ARTICLE XIV - ELECTRICAL WORK

14.1 GENERAL

A. Description. The work under this article of the specifications consists of the furnishing and installation of all labor and materials required to complete all electrical work as indicated on the drawings and/or specified herein. The work includes but is not limited to the following:

1. Removal of existing light pole assemblies and luminaires.

2. Provision of new light pole assemblies, reinstallation of luminaires, and reintegration into the Harbors GE Light Grid Network System.

3. Provision of temporary lighting.

4. Underground electrical distribution system including ductlines and conductors.

5. As-built drawings.

6. Testing.

B. **Work included in this Article must be completed by a valid State of Hawaii Specialty Contractor licensed "C-13" Electrical Contractor.**

C. Coordination with Other Trades. During pricing and construction, Contractor shall coordinate his work with other trades to avoid omissions and overlapping of responsibilities.

D. Special Conditions.

1. Contractor shall arrange for Harbors inspection and acceptance of new work.

2. The Harbors Construction Engineer shall witness all tests. The Contractor shall schedule all testing, in writing, with the Harbors Division Construction Engineer, a minimum of two (2) weeks prior to testing.

3. Network Lighting Control System. Existing luminaires reinstalled on new light poles shall be properly reintegrated into the existing Harbors GE Light Grid, networked wireless lighting control system. Coordinate with the lighting control system manufacturer and Harbors to integrate, program and test the network control system for completeness and functional operation.

E. Rules and Permits. The entire installation shall be done in strict accordance with the latest rules and regulations of the National Electrical Code (NEC), National Electrical Safety Code (NESC) and any applicable local electrical ordinances.

F. Symbols. The standard electrical symbols, together with the special symbols, notes and instructions indicated on the drawings, describe the work required and are to be included as a part of these specifications.

G. Drawings and Coordination of Work. These specifications are accompanied by drawings indicating the location of work to be performed.

1. The drawings and these specifications are complementary, each to the other, and what is called for by one shall be as binding as if called for by both.

2. Every effort has been made to indicate clearly and specifically all work required to be performed by the Contractor; however, any item of material, equipment or work not specifically called for herein or on the drawings but which is required to complete the installation so that it will conform to the NEC, NESC, local laws, and the intent and meaning of the plans and specifications, shall be furnished and installed by the Contractor at no additional cost to the State.

3. Before installing, verify all dimensions and sizes of equipment at job site. Conduit routing is typical and may be altered in any logical manner. However, all changes shall be approved by the Harbors Construction Engineer and shown on "as-built" drawings.

14.2 SUBMITTALS

A. The Contractor shall submit shop drawings for approval in accordance with Article X - PROJECT DESCRIPTION.

1. Light pole assemblies, including luminaire mounting brackets, accessories, installation, and construction details. Submit dimensions, wind load determined in accordance with AASHTO LTS2, pole deflection, pole class and other application information.

2. Junction boxes.

3. Fused connector kits and fuses.

B. Shop drawings and catalog cuts for substitute materials shall clearly specify compliance with and/or deviation from specified material. Approval of shop drawings and catalog cuts shall not release Contractor from complying with intent

of specifications and drawings. Any deviations from approved shop drawings shall have prior approval by the Harbors Construction Engineer.

14.3 MATERIALS AND EQUIPMENT

A. General.

1. Materials and equipment shall be new (unless otherwise specified herein) and shall bear the inspection label of the Underwriter's Laboratories, Inc. where such inspection and labeling service is rendered for the materials and equipment in question.

2. Brand names and catalog numbers used herein to specify materials and equipment (unless otherwise noted) are to indicate the standards of design and quality required. Materials and equipment of equal quality of other manufacturers will be accepted subject to the approval of the Harbors Construction Engineer.

3. Electrical distribution equipment and light poles shall be supplied through a locally-based manufacturer's designated representative by a local distributor.

4. Where two or more similar type items are furnished, all shall be of the same manufacture, e.g. safety switches shall be of the same manufacturer unless otherwise noted.

B. Light Poles. Provide as indicated on the contract drawings. Refer to Article XV - COATING for requirements.

C. Junction Boxes. Stainless steel Type 316, NEMA 4X, neoprene gasket, stainless steel Type 316 screws, size as indicated.

