

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.
- (12) **Manual Operation** - Operation of signal controller by hand- operated switch.
- (13) **Minimum Period** - In semi-traffic-actuated controllers, shortest time for which right-of-way will be given to approaches not having detectors.

- 49 **(14) Minor Movement Interval** - Auxiliary phase added to controller phase
50 (parent phase) and modified by auxiliary movement controller.
51
- 52 **(15) Minor Street** - Roadway approach or approaches at intersection
53 normally carrying smaller volume of vehicular traffic.
54
- 55 **(16) Non-Parent Phase** - Controller phase not modified by auxiliary control
56 unit.
57
- 58 **(17) Parent Phase** - Controller phase modified by auxiliary control unit.
59
- 60 **(18) Passage Period** - Time allowed for vehicle to travel at selected speed
61 from detector to nearest point of conflicting traffic.
62
- 63 **(19) Pedestrian Detector** - Detector, usually of push-button type, installed
64 near roadway and operated by hand.
65
- 66 **(20) Pressure-Sensitive Vehicle Detector** - Detector installed in roadway,
67 actuated by pressure of vehicle passing over its surface.
68
- 69 **(21) Pre-Timed Controller** - Automatic control device for supervising
70 operation of traffic control signals in accordance with pre-timed cycle and
71 divisions.
72
- 73 **(22) Recall Switch** - Manually operated switch in actuated controller to
74 provide for automatic return of right-of-way to street.
75
- 76 **(23) Right-of-Way** - Privilege of immediate use of highway.
77
- 78 **(24) Signal Indication** - Illumination of traffic signal lens or equivalent
79 device, or of combination of several lenses or equivalent devices.
80
- 81 **(25) Time Cycle** - Number of seconds required for one complete revolution
82 of timing dial or complete sequence of signal indications.
83
- 84 **(26) Traffic-Actuated Controller** - Digital control device for supervising
85 operation of traffic control signals in accordance with varying demands of
86 traffic as registered with controller by loop detectors or pedestrian push
87 buttons.
88
- 89 **(27) Traffic Phase** - Part of cycle allocated to traffic movements receiving
90 right-of-way or to combinations of traffic movements receiving right-of-way
91 simultaneously during one or more intervals.
92
- 93 **(28) Unit Extension** - Minimum time, during extendible portion, for which
94 right-of-way must remain on traffic phases following actuation on that phase,
95 subject to extension limit.
96

97	623.02 Materials.	
98		
99	Structural Concrete (Class B)	601
100		
101	Reinforcing Steel	602
102		
103	Dark Green Enamel Paint	708.03
104		
105	Paint Thinner	708.04
106		
107	Concrete Pull Box	712.06(B)
108		
109	Conduits	712.27
110		
111	Traffic Signal Standards	770.01
112		
113	Traffic Signal Heads	770.02
114		
115	Dual Indication Unit (Fiberoptics)	770.03
116		
117	Pedestrian Signal	770.04
118		
119	Controller Equipment	770.05
120		
121	Conductors and Cables	770.06
122		
123	Epoxy Sealer	770.07
124		
125	Hot Applied Rubberized Sealant	770.08
126		
127	High Performance Detector Loop Sealant	770.09
128		
129	Approach-Only Microwave Vehicle Detector	770.10
130		
131	Preemption Detectors	770.11
132		

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

138
 139 Electrical equipment shall conform to standards of the following, wherever
 140 applicable:

- 141
- 142 (A) NEMA.
- 143
- 144 (B) UL, Inc.

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145

146 (C) Electrical Testing Laboratories (ETL).

147

148 (D) National Electrical Testing Association, Inc. (NETA).

149

150 (E) Electronics Industries Association (EIA).

151

152 Materials shall conform to requirements of the contract documents and the
153 following:

154

155 (A) NEC.

156

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

159

160 (C) ASTM.

161

162 (D) ANSI.

163

164 (E) Local utility company rules.

165

166 (F) Local ordinances that may apply.

167

168 **623.03 Construction.** Perform work in accordance with requirements of the
169 contract documents and the following: NEC; General Order Nos. 6 and 10 of the
170 Hawaii Public Utilities Commission; ASTM; ANSI; local utility company rules; and
171 local ordinances that may apply.

