F to 120°F
Ambient Relative Humidity: 5 percent to 100 percent
Weather: Rain, sleet, snow and ice
Provide, as necessary, enclosures, sunshields, thermostatically controlled heaters, etc., to assure normal operations under these conditions.
 - b. Indoor Unheated Areas
Ambient Temperature: 35°F to 120°F
Ambient Relative Humidity: 5 percent to 100 percent
 - c. Indoor Environmentally Controlled Areas
40° to 90°F

G. Power Supplies

Electrical instruments and control devices shall be provided for operation on 120 volts, 60 Hz single-phase current. This requirement is to prevent total loss of control because of the failure of a common DC power supply. This requirement shall be waived upon demonstration to the satisfaction of the Owner that the ICM system supplier shall install dual DC power supplies in each panel with automatic failure detection and annunciation and switch over without loss of control functions. These dual power supplies shall be totally independent with all solid-state rectifiers, regulators, failure sensing, and output switching. Source of operating power shall be 120 volts, 60 Hz single-phase commercial power. Units shall be rack mounted within the control panels.

H. Signal Isolators, Converters and Conditioners

Ensure that input-output signals of all instruments and control devices are compatible. Unless otherwise specified, signals between field and panels shall be 4 to 20 mA DC unless specifically indicated otherwise. Granting such approval does not relieve the ICM system supplier from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application. Provide items as manufactured by AGM Electronics, Action Instruments, or equal.

I. Auxiliary Contacts by Others

Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

J. Air Supply Valves

Provide valves for instrument air supply shut-off, regulating, switching, metering, valve manifolds, etc, equal to valves manufactured by Whitey Company, Nupro Company, Tylok International or equal.

K. Instrument Piping

Provide instrument air and instrument pneumatic piping, as specified in other sections and as necessary and/or as specified herein. Instrument air header shall be furnished and installed under other sections. Connect to main instrument air header at a point not more than 10 feet distant from air consuming device(s). All connections to equipment shall be made with separable or union type fittings and shall include shut-off valves. All hydraulic and/or pneumatic piping shall be tested for leaks prior to placing the system in operation. Provide quality of instrument pneumatic air fittings equal to Swagelok as manufactured by Crawford Fitting Company, Cajon as manufactured by Cajon Company, Tylok International, or equal.

L. Painting

The Contractor shall provide factory paint for all instruments and equipment except where in pipelines. Paint shall be as required in Section 09900 of these Specifications for cabinets, boxes, structural supports, brackets, etc.

M. Electrical

1. The construction work shall include all the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Section 16000.
2. Wiring installations shall include cables, conductors, terminals connectors, wire markers, and all other required materials not specifically included in other sections. For wiring materials, refer to Section 16000 and details on the electrical drawings.
3. Provide the materials and complete all the required installations for equipment grounding as specified in Section 16000 of these Specifications, and indicated on the electrical Drawings.
4. Incidental items, not included in the Contract Documents, that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided by the ICM system supplier.
5. Field Wiring: The Contractor shall use 14-gauge or larger stranded cable for multiple conductors for instrument signal wiring of low voltage service. Shielded conductors shall be provided if necessary for proper performance and operation of equipment. Use insulation rated for intended service. Signal wiring shall be rung out prior to termination. Wire number tags shall be provided and marked in indelible waterproof form of slip-on type or equal for each termination. Pre-insulated crimp-on connectors shall be provided for wire terminations. A ratchet-type

crimping tool shall be used that does not release until proper crimp pressure has been applied. All alarm and status signals shall be 30 volt DC maximum.

N. Process Connections

Instrument impulse piping, tubing and capillary tubing shall be provided to meet the intended process service and ambient environmental condition for corrosion resistance, etc. Lines shall be sloped according to service to promote self-draining or venting back to the process. Connection shall be terminated to process lines or vessels in a service rated block valve, provided under other sections that will permit closing off the impulse line or removal of the element without requiring shut-down of the process. Blow-down of drip legs and valves shall be included for terminations of impulse lines at the instruments. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other sections of these Specifications.

