



DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII

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DEPARTMENT OF WATER SUPPLY
COUNTY OF HAWAII
HILO, HAWAII

ADDENDUM NO. 6

JOB NO. 2019-1109

INVITATION FOR BIDS
FOR THE

**'ŌLA'A #3 CHLORINATION SYSTEM REPLACEMENT
DISTRICT OF PUNA**

County of Hawai'i – State of Hawai'i

The following revisions and changes shall be made a part of the contract bidding documents:

1. Changes to **SPECIAL PROVISIONS:**

DELETE Pages SP-13 to SP-29 and **REPLACE** with the attached revised Pages SP-13A to SP-27A.
Revisions have been made to **Section 304: Mechanical and Electrical.**

2. Changes to **PLANS:**

ADD the attached Sheets G-01 to E-05, which detail electrical work.

BY AUTHORITY OF THE DEPARTMENT OF
WATER SUPPLY COUNTY OF HAWAII

Date: January 11, 2021

By: 
Keith K. Okamoto, P.E., Manager-Chief Engineer

Please sign and return immediately to the Manager-Chief Engineer of the Department of Water Supply.

Receipt of a copy of **ADDENDUM NO. 6** for JOB NO. 2019-1109, INVITATION FOR BIDS FOR THE 'ŌLA'A #3 CHLORINATION SYSTEM REPLACEMENT, District of Puna, County of Hawai'i, State of Hawai'i, is hereby acknowledged.

NAME OF BIDDER

Date: _____

By: _____

...Water, Our Most Precious Resource...Ka Wai A Kāne...

The Department of Water Supply is an Equal Opportunity provider and employer.

SECTION 304 - MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 “Mechanical and Electrical”, in the Water System Standards, 2002.

304.03 – ELECTRICAL WORK.

The following shall be ADDED to and be made a part of this subsection.

A. SCOPE OF WORK.

1. Provide all articles, materials, equipment, operations, and services herein or on Drawings, including all labor, materials, taxes, fees, insurance, and incidentals required to insure completion.
2. TEST COMPLETE INSTALLATION. Installation shall be complete in every detail as specified and ready for use. Any item supplied by Contractor developing defects within one year of final acceptance by Department of Water Supply shall be replaced by such materials, apparatus, or parts to make such defective portion of complete system conform to true intent and meaning of these Drawings and Specifications, at no cost to Department of Water Supply.
3. WORK SHALL INCLUDE:
 - a. Installation of a package chlorination system and related control work.
 - b. Installation of ventilator fan(s) and related control work.
 - c. Walkthrough of overall facility’s electrical systems, and specific training on all equipment, and instrumentation installed at the ‘Ōla‘a #3 Deepwell site, with the Department’s Operations personnel of the operational district in which the facility resides.

B. WORK BY OTHERS.

1. Concrete, forming, excavation, backfilling and painting provided by respective sections of this contract.
2. Equipment utilizing electricity shall be provided by respective sections of this contract. Installation of equipment complete with power wiring and electric controls and interlock wiring shall be part of Electrical Work.
3. During bidding and construction, Contractor shall coordinate his work with utilities and other trades to avoid omissions and overlapping responsibilities. Electrical Contractor shall notify other trades and suppliers of project voltages and of existing equipment when new work must be compatible with existing conditions.

C. MATERIALS AND WORKMANSHIP.

1. DEPARTURES FROM SPECIFICATIONS:
 - a. Departures resulting from substitution of materials or system shall be accompanied by appropriate changes in all affected work of every trade. Such changes shall be at no increase in the contract amount and shall be the responsibility of the subcontractor or

supplier responsible for the departures. Changes proposed by the Contractor shall be based on a system approach and shall be allowed if implemented without decrease in quality in performance or operations, increase in utility space to install the equipment. Such departures shall be submitted and noted in shop drawings for approval by the Department of Water Supply. Departures initiated by other trades, requiring changes in the electrical system as well as other systems, shall be accompanied by appropriate changes to all affected work of every trade, at no increase in contract amount, by the trade responsible for the departures.

- b. The General Contractor shall be responsible to coordinate, approve, and select systems that do not impose unaccounted for impact on the electrical work. It shall be understood that after the award of contract, all departures having electrical impact, shall make appropriate changes to the electrical system required to accommodate the departures and shall be at no additional cost to the Department of Water Supply.

