

SECTION 770 – TRAFFIC SIGNAL MATERIALS**770.01 Traffic Signal Standards.**

(A) Type I Traffic Signal Standards. Steel Type I traffic signal standards shall be furnished. Each traffic signal standard shall be furnished with anchor base; uniform, continuously tapered steel shaft; anchor bolts and nuts; handhole and handhole cover; and other associated hardware necessary to make each traffic signal standard complete. Entire assembly shall have no rough edges or surfaces, depressions, or other defects.

(1) Shaft. Shaft shall be constructed of minimum No. 10 gage material from open hearth, hot rolled steel or high tensile low alloy steel conforming to ASTM A 1011 or ASTM A 595, with one-piece construction. Shaft length with 10-foot mounting height shall be provided.

(2) Handhole. Shaft shall have reinforced opening for a handhole, located approximately 9 inches above bottom surface of anchor base plate. Reinforced opening shall be furnished with gasket, cover plate, and non-slip fastener. Opening shall have 3-inch by 5-inch minimum inside measurement. A 1/4-inch by 1-inch long bolt, with nut and washer, shall be welded inside shaft opposite handhole.

(3) Anchor Base. Steel casting, steel forging, or steel plate anchor base shall be integral part of standard. Anchor base shall be of sufficient strength to support standard. Anchor base shall have four holes, on 8-1/2 inch diameter bolt circle (6 inches square), sized to accommodate anchor bolts provided. Base plate shall be secured to lower end of shaft with continuous arc welds.

(4) Anchor Bolts. Anchor bolts shall have size, strength, and length in accordance with manufacturer's recommendations and shall conform to Subsection 718.01 - Standard Fasteners. Anchor bolts shall have "L" bends or plate washers at bottom. Each anchor base shall have four anchor bolts, with leveling nut, top nut, and two washers for each anchor bolt. Anchor bolts, washers, and nuts shall be zinc-coated.

(5) Finish. Complete standard and other ferrous material after fabrication shall be hot-dipped and zinc-coated, internally and externally in accordance with AASHTO M 232 and AASHTO M 111.

(B) Type II and Type III Traffic Signal Standards. Type II and Type III traffic signal standards shall accommodate mast arm mounting of traffic signals, with or without bracket-mounted traffic signals.

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(1) Description. Traffic signal standards with single tapered tube mast arm shall include the following:

(a) Tapered steel shaft complete with anchor base, anchor bolts, handhole, ground lug, cast pole top, and flange plate near top of pole for mounting mast arm.

(b) Tapered steel arm complete with mounting flange plate, hanger clamp, and outlet having 1-inch I.D. rubber grommet to accommodate wiring each signal, and removable end cap.

(c) Steel castings conforming to ASTM A 27, grade 65-35, and gray iron castings conforming to ASTM A 126, Class A. Steel castings shall be clean and smooth with details well defined and true to pattern.

(2) Design. Traffic signal standards shall be designed to support traffic signals mounted on mast arm. Traffic signal mounting height shall be 25 feet unless otherwise indicated in the contract documents.

(3) Shaft. Shaft shall be constructed of No. 10 gage minimum, hot-rolled sheet steel conforming to ASTM A 1011 or ASTM A 595. Silicon content shall be kept to less than 0.06 percent, and boron shall not be added. Transverse seams shall be perpendicular to shaft axis. Reinforce transverse seams with internal sleeves welded in place. Shaft size shall be minimum of 9-3/8 inches outside diameter (bottom of shaft) by 5-1/4 inches outside diameter (top of shaft) by 20 feet long.

Four inch by 6-1/2 inch reinforced handhole frame shall be welded, complete with cover, into shaft approximately 9 inches above bottom of base. Reinforced handhole frame shall be tapped for cap screws to secure cover plate.

Flange plate of thickness recommended by manufacturer shall be welded to pole near top. Flange plate shall be supported with side plates tangent to pole, and gusset plates at top and bottom. Flange plates shall have deburred 2-1/2 inch-diameter wiring hole and four tapped bolt holes. Welding shall be performed in accordance with Subsection 501.03(D) - Shop Work and Fabrication.

J-hook wire support shall be welded near top of shaft. Top of shaft shall be capped with cast pole top, secured in place with setscrews.

(4) Anchor Base. Single-piece steel anchor base of sufficient strength, shape, and size to support standard shall be secured to lower end of shaft by two continuous electric arc welds. Shaft shall

97 telescope with base. One weld shall be on inner portion of base at
98 end of shaft and another weld shall be on outside at top of base. An
99 approximately 2-inch separation shall be provided between the two
100 welds.