O. Programmable Controller Connections

Relays with isolated contacts shall be provided at the field instruments for outputs from the programmable controller. Refer to the schedules for inputs to the programmable controller.

P. Schedules

Schedules, where required, are attached in the following sections. The schedules shall not be construed as a bill of materials. Refer to the Drawings and Specifications for the scope of work.

2.02 PRIMARY ELEMENTS

A. Quality Assurance

1. Manufacturer

In addition to requirements of this section, instrumentation and control equipment furnished shall be manufactured by a firm regularly and currently engaged in the design and manufacturer of similar equipment. All equipment furnished shall be new and of current design.

2. Maintainability

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

3. Materials and Installation

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

manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

2.03 LIMIT SWITCHES

- A. Limit switches shall be mounted and wired in conjunction with the PLC as shown in the control diagrams and shall be Allen Bradley #802MC-AY5, or equal.

2.04 PANEL MOUNTED AND MISCELLANEOUS INSTRUMENTS

A. Description

Requirements of Section 16000 and other portions of this section form a part of this section. This section specifies the panel mounted and miscellaneous field instruments and equipment to perform the required functions in conjunction with information and equipment specified in other parts of this section.

1. Unit Responsibility

It shall be the responsibility of the qualified single firm as described in this section to ensure that the instruments and equipment furnished under this section are compatible with the equipment furnished under parts of this section and other sections of these Specifications, and that the signal transmission methods are compatible.

2. Control and Performance Terminology

Control and performance terminology used hereinafter in this section shall be defined in SAGA Standard PMC20-2-1970, "Process Measurement and Control Terminology."

3. Cases

Cases of front of panel-mounted instruments shall be of uniform design and color scheme wherever possible. The front of case colors shall be compatible with panel colors subject to final approval by the Owner. Normally, compatible standard colors of the manufacturer shall be acceptable.

B. Manufacturer

In addition to requirements of other portions of this section, instrumentation and control equipment furnished shall be manufactured by a firm regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of the most recent design. Except where stated otherwise, the instruments furnished under this section shall be as manufactured by Rosemount or approved equal. Unless otherwise stated, ancillary equipment shall be as manufactured by the above or Action Instruments, AGM Electronics, or equal.

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

Materials and Installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

2.05 UNINTERRUPTIBLE POWER SYSTEM

- A. An uninterruptible power system shall be supplied to provide a constant AC power source to the PLC. Input voltage shall be 120V plus or minus 10 percent nominal with switch to inverter at 96 VAC. The transfer to commercial (line) power will occur at 101 VAC. Maximum allowable transfer time is 4 milliseconds. Unit shall include current limiting for overload protection. The maximum allowable harmonic distortion is 7 percent. Battery supply shall be sealed lead acid type and the battery charger shall be an integral part of the UPS. The power rating of the UPS shall be rated in volt-amperes (VA) and shall operate at half load for 10 minutes minimum. The UPS shall be capable of communicating with the PLC via an RS 232 communication port. The unit shall be a rack-mount type unit, Eaton Ferrups, or approved equal. The UPS shall be installed in the control panel and the 120 VAC input power shall be wired to the UPS terminals (no power card to receptacle allowed). The power input shall not be connected to a GFI source.

2.06 OPERATOR INTERFACE PANEL

- A. The operator interface shall be flush mounted on the panel front of CP-1. The operator interface shall have a 10.4-inch color TFT screen. The operator interface shall be as manufactured by Allen Bradley, model number 2711P-B10C4D9.

2.07 ETHERNET INTERFACE SWITCH

- A. Provide an Ethernet switch capable of interfacing with the PLC, operator interface terminal, and the existing City SCADA system as shown on the Drawings.
- B. Acceptable manufacturers: Hirschmann, or approved equal.