2. CONSTRUCTION METHODS:

- a. Construction shall conform to construction practices as recommended by the American Electricians Handbook by Croft (latest edition), Edison Electrical Institute, National Electric Safety Code and Applicable Instructions of manufacturers of equipment and material supplied for this project.

- b. Grounding:

- i. General

- 1) Description

- a) “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
 - b) The terms “connect” and “bond” are used interchangeably in this specification and have the same meaning.

- 2) Submittals

- a) Submit four (4) copies of the following in accordance with Section 304.03.D – SUBMITTALS.

- (i) Shop Drawings:

- (a) Submit sufficient information to demonstrate compliance with drawings and specifications.
 - (b) Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

- (ii) Test Reports:

- (a) Two weeks prior to the final inspection, submit ground resistance field test reports to the Department’s Project Engineer.

(iii) Certifications:

- (a) Certification by the Contractor that the grounding equipment has been properly installed and tested.

3) Applicable Publications: Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

a) American Society for Testing and Materials (ASTM):

- (i) B1-2013 Standard Specification for Hard-Drawn Copper Wire
- (ii) B3-2013 Standard Specification for Soft or Annealed Copper Wire
- (iii) B8-2011 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

b) Institute of Electrical and Electronics Engineers, Inc. (IEEE):

- (i) 81-2012 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

c) National Fire Protection Association (NFPA):

- (i) 70-2017 National Electrical Code (NEC)
- (ii) 70E-2017 National Electrical Safety Code

d) Telecommunications Industry Association, (TIA):

- (i) J-STO-607-A-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

e) Underwriters Laboratories, Inc. (UL):

- (i) 44-2010 Thermoset-Insulated Wires and Cables
- (ii) 83-2008 Thermoplastic-Insulated Wires and Cables
- (iii) 467-2007 Grounding and Bonding Equipment
- (iv) 486A-486B-2003 Wire Connectors

ii. Products

1) Grounding and Bonding Conductors

- a) Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
- b) Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

- c) Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
- 2) Ground Rods
 - a) Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467. Stainless steel shall be substituted for instances where soil conditions have been determined to be corrosive.
 - b) Quantity of rods shall be as required to obtain the specified ground resistance.
- 3) Concrete Encased Electrode
 - a) Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.
- 4) Splices and Termination Components
 - a) Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).
- 5) Ground Connections
 - a) Above Grade:
 - (i) Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and external tooth lockwashers. Bolts shall be torqued to the values recommended by the manufacturer.
 - b) Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.
- 6) Equipment Rack and Cabinet Ground Bars
 - a) Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.
- 7) Ground Terminal Blocks
 - a) At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

iii. Execution

1) General

- a) Install grounding equipment in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- b) All grounding shall conform to single point grounding (SPG) system, no exceptions. Multi-point grounding shall be strictly prohibited.
- c) Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in proximity with electrical circuits shall be bonded and grounded.

2) Inaccessible Grounding Connections

- a) Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3) Secondary Voltage Equipment and Circuits

- a) Switchgear, Panel Boards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:
 - (i) Connect the equipment grounding conductors to the ground bus.
 - (ii) Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

4) Raceway

a) Conduit Systems:

- (i) Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
- (ii) Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
- (iii) Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
- (iv) Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with an equipment grounding conductor to the equipment ground bus.

b) Feeders and Branch Circuits:

- (i) Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

- c) Boxes, Cabinets, Enclosures, and Panelboards:
 - (i) Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
 - (ii) Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - (iii) Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- 5) Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- 6) Corrosion Inhibitors
 - a) When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- 7) Conductive Piping
 - a) Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- 8) Ground Resistance
 - a) Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Department of Water Supply. Final tests shall ensure that this requirement is met.
 - b) Grounding system resistance shall comply with the electric utility company ground resistance requirements.
 - c) Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
 - d) Services at power company interface points shall comply with the power company ground resistance requirements.
 - e) Below-grade connections shall be visually inspected by the Department's Project Engineer prior to backfilling. The Contractor shall notify the Department's Project Engineer 24 hours before the connections are ready for inspection.