101
102 Base shall have four holes sized to accommodate anchor bolts.

103
104 **(5) Tapered Mast Arm.** Mast arm shall be made from material
105 from single length of No. 10 gage minimum hot rolled sheet steel
106 conforming to ASTM A 1011 or ASTM A 595. Silicon content shall be
107 kept to less than 0.06 percent, and boron shall not be added.

108
109 Large end of mast arm shall telescope with flange plate of
110 thickness recommended by manufacturer. Flange plate shall be
111 welded to mast arm by two continuous electric arc welds. One weld
112 shall be on outer portion of plate next to shaft and another weld shall
113 be on inner portion at end of tubular cross section. Four holes in
114 flange plate shall match four tapped holes in mounting plate on pole.

115
116 **(6) Anchor Bolts.** Each pole shall have four steel anchor bolts,
117 with each bolt fitted with two hex or heavy hex nuts. Each anchor bolt
118 shall have "L" bend or plate washer welded to bottom. Anchor bolts
119 shall be threaded at top end. Bolts shall be of strength, size, and
120 length recommended by manufacturer and as specified in Subsection
121 718.01 - Standard Fasteners, to support pole shaft, mast arm, and
122 mounted signal heads.

123
124 **(7) Zinc-coating.** Steel and iron parts of base, shaft and mast arm
125 shall be zinc-coated in accordance with AASHTO 232. Washers and
126 nuts may be hot-dip zinc-coated or electro-zinc-coated.

127
128 **(C) Standard Specifications.** Design of traffic signal standards and
129 appurtenances shall conform to AASHTO publication, *Standard*
130 *Specifications for Structural Supports for Highway Signs, Luminaires and*
131 *Traffic Signals.*

132
133 **(D) Certification and Mill Test Reports.** Certification and mill test
134 reports shall be submitted with the following information:

135
136 **(1)** List of component parts including the following:

137
138 **(a)** Description of each part.

139
140 **(b)** Materials manufacturing location (including ASTM
141 number where applicable).

142
143 **(c)** Certificate of compliance.
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145 (2) Shop drawings accompanied by complete and detailed
146 engineering computations that justify selection of dimensions and
147 material. Hawaii Licensed Professional Engineer (Structural) shall
148 certify computations.

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150 (3) Copy of mill test report for structural members (posts and
151 beams), including physical and chemical descriptions of material
152 incorporated.

153
154 **770.02 Traffic Signal Heads.**

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156 (A) **Standard Traffic Signal Heads.** Each signal head shall conform to
157 the following characteristics: adjustable, light-colored, vertical-type, with
158 number and type of sections as specified; indications in one direction only;
159 and adjustable through 360 degrees about its vertical axis.

160
161 Vertical signal heads shall contain three sections with the following
162 configuration:

TABLE 770.02-1 - STANDARD TRAFFIC SIGNAL HEAD CONFIGURATION	
Red	Top
Yellow	Center
Green	Bottom

164
165 (1) **Optical Units.** Each optical unit shall include lens, reflector,
166 lampholder, and clear traffic signal lamp.

167
168 Standard lenses shall be of color specified, circular in shape,
169 and have diameter of approximately 12 inches. Lenses shall be true
170 to color, free from imperfections, and of high luminous transmission.
171 Lens may be made of glass or of polycarbonate resin. Glass lens
172 shall conform to latest ANSI standard for glass lens. Polycarbonate
173 lens shall be molded of ultraviolet, pre-tinted transparent
174 polycarbonate.

175
176 Each reflector shall have one-piece, clear glass parabolic
177 reflector, free from bubbles and striae, or Alzak (proprietary anodizing
178 process) processed aluminum alloy. Convex surface of clear glass
179 shall be coated by silver using chemical deposition. Reflector shall be
180 of sufficient thickness such that lighted filament of 150-watt
181 incandescent lamp is not visible through silver layer. Silvered surface
182 shall be protected by additional coating of electrolytically deposited

183 copper. Opening in back of reflector for lampholder shall cause no
184 dark spots cast on lens.

185
186 Lampholder shall be weatherproof, of molded construction,
187 immune to operating temperatures in unit, vibration-proof, and
188 substantially supported. Lampholder shall have two wires of sufficient
189 length so that lampholder may be connected to terminal block
190 specified herein. Lamp filament shall be positioned at focal center of
191 reflector.

