SECTION 623 - TRAFFIC SIGNAL SYSTEM

623.01 Description. This section describes furnishing, installing, modifying, or replacing traffic signal system.

Definitions.

(1) Actuation - Operation of any type of detector.

(2) Clearance Interval - Length of time of display of signal indication following right-of-way interval.

(3) Detector for Traffic Actuation - Device that pedestrians or vehicles can register their presence with traffic-actuated controller.

(4) Extendible Portion - That part of green interval that follows initial portion.

(5) Extension Limit - Maximum time that traffic phase may retain right-of-way after actuation on another traffic phase, after timing out initial portion.

(6) Flashing Feature - Feature incorporated to stop normal signal operation and cause flashing of predetermined combination of signal lights.

(7) Initial Portion - Part of green interval that is timed-out or separately controlled by traffic-actuated controller before extendible portion of interval takes effect.

(8) Interval - Several divisions of time cycle during which signal indications do not change.

(9) Interval Sequence - Order of appearance of signal indications during successive intervals of time cycle.

(10) Magnetic Vehicle Detector - Detector actuated by movement of vehicle passing through magnetic field.

(11) Major Street - Roadway approach or approaches at intersection normally carrying greater volume of vehicular traffic.


(13) Minimum Period - In semi-traffic-actuated controllers, shortest time for which right-of-way will be given to approaches not having detectors.
(14) **Minor Movement Interval** - Auxiliary phase added to controller phase (parent phase) and modified by auxiliary movement controller.

(15) **Minor Street** - Roadway approach or approaches at intersection normally carrying smaller volume of vehicular traffic.

(16) **Non-Parent Phase** - Controller phase not modified by auxiliary control unit.

(17) **Parent Phase** - Controller phase modified by auxiliary control unit.

(18) **Passage Period** - Time allowed for vehicle to travel at selected speed from detector to nearest point of conflicting traffic.

(19) **Pedestrian Detector** - Detector, usually of push-button type, installed near roadway and operated by hand.

(20) **Pressure-Sensitive Vehicle Detector** - Detector installed in roadway, actuated by pressure of vehicle passing over its surface.

(21) **Pre-Timed Controller** - Automatic control device for supervising operation of traffic control signals in accordance with pre-timed cycle and divisions.

(22) **Recall Switch** - Manually operated switch in actuated controller to provide for automatic return of right-of-way to street.

(23) **Right-of-Way** - Privilege of immediate use of highway.

(24) **Signal Indication** - Illumination of traffic signal lens or equivalent device, or of combination of several lenses or equivalent devices.

(25) **Time Cycle** - Number of seconds required for one complete revolution of timing dial or complete sequence of signal indications.

(26) **Traffic-Actuated Controller** - Digital control device for supervising operation of traffic control signals in accordance with varying demands of traffic as registered with controller by loop detectors or pedestrian push buttons.

(27) **Traffic Phase** - Part of cycle allocated to traffic movements receiving right-of-way or to combinations of traffic movements receiving right-of-way simultaneously during one or more intervals.

(28) **Unit Extension** - Minimum time, during extendible portion, for which right-of-way must remain on traffic phases following actuation on that phase, subject to extension limit.
623.02 Materials.

Structural Concrete (Class B) 601
Reinforcing Steel 602
Dark Green Enamel Paint 708.03
Paint Thinner 708.04
Concrete Pull Box 712.06(B)
Conduits 712.27
Traffic Signal Standards 770.01
Traffic Signal Heads 770.02
Dual Indication Unit (Fiberoptics) 770.03
Pedestrian Signal 770.04
Controller Equipment 770.05
Conductors and Cables 770.06
Epoxy Sealer 770.07
Hot Applied Rubberized Sealant 770.08
High Performance Detector Loop Sealant 770.09
Approach-Only Microwave Vehicle Detector 770.10
Preemption Detectors 770.11

Structural steel anchor bolts and steel plates shall conform to AASHTO M 164 and ASTM A 36, respectively. Exposed anchor bolts, nuts, and washers shall be zinc-coated, in accordance with AASHTO M 232. Anchor bolts and nuts shall be galvanized after threads are cut. After galvanizing, ensure that all nuts will turn on bolts to full thread depth. Coat threads with paraffin wax.