9) Acceptance Checks and Tests

- a) Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.
- b) Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- c) Below-grade connections shall be visually inspected by the Department's Project Engineer prior to backfilling. The Contractor shall notify the Department's Project Engineer 24 hours before the connections are ready for inspection.

c. Testing:

- i. All wiring shall be tested to ensure proper operation according to functions specified herein on drawings and other sections of these Specifications.
- ii. Insulation resistance of wires shall be according to requirements of the National Electric Code. All feeder cables, #4 or larger, shall have insulation resistance of 1.5 megohms or higher. Insulation resistance shall be measured by a 500 volts megger, Fluke Inc. or equal. Resistance of feeder cables shall be recorded and turned over in 4 copies to Department's Project Engineer during final inspection. Proper operation of all electrical devices shall be demonstrated at request of the Department of Water Supply during final inspection.

d. Conduits:

- i. All conduits and fittings below grade shall be Schedule 80 PVC with concrete jacket encasement (minimum 2" thickness) and marked with detectable underground warning tape.
- ii. Conduits transitioning from below grade to above grade shall be Type 316 stainless steel. The transition section shall be inclusive of sweep and all vertical riser portions below grade. The transition section shall end with a 304 stainless steel coupling set 1-1/2" above finished grade. Coupling shall have anti-seize compound applied to prevent galling.
- iii. All conduits and fittings above grade that are exterior to the control building or in an open area exposed to environmental conditions shall be 316 stainless steel with supports every 5'.
- iv. All conduits and fittings above grade that are interior to the control building shall be reinforced thermosetting resin conduit (RTRC) with supports every 5'.

- v. Flexible Conduit: Liquid-tight flexible steel, zinc-coated, jacketed with high density polyethylene and with factory approved fittings. Liquid-tight with factory fittings for wet or moist areas.
- vi. Conduits shall be cut square and inner edges reamed. Butt together evenly in couplings.
- vii. Bends and offsets shall be made with hickey or conduit-bending machine. Do not use vice or pipe tee. Bends shall be made so that interior cross-sectional area will not be reduced. Radius of curve of inner edge of field bend shall not be less than ten times the internal diameter of conduit.
- viii. Use of running threads not permitted. Where conduits cannot be joined by standard threaded couplings, approved water-tight conduit unions shall be used.
- ix. Cap conduits during construction with plastic or metal-capped bushings to prevent entrance of dirt or moisture. All conduits shall be swabbed out and thoroughly dried before wires or cables are pulled in.
- x. Conduit shall be free from other piping, valves, or mechanical equipment.
- xi. Fish wires, cords, strings, chains, or the like shall not be placed or inserted in the conduit system during installation.
- xii. Insulating bushings and two locknuts installed on each end of every run of conduit at enclosures and boxes. Provide grounding bushings as required for grounding receptacles and to connect conduits to switchboard with #10 bare copper.
- xiii. Conduits shall be securely fastened in place to all outlet boxes and to structure or support. Project adequate number of conduit threads through box for bushings. Anchorage for 1-1/2 inches and smaller conduit shall be made with one-hole 304 stainless steel conduit straps or clamps; 2 inches or larger conduit shall be anchored with 304 stainless steel "U" clamps or equal fittings.
- xiv. Exposed conduit parallel with or at right angles to structural or architectural elements shall be securely fastened in place with one-hole 304 stainless steel pipe straps with screws or bolts and spaced not more than 5 feet apart; or with approved beam clamps or approved single or gang pipe hangers spaced not more than 5 feet apart as the conditions require. Vertical runs shall be supported at intervals not exceeding 5 feet by approved clamp hangers.
- xv. Run Length Requirements:
 - 1) Conduit runs with one 90° bend or equivalent, 150 feet maximum without pull box.
 - 2) Conduit runs with two 90° bends or equivalent, 100 feet maximum without pull box.

e. Conductors:

- i. Mechanical means for pulling shall be torque-limiting type and not used for #2 AWG and smaller wires.
- ii. Pulling tensions shall not exceed wire manufacturer's recommendation.