2.08 PROGRAMMABLE LOGIC CONTROLLER (PLC)

- A. General Characteristics
 - 1. The programmable logic controller hardware shall be provided in a modular version. The modular system shall be expandable up to three chassis that include AC, DC, pulse accumulation and relay contact points on modules that plug into the I/O chassis.
 - 2. The logic controller is a multiplexed system. The PLC system consists of a power supply, inputs, outputs, and a processor that contains the memory. Wiring terminals on the PLC system shall terminate the field wiring from the I/O points.

3. The systems must offer connectivity with the operator interface panel, solid state motor controllers, flow metering system, chemical metering pumps and communication systems, as specified in the Drawings and elsewhere in this section.
4. The small logic controller shall have diagnostic indicators to show the following:
 - a. CPU Ready
 - b. CPU Running
 - c. Battery Low
 - d. Ethernet Active
 - e. Memory Write – Protected
 - f. Modbus Active
 - g. Modbus + Active
 - h. Modbus Error

B. Manufacturer (CompactLogix)

The CPU shall be Allen Bradley CompactLogix 1679-L33ERM, no equal.

C. Specific Characteristics

1. User Logic Memory: 1.5 MB
2. Communication:
 - a. Modbus (RS-232): 2 serial port (9-pin D-shell)
 - b. Ethernet: 10/100 BASE-T
3. Total Number of Racks: 8
4. Type of Memory Storage: RAM, Flash

D. Input/Output (I/O) Characteristics

1. The input circuits shall be available in discreet input, 4-20 mA analog current, and pulse accumulation as shown on the Drawings. The input terminals shall have self-lifting pressure plates to allow for easy wire insertion and secure connections. The terminals shall accept up to two #14 AWG wires. A hinged protective cover shall be provided and have write-on areas for identifications of external circuits. All input circuits shall have optical isolation (1500 volt minimum) and filtering to guard against high voltage transients from the externally connected devices.
2. The output circuits shall be available in 120 VAC relay contacts, and 4-20 mA analog current as shown on the Drawings. The output terminals shall have self-lifting pressure plates to allow for easy wire insertion and secure

connections. The terminals shall accept up to two #14 AWG wires. A hinged protective cover shall be provided and have write-on areas for identifications of external circuits.

3. Status indicators shall be provided for each of the input and output circuits and shall be illuminated when the circuit is energized.
4. Provide I/O cards as follows:
Analog Input: Allen Bradley 1769-IF8
Analog Output: Allen Bradley 1769-OF4
Digital Input: Allen Bradley 1769-IQ16
Digital Output: Allen Bradley 1769-OB16
5. Contractor shall supply additional cards as necessary to provide 20% spare I/O capacity.

E. Special Function Characteristics

1. Program timers shall be available in both on-delay and off-delay with a time base selection of 0.01 seconds, and timer range from 0.01 to 327.67 seconds. Additional time bases and longer timing intervals can also be supported.
2. Counters shall be available in both count up and count down with a range of -32,768 to 32,767.
3. Sequences shall have a minimum capacity of 16 bits by 100 steps and be cascadable, time- or event-driven.
4. Shift registers shall be available with a minimum of 16-bit groups and be cascadable, time- or event-driven.
5. Provide PLC programming for pulse accumulators.

F. Service and Installation Conditions

1. The logic controller, excluding programming tools, shall be capable of operating in an ambient temperature of 0°C to 60°C with humidity of 5-95 percent, non-condensing.
2. The PLC shall meet NEMA standard ICS 2-230 for noise immunity and be both UL 508 listed and CSA22.2-K2 certified.

G. Power Supply

1. The logic controller's power supply shall be rated 30 watts and accept AC power of 120 VAC, 60 Hz. It shall be capable of withstanding a power loss for a minimum of 20 milliseconds while still remaining in operation.

2. The incoming line wiring terminals shall include self-lifting pressure plates, shall allow for easy wire insertion and secure connections. Terminals shall accept two #14 AWG wires. A hinged protective cover shall be provided.

H. Mechanical

The logic controller shall withstand vibration of 0.015-nch peak to peak displacement, 2.5g peak (maximum) acceleration, 1 hour/axis.

2.09 RADIO

- A. Radio shall be MDS entraNET 900.