Electrical equipment shall conform to standards of the following, wherever applicable:

(A) NEMA.
(B) UL, Inc.
Materials shall conform to requirements of the contract documents and the following:

(A) NEC.

(B) General Order Nos. 6 and 10, of the Hawaii Public Utilities Commission.

(C) ASTM.

(D) ANSI.

(E) Local utility company rules.

(F) Local ordinances that may apply.

623.03 Construction. Perform work in accordance with requirements of the contract documents and the following: NEC; General Order Nos. 6 and 10 of the Hawaii Public Utilities Commission; ASTM; ANSI; local utility company rules; and local ordinances that may apply.

(A) Equipment List and Drawings. Submit within seven days following contract award 10 copies of materials and equipment purchase requisition, including copies of equipment list, manufacturer’s brochures, catalog cuts, and shop drawings.

Prepare diagrams and drawings using graphic symbols indicated in IEEE publication *Graphic Symbols for Electrical and Electronic Diagrams*.

Order materials and equipment immediately upon acceptance by the Engineer. If the Contract award is rescinded by the Department after ordering of materials and equipment, the Department will purchase ordered materials and equipment at cost based on invoices. Purchase price will include transportation cost and applicable State excise taxes. Purchase price will not include profit.

Upon completion and acceptance of work, submit construction as-built drawings showing detailed construction changes.

(B) Excavation and Backfill. Excavate and backfill in accordance with Section 204 - Excavation and Backfill for Miscellaneous Facilities.
(C) Installation.

(1) Foundations. Construct foundations as indicated in the contract documents. Foundations within clear zone, as defined by AASHTO Roadside Design Guide, including anchor bolts, shall not extend more than 4 inches above surrounding ground.

Set forms true to correct line and grade. Use rigid forms, securely braced in place. Place conduit ends and anchor bolts in proper position and height and hold in place with rigid top template. In addition to rigid top template, hold anchor bolts in place by means of rigid bottom template made of steel. Bottom template shall provide proper spacing and alignment of anchor bolts near their bottom embedded end. Install bottom template before placing footing concrete. Anchor bolts installed more than 1:40 from vertical will be rejected. Hold conduit ends and anchor bolts in place by template until concrete sets. Cure concrete for not less than 72 hours.

Mix, place, and cure concrete for foundations in accordance with Section 601 - Structural Concrete and Section 503 - Concrete Structures.

(2) Metal Traffic Signal Standards. Install metal traffic signal standards with shaft plumb on concrete foundations.

Locations of standards indicated in the contract documents are approximate. Set standards at required locations or as ordered by the Engineer.

Place leveling grout with weepholes under entire metal traffic signal standard base plates.

(3) Signal Heads. Assemble signal heads. Plumb, level, balance, and secure signal head assembly. Adjust direction of signal heads as required or as ordered by the Engineer. Conceal conductors within standards and mounting assemblies.

Do not install signal heads until signal equipment, including controller, is in place and ready for operation. Cover or direct signal face away from traffic when proposed system is not activated.

(4) Controller and Cabinet. Mount controller cabinet. Assemble, wire, and house controller and auxiliary equipment specified in cabinet. Locations of controller and cabinet indicated in the contract documents are approximate. Set controller and cabinet at required locations as ordered by the Engineer.
(5) **Vehicle Detectors.** Install inductive loop vehicle detectors. Use compressed air to remove debris from saw-cut groove before inserting loop cable. Make loop cable continuous within roadway. Splice loop cable in pull box. Fill saw-cut groove with epoxy sealer, hot applied rubberized sealant, or one-part urethane sealant designed for use as protective seal for traffic inductive loop detectors installed in HMA or concrete pavements.

(6) **Pull Boxes.** Furnish and install pull boxes as indicated in the contract documents. Carefully excavate for pull boxes.

Install pull boxes so that covers are level with curb or sidewalk grade or 1 inch above existing ground.

(7) **Conduits.** Lay polyvinyl chloride (PVC) conduits carefully in trenches prepared to receive conduits. Concrete encase PVC Schedule 40 conduits under roadway areas. Use PVC Schedule 80 conduits, direct buried, in areas not exposed to traffic.