- iii. Where necessary, powdered soapstone used as lubricant for drawing wires through conduit. No other means of lubricating allowed. Conduit fittings shall not be used with conductors larger than #2 AWG.
- f. Splicing:
 - i. Splice by approval only.
 - ii. Wires shall be formed neatly in enclosures and boxes.
 - iii. Splices made according to NEC. Conductors #10 and smaller twisted and secured with twist on wire connectors. Conductors #8 through #4/0 spliced with solderless clamp or compression (indent) connectors.
 - iv. Splices reinsulated according to wire manufacturer's instructions. Splice insulation shall be 150% in thickness of original wire insulation and of the same electrical and mechanical characteristics. Insulating type (600V use) shall be neoprene, Okoprene by Okonite Company or approved equal. Jacketing and insulating tape shall be high density cold setting polyethylene adhesive tape, Scotch No. 33 by Minnesota Mining and Manufacturing Company or approved equal.
- g. Finishing:
 - i. Structural and architectural elements cut or drilled for installation of electrical system then patched, repaired, and restored. Drilling, cutting, patching, repairing, and restoring subject to approval of the Department of Water Supply.
 - ii. Attachment of electrical equipment to wood by pan head, stainless steel wood screws. Attachment to concrete by embedded or expansion inserts and bolts. Powder charge driven with approval only. Close unused knockouts on boxes or expansion with metal cap.
 - iii. Wipe clean all exposed raceways and enclosures with rag and solvent. Unfinished raceways and enclosures prime painted and finished by Painting Section. Factory finished enclosures shall be painted. Panelboards identified by stenciling with paint on back of doors the voltage and designation. Voltage ratings stenciled on the front of disconnect switches and junction boxes where wires are terminated for connection to equipment that are not part of this contract.
- 3. EXTERIOR WORK: Materials, equipment, and construction methods specified in other paragraphs of the specifications for Electrical Work shall apply to the exterior work.
 - a. Ductlines and Handholes:
 - i. Ducts and fittings shall be round bore, for use with tapered fittings and manufactured from polyvinyl chloride (PVC). Cantex Inc., J-M Manufacturing Company Inc., Schedule 80.
 - ii. Concrete for ductlines shall be according to the "Concrete Section". Concrete for ductline jackets shall be 3000 psi compressive strength in 28 days with aggregates of #3 fine size.
 - iii. All handholes shall be watertight to surface runoff and resist leakage while submerged beneath 12" of standing water. Handholes shall be free draining with

washed drainage rock extending a minimum depth of 12" below depth of handhole. All penetrations into handhole by ductlines shall be properly seal around perimeter of ductline to prevent infiltration of water.

- b. Trenching and backfilling for ductlines and handholes shall be according to the "Trenching and Backfilling Section". Depths of trenches on slope shall be measured from finished grade of lower edge.
 - i. Backfill Material, Type A: Backfill material shall consist of earth and gravel mix with gravel content consisting of 1-inch diameter maximum and not exceeding fifty percent (50%) by volume of the mix.
 - ii. Backfill Material, Type B: Backfill material shall consist of earth and gravel mix with gravel content consisting of 1/2-inch diameter maximum and not exceeding twenty percent (20%) by volume of the mix.
 - iii. Any existing underground piping or conduit that is encountered shall be properly shored and protected from damage. Any damage to existing utilities resulting from the Contractor's operations shall be repaired by him at his own expense.
- c. Identification Tags: Each set of cables in handholes shall be identified by a noncorrosive metal tag. Letters shall be minimum 1/4 inch high identifying the cable as to use and/or voltage. Tags shall be wrapped around the cables and taped. Power tags shall be red.
- d. Ductlines:
 - i. Ducts and/or conduits shall be laid in the trenches on Carlon Snap-N-Stac plastic spacers treated against termite or concrete spacers. Spacing between ducts shall be as follows:
 - 1) Control/Instrumentation and control/instrumentation ducts - 1-1/2 inches of concrete.
 - 2) Electric power and electric power ducts - 1-1/2 inches of concrete
 - 3) Electric power and control/instrumentation ducts - 3 inches of concrete
 - ii. After all ducts are installed, duct bank shall be securely bound with #12 steel tie wire and anchored to prevent movement during concrete pouring. Tapered ends of ducts or conduits shall be coated with sealing compound before coupling is applied to insure a water-tight joint. Reinforcing steel, shoring and forming, where required, shall be installed according to Concrete Section of this Specification. Concrete shall be poured on ducts without the use of mechanical vibrators. Concrete shall be tampered manually with wooden rods.
 - iii. All ducts shall be sufficiently supported to ensure entire length of conduit run maintains a consistent slope with no sagging between supports. Ducts shall maintain a consistent slope downwards towards the closest handhole.
 - iv. Ducts shall be completely encased in concrete. The thickness of concrete encasement is minimum and may be increased to fit the actual shape of the trench. Changes in direction of runs exceeding 5 degrees shall be accomplished by using special couplings or bends manufactured for this purpose. Where conduit lines

enter handholes, the conduits shall terminate in end bells. Conduit shall be thoroughly cleaned before laying. When it is necessary to cut a tapered end on a piece of conduit at the site, the cut shall be made with saw and tapered with a lathe designed to match the original taper.