D. Disconnect and Protective Devices: Provide waterproof, molded rubber connector kits. Connectors shall be 600-volt, quick disconnect, in-line connectors, fused for phase conductors and non-fused for neutral conductors. Opening in line conductor connectors shall be suitable for the furnished conductors. Lubrication and taping shall be as recommended connector manufacturer. Fused connectors shall accommodate standard midget, ferrule-type fuses with ampere rating as indicated.

E. Raceways.

1. Polyvinyl chloride (PVC) Schedule 40. All underground ductlines shall be concrete encased.

2. Rigid Steel Conduit: Rigid steel, zinc-coated inside and outside, for use with threaded fittings. ANSI C80.1.

F. Wire and Cable.

1. Conductors. All conductors shall be copper, No. 12 AWG minimum. No. 8 AWG and larger diameter shall be stranded; No. 10 AWG and smaller shall be solid. Do not provide wires and cables manufactured more than 12 months prior to the date of delivery to the site. Aluminum conductors shall not be provided.

2. Color Coding. Provide for feeder and branch circuit conductors. Color shall be green for grounding conductors and white for neutral conductor. Color of ungrounded conductors shall be as follows:

i. 480/277 volt, three phase:

a) Phase A - brown
b) Phase B - orange
c) Phase C – yellow

ii. 120/240 volt, single phase:

a) Phase A - black
b) Phase B - red

3. Insulation. Type XHHW or RHW-2 unless otherwise specified.

4. Bonding Conductors. Solid bare copper wire for sizes No. 8 AWG and smaller diameter; Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

5. Lighting Branch Circuit Wiring. Conductors shall be of No. 10 American Wire Gauge (AWG) minimum size, except where otherwise indicated. Conductor installation shall be Type RHW-2 or VW-1; 90 degrees C rated. Minimum insulation thickness shall be 45 mils. All conductors shall be 7-strand copper, 600 volts.

G. Splices. Any splices necessary shall be compression type, mechanically firm and made only in wireway, pull boxes or handholes. Splices shall be sufficiently taped and coated to provide a completely waterproof permanent joint. An approved plastic electrical tape and waterproof coating shall be used. A minimum of two layers of tape shall be applied.

H. Electrical Tapes.

1. Insulating Tape. UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2. Other Tapes. Tapes shall be UL listed for electrical insulation and other purposes in wire and cable splices. Terminations, repairs and miscellaneous purposes, electrical tapes shall comply with UL 510.

I. Cable Wrap. Nylon, twist-on type, ASTM D 4066 Group 2. Manufactured by Heyco Products, Inc. or approved equivalent.

J. Cable Support Grip. Wire mesh grip, tin-coated bronze wire or stainless steel wire (302 - 304). Manufactured by Hubbell or approved equivalent.

K. Warning Tape, Pre-printed polyethylene tape marked with "CAUTION BURIED ELECTRICAL LINE BELOW," 4 mil thick, detectable foil backed, 3" minimum width.

L. Duct Seal. Pliable, non-toxic material used for application around and in conduits and to minimize moisture and rodent/insect infiltration. Must be re-enterable material allowing form removal/reapplication after initial installation. Non-drying, non-cracking, non-corrosive material that will not adversely affect raceways and conductors. Provide duct seal at all conduit risers at light poles and duct entries at handholes.

M. Hardware, Supports, Backing, Etc. All hardware, supports, backing and other accessories necessary to install electrical equipment shall be provided. Steel materials shall be stainless steel Type 316. Channel irons shall be stainless steel Type 316, unless otherwise indicated.

14.4 CONSTRUCTION METHODS

A. General.

1. Workmanship subject to approval of Harbors Construction Engineer and inspectors of the utilities who shall be afforded every opportunity to determine skill and competency.

2. Construction shall conform to construction practices as recommended by American Electricians practices as recommended by American Electricians Handbook by Croft (latest edition), National Electrical Code, National Electrical Safety Code, and applicable instructions of manufacturers of equipment and materials supplied for project.