192
193 Each reflector, lens, and hood shall be designed to minimize
194 sun phantom.

195
196 Lamps shall be 135 watts, 120 volt, 5000-hour rated life, clear,
197 traffic signal lamps conforming to ITE *Standard for Traffic Signal*
198 *Lamps*.

199
200 Incandescent, non-programmable vehicle signal shall conform
201 to the following requirements:

202
203 **(a)** Replace incandescent signal of vehicle signal head with
204 Light-Emitting Diode (LED) signal assembly comprised of high-
205 out LED light source protected by impact-resistant
206 polycarbonate lens. LED head assembly shall replace
207 standard 12-inch incandescent polycarbonate signal head.
208 Operating at 60 to 135 volts and with maximum power
209 consumption of 22 watts.

210
211 **(b)** To ensure quality and performance, LED head shall
212 have prior history of testing and use by CALTRANS and shall
213 exceed ITE standards. Failure on one LED shall not affect
214 other LED. LED head shall have fully-encapsulated electronic
215 circuitry and configuration for 12-inch ball. LED head shall be
216 McCain Traffic Supply 12-inch LED Traffic Head or equal.

217
218 **(2) Housing.** Signal head housing or case shall be assembly of
219 separate interchangeable sections. Interchangeable sections shall be
220 expandable type for vertical mounting without tie rods, and shall be
221 secured together in watertight manner to form unit. Individual optical
222 units shall be housed in each section. The side of housing or door
223 containing lens shall be square. Housing may be of aluminum or
224 polycarbonate resin.

225
226 Die cast aluminum housing shall conform to ASTM B 85 with
227 aluminum doors and end plates. Parts shall be clean, smooth and
228 free of flaws, cracks, blowholes, and other imperfections.

229
230

230 Polycarbonate housing shall be ultra-violet-stabilized virgin
231 polycarbonate resin of specified color, injection molded, complete with
232 integral top, bottom, and sides; and shall have minimum thickness of
233 0.09 inch.

234
235 Each section shall be furnished complete with one-piece hinged
236 door mounting for lens and other parts of optical system, watertight
237 gaskets, and simple door-locking device. Optical system shall be
238 mounted to allow for swinging various parts open for ready access or
239 removal. Sections shall be interchangeable and designed to permit
240 removing or adding of sections. Round opening shall be provided in
241 top and bottom of each section face to receive 1-1/2 inch supporting
242 pipe frame.

243
244 Exposed bolts, screws, hinge pins, and door-locking devices
245 shall be made of stainless steel. Interior screws and fittings shall be
246 made of stainless steel or other corrosion-resistant material accepted
247 by the Engineer.

248
249 Gaskets, including door, lens and reflector gaskets, shall be of
250 neoprene. Lampholder gaskets shall be heat-resistant.

251
252 Lampholders shall be wired to provide for connection of white
253 wire to shell of lampholder and black or colored wire to bottom or end
254 terminal of lampholder. These wires shall connect to terminal block
255 mounted inside at back of housing. Each terminal block shall be
256 furnished with sufficient screw-type terminals spaced to terminate all
257 field conductors and lamp conductors independently. Terminals to
258 which field conductors are attached shall be permanently identified or
259 conductors shall be color-coded to aid field wiring.

260
261 Each lens shall be furnished with removable tunnel-type hood
262 made of 0.030-inch-thick sheet aluminum or of polycarbonate with
263 minimum thickness of 0.060 inch. Hoods shall be 11 inches minimum
264 in length.

265
266 Aluminum housing shall be painted with one coat of alkyd,
267 corrosion-inhibiting, lead and chromate free, VOC (volatile organic
268 compound) -compliant primer coating, Society for Protective Coatings
269 Specification SSPC-25; and one coat of medium gray enamel alkyd,
270 semi-gloss, low VOC content, Master Painters Institute (MPI)
271 Standard No. 94. Dark green enamel finish coat shall be Alkyd Urea
272 Exterior Baking Enamel, Federal Standard FED-STD-595B. Dark
273 green enamel shall match color chip on file with the Department.
274 Signal face housing and entire surface of hood used in front of signal
275 lens shall be painted dull black. Polycarbonate housing shall be
276 painted dark green.