172

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

177

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

180

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

187

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

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191 (B) **Excavation and Backfill.** Excavate and backfill in accordance with
192 Section 204 - Excavation and Backfill for Miscellaneous Facilities.

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(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.

241 **(5) Vehicle Detectors.** Install inductive loop vehicle detectors.
242 Use compressed air to remove debris from saw-cut groove before
243 inserting loop cable. Make loop cable continuous within roadway.
244 Splice loop cable in pull box. Fill saw-cut groove with epoxy sealer,
245 hot applied rubberized sealant, or one-part urethane sealant designed
246 for use as protective seal for traffic inductive loop detectors installed in
247 HMA or concrete pavements.
248

249 **(6) Pull Boxes.** Furnish and install pull boxes as indicated in the
250 contract documents. Carefully excavate for pull boxes.
251

252 Install pull boxes so that covers are level with curb or sidewalk
253 grade or 1 inch above existing ground.
254

255 **(7) Conduits.** Lay polyvinyl chloride (PVC) conduits carefully in
256 trenches prepared to receive conduits. Concrete encase PVC
257 Schedule 40 conduits under roadway areas. Use PVC Schedule 80
258 conduits, direct buried, in areas not exposed to traffic.
259

260 Set conduits to be encased in concrete structure or encased in
261 concrete to required lines and grades. Support conduit rigidly in place
262 by masonry material, manufactured conduit spacers, or other
263 accepted means, so that conduit will not dislodge during concrete
264 placing and tamping. Place concrete encasement using hand shovels
265 only. Cure concrete for at least 12 hours before backfilling and
266 compacting.
267

268 Whether shop or field cut, ream end of conduits to remove
269 burrs and rough edges. Make cuts square and true. Slip joints or
270 running threads will not be allowed for coupling conduit. When
271 standard coupling cannot be used for coupling metal-type conduit, use
272 of UL or ETL listed threaded union will be allowed.
273

274 Install rigid steel conduit in accordance with NEC requirements
275 for rigid metal conduit. Use white and tinted ready-mixed paint on
276 threads of joints. Repair zinc-coated surfaces in accordance with
277 Subsection 501.03(G)(2) - Repairing Damaged Zinc-Coated Surfaces.
278

279 Apply two coats of asphaltic base paint to exterior portions of
280 direct burial steel conduits not encased in concrete immediately after
281 installation.
282

283 Install and repair surfaces of PVC-coated rigid steel conduit in
284 accordance with manufacturer's recommendations.
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286 Install PVC conduit in accordance with NEC requirements. Use
287 solvent weld connections. Make solvent weld joints in accordance
288 with conduit manufacturer's recommendations.

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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) Conductors 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.

623.03

335 Immediately before installing conductors and cables in
336 conduits, pull wire brush through each conduit to remove extraneous
337 matter, obstructions, and debris.

338
339 Furnish conductors and cables on reels.

340
341 Pull conductors and cables directly from their cores or reels into
342 conduits with cable grip designed to provide firm hold on exterior
343 covering of conductor and cable. Do not pull off and lay conductors
344 and cables on ground before installation. Make pulls in one direction
345 only. Use UL or ETL listed inert lubricant. Do not leave conductors or
346 cables under tension or tight against bushings or fittings.

347
348 Remove the damaged ends resulting from use of pulling grips
349 immediately after pulling conductor and cable. Maintain conductor
350 and cable end seals. Do not pull open-ended conductors and cables
351 through conduits. Install conductors and cables continuous from
352 pulling point to pulling point. Splices between pulling points will not be
353 allowed.

354
355 Preemption Detector (Opticom) Conductors and Cables shall
356 be continuous, without splices, from detector to cabinet.

357
358 Run signal light conductors and cables continuously, with no
359 splices between terminal block located in cabinet and terminal block in
360 signal head. Branch signal light neutrals may be spliced at pull boxes.

361
362 After conductors and cables are installed, seal conduits ends
363 with duct sealing compound conforming to Subsection 712.27(E) -
364 Duct Sealing Compound. Seal vacant conduits with duct sealing
365 compound or plug designed for that purpose and accepted by the
366 Engineer.