3. Electrical outages shall be granted at the convenience of Harbors. Requests for electrical outages shall be submitted, in writing, a minimum of two (2) weeks prior to the requested outage date and shall be approved by the Harbors Construction Engineer. The request shall indicate the date and time of the requested outage, and the proposed outage duration. Contractor shall advise and/or coordinate work with the Harbors Construction Engineer, Harbors Kauai District, and all users and tenants a minimum of two (2) weeks in advance.

B. Wiring System. Unless otherwise indicated or specified herein, wiring shall consist of single conductor cables installed in conduit in areas where permitted by the National Electrical Code.

C. Installation of Conduit.

1. Conduits with respect to size shall be installed exactly as shown on the drawings. No deviation from the plan shall be permitted except to increase the size of conduits, if necessary, to accommodate the required size and number of conductors to be installed therein.

2. Conduits shall be installed approximately where shown. The exact location of conduits and conduit supports shall be determined after careful consideration has been given to the location of other existing electrical and civil work.

3. Conduit system shall be continuous from fitting to fitting so that electrical continuity is obtained between all conduits of the system.

4. Cap conduits during construction with plastic bushings to prevent entrance of dirt or moisture. Swab all conduits and dry before installing wires.

5. Run exposed raceway parallel with, or at right angles to structural elements.

D. Underground Ductlines.

1. All underground ductlines shall be PVC Schedule 40. Ductlines shall be jacketed and shall be installed by qualified electricians. Coat tapered ends of ducts or conduits with sealing compound before coupling is applied to insure watertight joint. Concrete shall be poured without the use of mechanical vibrators. Tamp concrete manually with wooden rods. Thickness of concrete encasement shown is minimum and may be increased to fit actual shape of trench.

2. The top of the ductline shall be at a minimum depth as indicated on drawings.

3. Duct lines shall have a continuous slope downward toward handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

4. Terminate conduits in end-bells where duct lines enter handholes. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. After laying, bind ducts with #12 wire and anchor to prevent movement during concrete pouring. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs.

5. The concrete encasement surrounding the ductbank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 2 inches unless otherwise indicated.

E. Aboveground Conductors.

1. Mechanical means for pulling shall be torque-limiting type and not used for #2 AWG and smaller wires.

2. Pulling tension shall not exceed wire manufacturer's recommendations.

3. Where necessary, powdered soapstone or water-based wire pulling lubricant may be used as a lubricant for drawing wires through conduit. No other means of lubricating will be allowed.

4. Form neatly in enclosures for minimum of crossovers.

5. Splicing of Wire and Cable.

i. Wires shall be formed neatly in enclosures and boxes.

ii. Splice in accordance with the National Electrical Code (NEC). Make splices in conductors #10 AWG and smaller with insulated, pressure type connector. Splice conductors #8 through #4/0 with high pressure compression (indent) copper sleeve connectors. Do

not use bolt-on connectors. Reinsulate splices and waterproof splices. Reinsulate splices according to wire manufacturer's instructions. Splice insulation shall be 200% in thickness of original wire insulation and of same electrical and mechanical characteristics. Tape shall be 7 mil minimum thickness vinyl plastic.

F. Underground Conductors.

1. Cable Pulling: Pull cables down grade with the feed-in point at the handhole or building of the highest elevation. Use flexible cable feeds to convey cables through the handhole opening and into the duct runs. Cable slack shall be accumulated at each handhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.

2. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

3. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

4. Cable Terminating: Protect terminations of insulated power cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Install all terminations of insulated power cables and cable splices in accordance with the manufacturer's requirements. Make terminations using materials and methods as indicated or specified herein or as designated by the written instructions of the cable manufacturer and termination kit manufacturer.

5. Splices for 600 Volt Class Cables: Make splices in underground systems only in accessible locations such as handholes, using a compression connector on the conductor and by insulating and waterproofing by one of the following methods suitable for continuous submersion in water.

   i. Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material and apply by a gravity poured method or by a pressure injected method. The component materials of the resin insulation shall be in a packaged form ready for convenient mixing without removing from the package. Do not allow the cables to be removed until after the splicing material has completely set.

ii. Gravity poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold. Do not allow cables to be moved until after the splicing materials have completely set.

iii. Heat shrinkable method shall employ materials and equipment contained in an approved commercial splicing kit.