Set conduits to be encased in concrete structure or encased in concrete to required lines and grades. Support conduit rigidly in place by masonry material, manufactured conduit spacers, or other accepted means, so that conduit will not dislodge during concrete placing and tamping. Place concrete encasement using hand shovels only. Cure concrete for at least 12 hours before backfilling and compacting.

Whether shop or field cut, ream end of conduits to remove burrs and rough edges. Make cuts square and true. Slip joints or running threads will not be allowed for coupling conduit. When standard coupling cannot be used for coupling metal-type conduit, use of UL or ETL listed threaded union will be allowed.

Install rigid steel conduit in accordance with NEC requirements for rigid metal conduit. Use white and tinted ready-mixed paint on threads of joints. Repair zinc-coated surfaces in accordance with Subsection 501.03(G)(2) - Repairing Damaged Zinc-Coated Surfaces.

Apply two coats of asphaltic base paint to exterior portions of direct burial steel conduits not encased in concrete immediately after installation.

Install and repair surfaces of PVC-coated rigid steel conduit in accordance with manufacturer’s recommendations.

Install PVC conduit in accordance with NEC requirements. Use solvent weld connections. Make solvent weld joints in accordance with conduit manufacturer's recommendations.
Make directional changes in non-metallic conduits with curved segments using accepted deflection couplings, or with short lengths of straight conduits and couplings. Deflection angle between two adjacent lengths of conduit shall not exceed 6 degrees. Do not use radius of less than 12 times nominal size of conduit, unless using factory-made ells.

Use steel or Schedule 80 PVC conduits for exposed construction except for communications cable risers. Use Schedule 80 PVC conduits for communication cable risers.

Thread connection for PVC conduit to rigid metal conduit on metal conduit side.

Provide each conduit run with 1/8-inch polyester or polyolefin pull line extending through entire length. Double additional 2 feet of polyester or polyolefin line back into conduit at each end of run. End conduits entering pull boxes with end bells. Cap or plug ends temporarily.

Cap or plug and mark ends of conduit stubouts. Ends of conduit runs shall extend at least 24 inches past face of curb or edge of pavement unless entering pull boxes. Install markers or markings on curb for ends of conduit runs. Show locations on as-built, as specified under Subsection 623.03(A) - Equipment List and Drawings.

Pass bullet-shaped test mandrel, 14 inches long with diameter 1/2 inch less than inside diameter of each conduit run. Scores found on mandrel deeper than 1/32 inch shall be indication of burrs or obstruction in conduit run. Remove burrs and obstructions. Redo mandrel test until no scoring on mandrel deeper than 1/32 inch is evident.

Keep interior of conduits clean during construction by temporarily plugging ends of conduits. Plug conduit ends at end of each workday, whenever work is stopped, and whenever conduits are subject to submergence in water. Install conduits to drain towards pull boxes or handholes.

(8) Conductor and Cables. Provide conductors and cables conforming to the NEC. Arrange conductors and cables within cabinets, signal heads, standards, and pull boxes neatly; and cable together using self-clinching nylon cable ties or other method approved by the Engineer.
Immediately before installing conductors and cables in conduits, pull wire brush through each conduit to remove extraneous matter, obstructions, and debris.

Furnish conductors and cables on reels.

Pull conductors and cables directly from their cores or reels into conduits with cable grip designed to provide firm hold on exterior covering of conductor and cable. Do not pull off and lay conductors and cables on ground before installation. Make pulls in one direction only. Use UL or ETL listed inert lubricant. Do not leave conductors or cables under tension or tight against bushings or fittings.

Remove the damaged ends resulting from use of pulling grips immediately after pulling conductor and cable. Maintain conductor and cable end seals. Do not pull open-ended conductors and cables through conduits. Install conductors and cables continuous from pulling point to pulling point. Splices between pulling points will not be allowed.

Preemption Detector (Opticom) Conductors and Cables shall be continuous, without splices, from detector to cabinet.