2.10 ANTENNA

- A. Antenna shall be Yagi directional type. Antenna installation shall include antenna cable, polyphaser lightning arrestor and all connectors required for a complete installation. Antenna shall be mounted on the roof of the building as shown on the plans. Mounting height and direction shall be provided by the Owner. Contractor to coordinate exact requirements with Owner prior to installation.

2.11 CONTROL PANEL

- A. Earthquake Design and Restraint

All panels shall be designed, constructed and attached to resist stresses produced by seismic forces.

- B. Earthquake Design Data

Submit with the shop drawings a complete set of detailed calculations or test results, details of constructions, and the method of attachment for all panels showing compliance with earthquake design restraint. The calculations and details shall be signed by a professional engineer who has demonstrated proficiency in structural engineering or civil engineering and is registered in the state of California. The calculations shall be performed specifically for this job, during the time frame of the job and be dated by the Engineer performing them. No control panels shall be delivered and mounted at project without approved submittal data.

- C. Minimum Earthquake Forces

The minimum earthquake forces shall be those prescribed for essential facilities by the Uniform Building Code and applicable supplements as published by the International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601.

- D. Construction

Control panels shall be furnished completely pre-wired, with factory or shop mounted instruments and controls and factory tested prior to shipment. Factory test reports, and tag number descriptions shall be submitted for review prior to shipment.

1. Piping and Wiring

Piping and wiring within each panel shall be done in a workmanlike manner and grouped and supported to give a neat appearance. All control components not flush mounted on the front of the panel shall be mounted on fully accessible subpanels or racks within the panels for easy removal. All signal lines leaving the panels shall terminate at bulkhead fittings or terminal blocks and shall be tagged to facilitate field connections.

2. Size and Supports

Panels shall be of sufficient size to adequately enclose all instruments designated as "panel-mounted" plus ample interior clearance to allow for installation, general servicing, and maintenance of the instruments. Weight of the instruments shall be supported by Unistrut, Famet, Caine or approved equal channel supports.

3. Exterior Panel Color

The exterior panel color shall complement adjacent panels and will be gray and be approved by the Owner. Short angled horizontal front edges of panels shall be protected by brushed and coated stainless steel angled strip with concealed fasteners.

4. Attachment methods shall be detailed on the panel fabrication drawing submittals. If requested by the Owner, structural calculations for the panels shall be furnished. This does not apply to calculations for seismic forces. Heavy panels shall be attached by anchor bolts embedded in beams supporting the floor. See the structural drawings for location of beams.

5. Space shall be provided for instruments indicated as furnished by others to be mounted and wired by the control panel manufacturer. These units shall be shipped to control panel manufacturer in sufficient time for wiring. Coordination of the instruments and controls to be located on each panel are shown on the instrumentation drawings, electrical schematics, and/or in the individual section.

6. Switching Circuit Schematics

Switching circuit schematics shown are illustrative of the desired function only; the Contractor may elect to perform the required functions by other standard logic techniques. Components and circuits used shall be subject to review. All switching circuits shall be checked and verified by testing before shipment.

7. Control Voltage

When the control voltage is not specified in the schematics, the Contractor shall use 120 VAC single-phase power as supplied from the power panels supplied under Section 16000; however, he shall provide a separate low voltage circuit for the indicating lamps or provide individual transformers with lamps. In any event, the lamp voltage shall not exceed

30 volts AC or DC. Manual disconnect switches (and relays if necessary) shall be provided internal to the panel to isolate process related groups of circuit elements from panel power and foreign voltages to permit trouble shooting without disabling controls for other processes.

8. Input-Output Terminal

The input-output terminal shall be labeled for easy identification, either labeled directly at the terminal with the appropriate identification, or the wires and terminals shall be numbered with a cross-reference chart mounted in a plastic holder mounted within the cabinet. Input and output terminals shall be located in a single location in the panel.

9. Arrangement

Where so indicated, the instruments mounted in the panels shall have the nominal size and general arrangement shown. Panel layouts and nameplates shall conform to the approved submittal.