G. Grounding.

1. Provide grounding for entire electrical installation as required by Article 250 of the National Electrical Code.

2. Final connection to equipment, raceways, and other metallic parts directly exposed to ungrounded electric conductors shall be No. 12 AWG minimum, copper, NEC type TW, green insulation. Use approved bonding terminal at panels.

3. All grounding wire runs shall be routed together with circuit conductors.

4. Install green-insulated equipment grounding conductor in all conduits. Conductor sizes per Article 250 of the National Electrical Code.

H. Finishing.

1. All cutting that may be required for the complete installation of the electrical work shall be carefully performed and all patching shall be finished to match existing conditions.

2. Close unused knockouts in boxes or enclosures with metal cap.

3. Wipe clean all new exposed raceways and enclosures with rag and solvent.

I. Miscellaneous Details. Cut, drill and patch as required to install electrical system. Repair any surface damaged or marred by notching, drilling or any other process necessary for installation of electrical work. Cutting, repairs and refinishing subject to the approval of the Harbors Division Construction Engineer. Need for remedial work determined by Harbors Division Construction Engineer as attributable to poor coordination and workmanship shall be cause for reconstruction to the satisfaction of the Engineer.

1. Touch-up all surfaces damaged by shipping, installation, etc., with paint matching original and as recommended by the paint manufacturer. Painting shall be in accordance with Article XV - COATING.

2. Repair holes left by removal of electrical equipment to match existing.

3. Furnish necessary test equipment and make all tests necessary to check for unspecified grounding, shorts and wrong connections. Correct faulty conditions, if any.

J. Cleaning and Repairing. During the progress of work, all rubbish, waste lumber, displaced materials, etc. shall be removed as soon as possible and upon completion of the work, Contractor shall remove from the State's property and from all public and private property, at his own expense, all temporary structures, rubbish and waste material resulting from his operations.

K. **Lighting systems shall be operational during all hours of darkness, throughout the construction period at sufficient lighting levels as determined by Harbors. Provide all temporary power, lighting equipment, wiring and connections, related appurtenances, and complete maintenance as necessary to maintain continuity of electrical power to existing and/or new lighting systems during night time hours as required by the tenant/users/Harbors at no additional cost to the State.**

14.5 TESTING AND INSPECTION - All testing shall be witnessed by the Harbors Construction Engineer. The Contractor shall schedule all testing with the Harbors Construction Engineer, in writing, a minimum of two (2) weeks prior to testing.

L. If the Harbors Construction Engineer (or his representative) shall discover any of the following errors, the Contractor, at his own expense, shall go over all similar portions of the entire job, taking the necessary or directed remedial action.

1. Impaired clearances.

2. Improper finish.

3. Improper adjustment.

M. Furnish necessary test equipment and make all tests necessary to check for unspecified grounding, shorts and wrong connections. Correct faulty conditions, if any.

N. The Contractor shall show by demonstration in service that all circuits and devices are in operating condition. Tests shall be such that each item of control equipment will function not less than five times.

O. Wherever test or inspection reveals faulty materials or installation, the Contractor shall take corrective action, at his own expense, repairing or replacing materials or installation as directed. The materials or installation shall then be retested.

P. Lighting System. Perform a functional test in which it is demonstrated that each and every part of the system functions as specified or as intended herein.

14.5 COMPLETION AND GUARANTEE

A. Completion. The entire electrical installation shall be complete in every detail as specified, ready for use and tested, free of all accidental grounds and short circuits. The installation shall not be considered complete until "As-Built" drawings have been submitted and approved.

B. Guarantee. The Contractor shall submit a written warranty stating that all parts of the electrical system be free from defects of material and workmanship. Any defects occurring within one year after final acceptance shall be corrected by the Contractor at no cost to the State.

14.6 MEASUREMENT AND PAYMENT - Payment for Electrical Work will not be measured and paid for separately, but shall be considered incidental to the applicable items in Article X of these specifications.