Run signal light conductors and cables continuously, with no splices between terminal block located in cabinet and terminal block in signal head. Branch signal light neutrals may be spliced at pull boxes.

After conductors and cables are installed, seal conduits ends with duct sealing compound conforming to Subsection 712.27(E) - Duct Sealing Compound. Seal vacant conduits with duct sealing compound or plug designed for that purpose and accepted by the Engineer.

When splicing is required, join conductors and cables with no-solder pressure connectors. Use no-solder pressure connectors for splicing conductors and cables, No. 8 AWG or larger. Leave no sharp points that can pierce taping. Splice and terminate conductors and cable in accordance with conductor and cable manufacturer’s recommendations. Submit conductor and cable manufacturer’s splicing instruction sheets.

Trim insulation to conical shape. Roughen conductor and cable insulation before applying splice insulation. Splice insulation includes layers of thermoplastic electrical insulating tape not more than 0.007 inch thick, conforming to Military Specification MIL-I-24391C. Apply splice insulation well lapped over and with same thickness as original insulation.
Coil neatly, at least 5 feet of slack conductor or cable near each traffic signal foundation, at both ends of each conductor and cable run, and at least 2 feet of slack at each traffic signal pull box.

Protect conductor and cable ends with tape to exclude moisture until ends are attached to terminal equipment. For conductor and cable connections in terminal cabinets, use Bell Telephone System or equivalent connectors accepted for outside use.

(9) Bonding and Grounding. Secure metallic conductor and cable sheaths, conduits, and standards mechanically and electrically to form continuous system. Ground system in accordance with the NEC and as specified herein. Provide No. 8 AWG copper wire or equivalent copper strap of same cross-sectional area for bonding and grounding jumpers.

Bond standards by bonding strap attached to anchor bolt or 3/16 inch or larger, brass or bronze bolt installed in lower portion of shaft.

Ground conduits and neutral wires at service points as required in accordance with the NEC, using No. 6 AWG or equal for grounding conductors.

Install copper-clad steel or pure copper ground rod 5/8-inch diameter by 8 feet long alongside each traffic signal standard and controller concrete base.

Connect grounding rods with No. 6 AWG wire to No. 8 AWG ground wire loop and power system neutral.

On wood poles, ground equipment mounted less than 8 feet above ground surface.

(10) Pull boxes. Install pull boxes so that covers are level with curb or sidewalk grade or 1 inch above existing ground.

Give frames and covers two coats of asphaltic base paint after installation.

(11) Continuity of Service. During relocation, reconstruction or other improvements of existing traffic signal systems, keep existing system operational until reconstructed or new traffic signal system is in service. Arrange work accordingly and provide temporary relocations and wiring as necessary.
(12) **Salvaging Electrical Equipment.** Salvage controller and electrical equipment not used in new system. Stockpile salvaged equipment neatly and deliver to locations designated by the Engineer.

Remove top of abandoned controller foundation, bolts, and conduits completely, or level existing controller foundations flush with grade.

(13) **Preemption (Opticom) Detectors.** Install optical detectors for preemption system in accordance with manufacturer’s recommendations.

(14) **Approach-Only Microwave Vehicle Detector.** Temporarily mount approach-only microwave vehicle detector on existing traffic signal standard, highway light standard, or at location designated by the Engineer. Provide fully operational detector, including conductors in existing conduits and controller, before disabling existing pavement loop detectors. Remove approach-only microwave vehicle detectors and conductors after permanent loop detectors are fully operational. Deliver approach-only microwave vehicle detectors and conductors to location designated by the Engineer. Repair holes and damages caused by approach-only microwave vehicle detectors to existing traffic signal and highway lighting standards.

(D) **Painting.** Furnish metal traffic signal standards and mast arms with natural, zinc-coated finish.

Paint signal head mountings with two coats of weatherproof dark enamel. Use enamel conforming to Subsection 708.03 - Dark Green Enamel Paint.

Paint controller cabinet, other than aluminum, with one coat of accepted metal primer and two coats of aluminum paint conforming to AASHTO M 69.

Supply aluminum signal standard and controller cabinet with polished natural aluminum finish, requiring no painting.