- v. After the conduit line has been completed, a mandrel not less than 12 inches long having a diameter 1/4 inch less than the inside diameter of the conduit, shall be pulled through each conduit after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth and/or gravel have been left in the line.
- e. Cables shall be thoroughly lubricated with soapstone before drawn into ducts.
- 4. **DEVICES AND EQUIPMENT:** All devices, materials, and equipment specified herein shall be manufactured and installed in accordance with the appropriate articles in the NEC except as noted.
 - a. **Wiring Materials:**
 - i. **Stainless Steel Materials:** All stainless-steel major component materials shall be Type 316 stainless steel, with Type 304 stainless steel hardware use appropriately to prevent galling.
 - ii. **Enclosures and Cabinets:** Enclosures and cabinets for panelboards, breakers, and switches shall be NEMA type, fabricated from galvanized steel, prime painted and enamel finished according to NEMA specifications.
 - iii. **Large Junction Boxes:** For dry interior location, the box shall be fabricated from NEC gauge galvanized steel with matching screw-on type cover, field punched knockouts. For exterior and wet locations, the box shall be NEMA 4X stainless steel, with matching gasketed cover and threaded Myers type hubs for conduit connection. Screws shall be stainless steel.
 - iv. **Outlet and Small Junction Boxes:** Concealed boxes shall be pressed from NEC code gauge steel, galvanized 4" square x 1-1/2" deep minimum or as specified on drawings.
 - 1) Exposed boxes and weather exposed recessed boxes shall be galvanizes cast iron or NEMA 4X stainless steel, prime painted, enamel finished, threaded Myers type hubs for conduit connection.
 - 2) Extension or raised rings for pressed boxes pressed from NEC code gauge steel and galvanized. Use as required at device outlets and make box opening flush with finished surface.
 - v. **Device Boxes:** Device boxes for light switches and outlets exterior to the control building shall be cast, Type 316 stainless steel for use with conduit systems. Cooper Crouse-Hinds FD Series or approved equal. Device boxes to be furnished with cover specifically designed to meet NEC requirements for wet locations. Cooper Crouse-Hinds WLGF-FS & WLGF-FSV or approved equal.

- vi. Wires and Cables: Conductors shall be copper No. 12 AWG minimum, with 600-volt insulation ratings. All conductors shall be NEC type XHHW-2 insulated. Wiring in lighting fixtures shall be NEC Type TF, and TFF insulated. Manufacture and install according to NEC Articles 310 and 402. Wiring for all controls shall be extra flexible machine tool, color coded, XHHW-2.
- 1) Provide color coding for all service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors, and white for neutrals, except where neutrals of more than one system are installed in same raceway or box, the other neutral shall be white with a colored (not green) stripe. The color of the ungrounded conductors in different voltage systems shall be as follows:
 - a) 120/208 volt, 3-phase:
 - (i) Phase A – black
 - (ii) Phase B – red
 - (iii) Phase C – blue
 - b) 277/480 volt, 3-phase:
 - (i) Phase A – brown
 - (ii) Phase B – orange
 - (iii) Phase C – yellow
 - c) 120/240 volt, single phase:
 - (i) Line 1 – black
 - (ii) Line 2 – red
 - 2) Color coding shall be maintained throughout entire system. Use other colors when more wires than above are contained in one raceway. Engineer shall determine whether deviation from color coding will be permitted.
 - 3) Wire Markers: All wires shall be tagged with circuit identifying markers at both ends of termination, within 3 inches of the termination. Markers shall be cloth with plastic letters covered with mylar film. Markers shall have high strength adhesive bond, be able to withstand abrasion, shall be oil and water resistant, and shall be taped around cable near termination.
 - 4) Instrument Signal Cable:
 - a) Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Provide twisted shielded cable with individual shield for each pair. Provide twisted shielded cable multi-pair with overall shield and jacket. Provide triads wherever 3 wire circuits are required. Circuits shall not be made using conductors from different pairs or triads.