10. Louvers shall be provided, when required for cooling, near the bottoms and tops on the rear doors and sides of panels. 80-mesh screens shall cover the insides of louvers.

E. Panel Mounting

Control panels shall be mounted full height dedicated control section of switchboard indicated on the drawings.

F. Panel Accessories

1. Relays and Timers

Relays and timers and other internally mounted equipment, if required, shall be of the types specified in Section 16448 of these Specifications.

2. Panel Face Mounted

Panel face mounted equipment shall be of the types specified in this section. Face mounted equipment shall be mounted on the face of the switchboard.

3. Selector Switches, Push Buttons and Pilot Lights

Selector switches, push buttons and pilot lights shall be oil-tight Microswitch types CMC PM and PML, or equal.

4. Panels

Panels shall be internally lighted by fluorescent lamps, provided with guards and a three-way switch located convenient to each access door. Two duplex-grounded type receptacles shall be provided in each panel section. The lights and receptacles shall be wired to outgoing terminal blocks for 120-volt, 60-hertz, single-phase supply.

5. Nameplates

Nameplates shall be black lamicaid with minimum 3/16-inch high white letters for major area titles, 5/21-inch for component titles, and 1/8-inch for subtitles and shall be fastened with a permanent but dissolvable adhesive or by screws.

6. Terminals

Electrical terminals shall be screw-type with 600-volt barrier for signals greater than 30 volts and 300 volt barriers for signals 30 volts or less.

7. Terminal Connections

Terminals shall be connected by compression spade lugs.

8. Wiring

Wiring may be bundled and laced or tied with plastic ties and supported to prevent sagging or damage during shipment. If preferred, wiring may be enclosed in plastic wireways, in which case it need not be laced inside the wireway. All wiring shall be made with PVC insulated stranded wire.

Terminal blocks shall be sectional barriered type with tubular clamp and white plastic identification strip (Buchanan Miniature, Phoenix, or approved equal). Each terminal shall be identified on the marker strip with a number neatly printed in ink. Where wires are terminated on screw terminals, insulated, crimped spade lugs shall be used. Wires shall be color coded with black for unswitched hot or power, red for switched hot or control, white for neutral, and green for ground. Wire size shall be 20 AWG stranded 600-volt insulation except where larger wire is required for a single load. Wiring shall have permanent markers at each end. Except as otherwise stated herein, Section 16000 requirements shall apply. No control wire shall be installed jointly in electrical power conduit.

PART 3 - EXECUTION

3.01 GENERAL

A. Inspection

Inspect each instrument and piece of equipment for damage, defects, completeness and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of the instruments and equipment.

B. Preparation

Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing the instruments and equipment. Maintain the areas in a broom-clean condition during installation operations.

C. Factory Testing of Control Panels

Verify, at the factory, wiring continuity and verify panel operation by simulated inputs and outputs. Provide a report certifying the control panels are operable and meet the requirements of these Specifications.

D. Manufacturers' Installation and Supervision

Furnish the services of authorized factory personnel especially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved instruction manual; (2) be present when the instruments and equipment are first put into operation; (3) inspect, check, adjust as necessary and approve the installation; (4) calibrate the instruments, in accordance with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable; and (5) prepare and submit the specified manufacturers' certified report. Include all costs for the representative's services in the contract price.

E. Instrument Calibration

Provide the services of factory trained instrumentation technicians, tools, and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least five times greater than the specified accuracy of the instrument being calibrated. Such test instruments shall have accuracies traceable to the National Bureau of Standards, as applicable. Provide a written report to the Owner on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerances, defects noted, correction action required, and apply to instrument calibration sticker with date after calibration correction made.

F. System Validation

Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each instrumentation system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output. Validate each system by simulating inputs at the first element in loop (i.e., sensor) of 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, or on/off and verifying loop output devices (i.e., recorder, indicator, alarm, etc., except controllers). During system validation, make provisional settings on levels, alarms, etc. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.

Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation. Test equipment for this function shall be as specified under "Instrument Calibration."