367
368 When splicing is required, join conductors and cables with no-
369 solder pressure connectors. Use no-solder pressure connectors for
370 splicing conductors and cables, No. 8 AWG or larger. Leave no sharp
371 points that can pierce taping. Splice and terminate conductors and
372 cable in accordance with conductor and cable manufacturer's
373 recommendations. Submit conductor and cable manufacturer's
374 splicing instruction sheets.

375
376 Trim insulation to conical shape. Roughen conductor and cable
377 insulation before applying splice insulation. Splice insulation includes
378 layers of thermoplastic electrical insulating tape not more than 0.007
379 inch thick, conforming to Military Specification MIL-I-24391C. Apply
380 splice insulation well lapped over and with same thickness as original
381 insulation.

382

383 Coil neatly, at least 5 feet of slack conductor or cable near each
384 traffic signal foundation, at both ends of each conductor and cable
385 run, and at least 2 feet of slack at each traffic signal pull box.
386

387 Protect conductor and cable ends with tape to exclude moisture
388 until ends are attached to terminal equipment. For conductor and
389 cable connections in terminal cabinets, use Bell Telephone System or
390 equivalent connectors accepted for outside use.
391

392 **(9) Bonding and Grounding.** Secure metallic conductor and
393 cable sheaths, conduits, and standards mechanically and electrically
394 to form continuous system. Ground system in accordance with the
395 NEC and as specified herein. Provide No. 8 AWG copper wire or
396 equivalent copper strap of same cross-sectional area for bonding and
397 grounding jumpers.
398

399 Bond standards by bonding strap attached to anchor bolt or
400 3/16 inch or larger, brass or bronze bolt installed in lower portion of
401 shaft.
402

403 Ground conduits and neutral wires at service points as required
404 in accordance with the NEC, using No. 6 AWG or equal for grounding
405 conductors.
406

407 Install copper-clad steel or pure copper ground rod 5/8-inch
408 diameter by 8 feet long alongside each traffic signal standard and
409 controller concrete base.
410

411 Connect grounding rods with No. 6 AWG wire to No. 8 AWG
412 ground wire loop and power system neutral.
413

414 On wood poles, ground equipment mounted less than 8 feet
415 above ground surface.
416

417 **(10) Pull boxes.** Install pull boxes so that covers are level with curb
418 or sidewalk grade or 1 inch above existing ground.
419

420 Give frames and covers two coats of asphaltic base paint after
421 installation.
422

423 **(11) Continuity of Service.** During relocation, reconstruction or
424 other improvements of existing traffic signal systems, keep existing
425 system operational until reconstructed or new traffic signal system is
426 in service. Arrange work accordingly and provide temporary
427 relocations and wiring as necessary.
428
429

429 **(12) Salvaging Electrical Equipment.** Salvage controller and
430 electrical equipment not used in new system. Stockpile salvaged
431 equipment neatly and deliver to locations designated by the Engineer.
432

433 Remove top of abandoned controller foundation, bolts, and
434 conduits completely, or level existing controller foundations flush with
435 grade.
436

437 **(13) Preemption (Opticom) Detectors.** Install optical detectors for
438 preemption system in accordance with manufacturer's
439 recommendations.
440

441 **(14) Approach-Only Microwave Vehicle Detector.** Temporarily
442 mount approach-only microwave vehicle detector on existing traffic
443 signal standard, highway light standard, or at location designated by
444 the Engineer. Provide fully operational detector, including conductors
445 in existing conduits and controller, before disabling existing pavement
446 loop detectors. Remove approach-only microwave vehicle detectors
447 and conductors after permanent loop detectors are fully operational.
448 Deliver approach-only microwave vehicle detectors and conductors to
449 location designated by the Engineer. Repair holes and damages
450 caused by approach-only microwave vehicle detectors to existing
451 traffic signal and highway lighting standards.
452

453 **(D) Painting.** Furnish metal traffic signal standards and mast arms with
454 natural, zinc-coated finish.
455

456 Paint signal head mountings with two coats of weatherproof dark
457 enamel. Use enamel conforming to Subsection 708.03 - Dark Green Enamel
458 Paint.
459