(E) **Electric Service.** Provide electric power service of 120 volts, single-phase, 60-cycle, during construction. Provide service connection, including underground steel conduit, from local power company’s pole to controller.

Furnish and install service connections such as conduits, weatherhead, wires, and meter loops, and comply with power company’s requirement for electric service.
(F) Field Test. Perform the following tests in the presence of Engineer:

(1) Test for continuity of each circuit.

(2) Test for grounding of each circuit.

(3) Megger test each circuit between circuit and ground. Insulation resistance shall not be less than values specified in Table 622.03-1 - Insulation Resistance, when measured with instrument having voltage rating of 500 volts.

(4) Functional test to show that system functions as specified.

Replace or repair fault in material or installation revealed by these tests. Repeat same tests until no fault appears.

(G) Other Services.

(1) Department of Transportation Services (DTS), City and County of Honolulu will perform the following:

(a) Make splices and connections in pull boxes and cabinet locations pertaining to signal heads, pedestrian buttons, vehicle detectors, preemption detectors, and intertie circuits.

(b) Install and program controller timings and conflict monitor cards.

(c) Align and tape programmed visibility heads.

(d) Inspect traffic signal construction.

(2) In association with the City’s work, the Contractor shall perform the following:

(a) Before leaving factory, conduct documented factory testing in accordance with CALTRANS requirements for each controller and cabinet. Dry-store controller assemblies. Perform second documented diagnostic testing procedure. If factory testing is satisfactory, cycle controller assembly through eight vehicle phases and four pedestrian phases for 120 continuous hours before field installation.

Test and document validation of controller, cabinet output and input, C1/C2/C20 operations, load switches, detector cards, dc cards, modems, flash condition, time source, preemption system, and conflict monitor. Have necessary testing hardware and software to perform accurate and
dependable test and validation of output signal displays, controller and cabinet functions, and conflict monitor certification. Submit testing plan and procedure to DTS for acceptance before starting tests. Any controller assembly or auxiliary equipment that fails within 30 calendar days after field installation will be considered defective. Replace defective controller assembly or auxiliary equipment with new controller assembly or auxiliary equipment within five calendar days. Pay repair cost incurred by DTS during 30-calendar day interval.

(b) Install controller assembly including anchor bolts, seals, grout, rerouted cables, extended power cables, ground wires, signal cables, and other adjustments to base, conduits, and cabinet for fully operational system.

(c) Remove existing cabinets and deliver to DTS designated storage facility in Honolulu.

(3) In addition to work specified in Subsection 623.03(G)(2), the Contractor shall perform the following:

(a) Furnish and deliver controller equipment to location designated by the Engineer for testing.

(b) After DTS completes testing, load and transport controller equipment to construction site and install in place.

(c) Arrange for phases of work with appropriate County agency or as ordered by the Engineer.

(d) Give at least three days advance notice to appropriate County agency when phases of the work require services of that agency.

(H) Restoring Pavements and Other Improvements. Restore to their original condition, existing pavements and other improvements, such as driveways, sidewalks, curbs, and gutters, disturbed by excavation. Use replacement material equal to or better in quality than existing materials. Match existing grades, thickness, texture, and color whenever applicable.

(I) Warranty. Provide new material and equipment for permanent construction.

Furnish copies of manufacturer’s warranty or warranties guaranteeing equipment free from defects in materials, design, and manufacturing, for not less than 12 months from date of acceptance.
Adjust or repair material and equipment under warranty within 24 hours from time of notification.

Temporarily replace under-warranty material and equipment requiring factory corrections, within 24 hours from time of notification. Install factory-corrected or new material and equipment no later than 30 days from time of notification.

623.04 Measurement. Traffic signal system will be paid on a lump sum basis. Measurement for payment will not apply.

623.05 Payment. The Engineer will pay for the accepted traffic signal system on a contract lump sum basis. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following pay item when included in the proposal schedule:

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<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tr>
<td>Traffic Signal System</td>
<td>Lump Sum</td>
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The Engineer will pay for the accepted hauling and stockpiling of salvaged materials and equipment off the right-of-way, as ordered by the Engineer, in accordance with Subsection 104.02 - Changes.

END OF SECTION 623