Immediately correct all defects and malfunctions disclosed by the tests. Use new parts and materials as required and approved and retest. Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, verification that the system meets these tolerances, and any provisional setting made to the devices.

G. Final Operational Testing and Acceptance

Upon completion of instrument calibration and system validation, test all systems under process conditions. The intent of this test is to demonstrate and verify the operational inter-relationship of the instrumentation systems. This testing shall include, but not be limited to, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and/or mechanical equipment. The Contractor shall furnish the test procedure checklist to the Owner for review and acceptance 5 days prior to any scheduled tests. The procedure will include all operational features in the system.

Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing. Upon completion of final operational testing, submit a certified report indicating that total ICM system meets all the functional requirements specified herein. The Owner shall countersign this report and it shall constitute final acceptance of the ICM system.

Testing shall be observed by the Owner. Notify the Owner in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon completion of this test, the ICM system supplier shall begin or have begun plant start-up.

Demonstrate that instruction manuals for the PLC are consistent with the latest version of programming utilized for final acceptance testing.

H. Start-Up Assistance

Provide the services of a factory trained and field experienced instrumentation engineer to assist the Owner's personnel during start-up of the plant process. Purpose of this assistance is to provide support in making final adjustments of settings on the instrument systems.

I. Instruction of the Owner's Personnel

Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of the Owner's designated personnel in the operation of each instrument system. This training shall be for the time period of 24 hours and shall be performed separately and after start-up has been finalized. The training shall be coordinated by the inspector at a time designated by the inspector. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the system descriptions and operation and maintenance manuals as required under these Specifications. If requested by the Owner, the ICM provider shall delete all programs from the PLC, reinstall all programs to the PLC with an ICM supplied portable computer, and demonstrate that the facilities are operating as intended.

3.02 SYSTEM DESCRIPTION

A. General

The supplier of other equipment and sub-systems shall be aware of the scope of the ICM system in order to ensure compatibility with all electrical controls and interface with the PLC and OIT. The electrical equipment is specified in Division

16. All I/O functions and status indicators shall be capable of being transmitted to the Owner's SCADA system. Installation, testing, calibrations, validation, startup and instructions shall be in accordance with the requirements as specified in this section and other applicable sections.

B. Local Automatic Control

1. Automatic Operation

The PLC shall be programmed to provide operations as described in Section 17100, General Operations.

2. Remote Monitoring and Control

The system supplier shall demonstrate that the PLC is capable of outputting status conditions to the Owner's SCADA system. The PLC shall be capable of receiving program or set point changes from the central SCADA.

3. Local PLC Programming

The facility PLC shall be capable of being programmed utilizing an IBM (or compatible) personal computer.

4. Operator Interface Terminal (OIT)

The OIT shall be programmed by the ICM supplier to provide functionality as described in Section 17100, General Operations.

3.03 SOFTWARE DOCUMENTATION

Prior to any on-site Engineer witness testing, the instrument contractor shall furnish complete software documentation in type written form including the following:

A. Narrative description of control logic and station operation including alarms and fail mode operation.

B. Lists of the following with functional description and PLC internal addresses:

1. Analog inputs
2. Analog outputs
3. Digital inputs
4. Digital outputs
5. Pulse inputs
6. Internal relays
7. Internal registers and initial value
8. Internal timers and initial value

- 9. Alarm setpoints and rung number
 - 10. Adjustable parameters
 - C. Complete ladder diagram of program.
 - D. System block diagram showing interface and terminal numbers.
- At the close of the project, the ICM shall provide on CD-ROM the final program complete with program installation instructions and associated software to reinstall the program.

3.04 SEQUENCE OF WORK

- A. The Contractor and system supplier will reference the sequence of events and project phase scheduling requirements. Restrictions and coordination shall be conformed to without variation without a written approval from the Owner's chief inspector operation manager. All phase testing, operation and installation acceptance require on-site testing. Final test of all the improvements at the project final acceptance shall be provided as stated in these Specifications.

END OF SECTION