460 Paint controller cabinet, other than aluminum, with one coat of
461 accepted metal primer and two coats of aluminum paint conforming to
462 AASHTO M 69.
463

464 Supply aluminum signal standard and controller cabinet with polished
465 natural aluminum finish, requiring no painting.
466

467 **(E) Electric Service.** Provide electric power service of 120 volts, single-
468 phase, 60-cycle, during construction. Provide service connection, including
469 underground steel conduit, from local power company's pole to controller.
470

471 Furnish and install service connections such as conduits,
472 weatherhead, wires, and meter loops, and comply with power company's
473 requirement for electric service.
474
475

475 (F) **Field Test.** Perform the following tests in the presence of Engineer:

476

477 (1) Test for continuity of each circuit.

478

479 (2) Test for grounding of each circuit.

480

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

485

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

487

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

490

491 (G) **Other Services.**

492

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

495

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

499

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

502

503 (c) Align and tape programmed visibility heads.

504

505 (d) Inspect traffic signal construction.

506

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

509

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

517

518 Test and document validation of controller, cabinet
519 output and input, C1/C2/C20 operations, load switches,
520 detector cards, dc cards, modems, flash condition, time source,
521 preemption system, and conflict monitor. Have necessary
522 testing hardware and software to perform accurate and

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523 dependable test and validation of output signal displays,
524 controller and cabinet functions, and conflict monitor
525 certification. Submit testing plan and procedure to DTS for
526 acceptance before starting tests. Any controller assembly or
527 auxiliary equipment that fails within 30 calendar days after field
528 installation will be considered defective. Replace defective
529 controller assembly or auxiliary equipment with new controller
530 assembly or auxiliary equipment within five calendar days. Pay
531 repair cost incurred by DTS during 30-calendar day interval.

532
533 **(b)** Install controller assembly including anchor bolts, seals,
534 grout, rerouted cables, extended power cables, ground wires,
535 signal cables, and other adjustments to base, conduits, and
536 cabinet for fully operational system.

537
538 **(c)** Remove existing cabinets and deliver to DTS
539 designated storage facility in Honolulu.

540
541 **(3)** In addition to work specified in Subsection 623.03(G)(2), the
542 Contractor shall perform the following:

543
544 **(a)** Furnish and deliver controller equipment to location
545 designated by the Engineer for testing.

546
547 **(b)** After DTS completes testing, load and transport
548 controller equipment to construction site and install in place.

549
550 **(c)** Arrange for phases of work with appropriate County
551 agency or as ordered by the Engineer.

552
553 **(d)** Give at least three days advance notice to appropriate
554 County agency when phases of the work require services of
555 that agency.

556
557 **(H) Restoring Pavements and Other Improvements.** Restore to their
558 original condition, existing pavements and other improvements, such as
559 driveways, sidewalks, curbs, and gutters, disturbed by excavation. Use
560 replacement material equal to or better in quality than existing materials.
561 Match existing grades, thickness, texture, and color whenever applicable.

562
563 **(I) Warranty.** Provide new material and equipment for permanent
564 construction.

565
566 Furnish copies of manufacturer's warranty or warranties guaranteeing
567 equipment free from defects in materials, design, and manufacturing, for not
568 less than 12 months from date of acceptance.

569
570

570 Adjust or repair material and equipment under warranty within 24
571 hours from time of notification.

572
573 Temporarily replace under-warranty material and equipment requiring
574 factory corrections, within 24 hours from time of notification. Install factory-
575 corrected or new material and equipment no later than 30 days from time of
576 notification.

577
578 **623.04 Measurement.** Traffic signal system will be paid on a lump sum basis.
579 Measurement for payment will not apply.

580
581 **623.05 Payment.** The Engineer will pay for the accepted traffic signal system on
582 a contract lump sum basis. Payment will be full compensation for the work
583 prescribed in this section and the contract documents.

584
585 The Engineer will pay for the following pay item when included in the proposal
586 schedule:

587	Pay Item	Pay Unit
588	589 Traffic Signal System	Lump Sum

590
591 The Engineer will pay for the accepted hauling and stockpiling of salvaged
592 materials and equipment off the right-of-way, as ordered by the Engineer, in
593 accordance with Subsection 104.02 - Changes.

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END OF SECTION 623