- b) Install instrument, signal, and data communication circuits without splices between instruments, terminal boxes, or panels. Shields as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables are not acceptable. Common ground return conductors for two or more circuits are not acceptable.
- c) Instrument signal cables shall be single twisted, shielded pair or triad, 16 AWG, UL listed with 600 volt insulation rating. Conductor material shall be bare annealed copper; stranded in accordance with ASTM B8. Insulation shall be 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket. The shield shall be 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire.

b. Circuit Breakers

- i. Provide circuit breakers: molded-case type provided for the current ratings and pole configurations as shown or as specified on the panelboard schedule or drawings and with a minimum interrupting current rating as shown on drawings or schedules, but not less than 22,000 AIC for 240 volt rated devices or 42,000 AIC for 480 volt rated devices. Series rated branch, main, or other devices are prohibited.
- ii. Provide circuit breakers listed in accordance with UL 489 for the service specified and load terminals with solderless connectors. Provide bolt-on type circuit breakers. Provide circuit breakers with machine-printed, circuit number labels indicting the load served.

c. Devices:

- i. Hardware, Supports, Backings, etc.: All hardware, supports, backings, and other equipment shall be provided. Wood materials shall be "wolmanize" treated against termite; iron or steel materials shall be galvanized for corrosion protection and nonferrous materials shall be brass or bronze.

D. SUBMITTALS.

1. The Department of Water Supply's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.
2. All submittals shall include one (1) copy of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Department of Water Supply to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.
3. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - a. Mark the submittals, "SUBMITTED UNDER SUBSECTION_____".

- b. Submittals shall be marked to show specification reference including the subsection and paragraph numbers.
 - c. Submit each subsection separately.
4. The submittals shall include the following:
- a. Submit as required to the Department of Water Supply for review and written approval one (1) copy of specified information and drawings, furnished bound in black, three tab, clear front report cover, Oxford (58806) or an approved equivalent and labeled with project title on a title page. Upon approval, one (1) copy of the approved submittal shall be furnished bound in white, three ring, hanging binders, Wilson Jones (W393-14W, W365-44W, or W365-49W) or an approved equivalent and labeled with project title on front cover and spine. Additionally, two (2) electronic copies of approved submittals shall be furnished in searchable PDF format and as applicable DWG format, on USB flash drives, Kingston DataTraveler 101 G2 (2GB). Mark one as "Engineering Copy" and the other as "Operations Copy".
 - b. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
 - c. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion, etc.) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and attached to the equipment.
 - d. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 - e. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.
5. Maintenance and Operation Manuals:
- a. Submit one (1) hardcopy and one (1) electronic copy (native PDF or printed to PDF, scans to PDF shall not be accepted) for systems and equipment specified in the technical sections. Furnish bound in white, three ring, hanging binders, Wilson Jones (W393-14W, W365-44W, or W365-49W) or an approved equivalent and labeled with project title on front cover and spine.
 - b. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
 - c. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.

- d. The manuals shall include:
 - i. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - ii. A control sequence describing start-up, operation, and shutdown.
 - iii. Description of the function of each principal item of equipment.
 - iv. Installation instructions.
 - v. Safety precautions for operation and maintenance.
 - vi. Diagrams and illustrations.
 - vii. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
 - viii. Performance data.
 - ix. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
 - x. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
 - e. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.
6. Shop Drawings:
- a. Prior to fabrication, the Contractor shall submit for written approval of the Department of Water Supply one (1) hardcopy and one (1) electronic copy (native PDF or printed to PDF, scans to PDF shall not be accepted) of complete installation drawings and manufacturer's wiring diagrams for the control and connection diagrams, installation detail, and any built-to-order equipment.
7. As-Built Drawings:
- a. Upon completion of the final inspection and testing, the Contractor shall conduct a thorough field survey of the complete electrical installation with detailed notations of equipment nameplate data; conduit sizes; conduit paths with GPS coordinates and depth below final grade of each joint; cables/wires in each conduit; cable/wire sizes; cable/wire length of run; and cable/wire connection at each end. Contractor shall provide, for the Department of Water Supply one (1) copy of as-built installation drawings and manufacturer's wiring diagram for any built-to-order equipment for review and written approval.
 - b. Upon approval, the Contractor shall provide, for the use of the Department of Water Supply, one (1) hardcopy and one (1) electronic copy (native PDF or printed to PDF, scans to PDF shall not be accepted) of such approved as-built installation drawings and manufacturer's wiring diagram for any built-to-order equipment.