277

278 **(3) Directional Louvers.** Directional louvers shall be constructed
279 to fit snugly in signal hoods. Outside cylinder and vanes shall be
280 constructed of No. 22 U.S. gage sheet steel, and vanes constructed of
281 No. 27 U.S. gage sheet steel; or cylinder and vanes of aluminum alloy
282 3003-H14 sheet of similar construction. Sheet steel louvers shall be
283 zinc-coated after fabrication. Louvers shall be painted dull black.

284
285 **(4) Back Plates.** Back plates shall be furnished and installed on
286 signal heads. Back plates shall be constructed of aluminum alloy
287 3003-H14 sheet having minimum thickness of 0.058 inch and
288 minimum dimensions equal to signal head size plus eight-inch border.
289 Back plates shall be painted dull black.

290
291 **(B) Signal Head Mounting.** Top of pole, bracket, cantilever, and under-
292 slung-mounted signal faces shall be supported by watertight assemblies of
293 1-1/2 inch standard steel pipe and malleable iron, or brass pipefittings and
294 hardware as specified. Mounting assembly members shall be plumb or level,
295 symmetrically arranged and securely assembled. Conductors shall be
296 concealed within assemblies. Pipe slipfitter assemblies shall be of cast-iron,
297 bronze, or malleable iron. Slipfitters shall fit over 4-1/2 inch outside diameter
298 standard pipe for top of pole mountings or 2-3/8 inch outside diameter tenon
299 at end of mast arms. Mast arm end mounting fittings shall be 90-degree-type
300 or elevator-type, as specified. Each slipfitter shall be provided with at least
301 two cadmium-plated steel setscrews to secure assembly in plumb position.
302 Each pipe bracket assembly shall be attached to traffic signal standard with
303 1-1/2 inch pipe couplings. Caps shall seal unused mounting holes in traffic
304 signal housing.

305
306 Signal faces shall be equipped with positive, non-ferrous, lock rings
307 and fittings that are designed to prevent signal faces from turning by external
308 forces. Lock ring and connection fittings shall have serrated contacts.
309 Fittings shall permit fastening at increments of less than 7 degrees.

310
311 Mountings shall be painted with one coat of zinc-coated metal primer
312 and two coats of dark green enamel, as specified for signal housings.

313
314 Mark various parts of each mounting for easy assembly, if mountings
315 are delivered disassembled.

316
317 Signal heads mounted at intermediate points on mast arms shall be
318 equipped with mast arm mounting bracket. Component parts of mast arm
319 mounting shall include bracket with vertical tube. Vertical tube shall have
320 upper and lower devices to fasten signal face at bottom and top of mast arm
321 face. Vertical tube shall be connected to mast arm with clamp casting and
322 two high-strength stainless steel bands. Stainless steel bands shall be

323 tightened by screw assembly (one per stainless steel band). Signal face
324 shall rotate through mounting assembly. Signal face shall rotate about mast
325 arm, and right and left from vertical plane.
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327 Polycarbonate traffic signal heads shall be equipped for post top
328 mounting, with internal reinforcement for mounting base; or shall be equipped
329 for Type IA mounting.
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331 **(C) Programmed Visibility Traffic Signal Heads.**
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333 **(1) General.** Signal heads shall permit visibility zone of indication
334 to be determined optically and require no hoods or louvers. Projection
335 indication may be selectively visible or veiled anywhere within 15
336 degrees of optical axis. No indication shall result from external
337 illumination, nor shall one light unit illuminate another light unit.
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339 **(2) Optical System.** Components of optical system shall include
340 lamp, lamp collar, optical limiter-diffuser, and objective lens.
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342 Lamps shall be nominal 150-watt, 120-volt AC, 3-prong, sealed
343 beam having integral reflector with stippled cover and average rated
344 life of at least 6,000 hours. Lamps shall be coupled to diffusing
345 element with collar including specular inner surface. Diffusing element
346 may be discrete or integral with convex surface of optical limiter.
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348 Optical limiter shall provide accessible imaging surface at focus
349 on optical axis for objects 900 to 1,200 feet away, and permit effective
350 veiling mask to be variously applied as determined by desired visibility
351 zone. Optical limiter shall include heat-resisting glass with positive
352 indexing means.
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354 Objective lens shall be high-resolution, planar incremental lens,
355 hermetically sealed within flat laminate of weather-resistant acrylic or
356 accepted equal. Lens shall be symmetrical in outline. Lens shall be
357 rotated to 90-degree orientation about optical axis without displacing
358 primary image.
359

360 Optical system shall accommodate projection of diverse,
361 selected indication to separate portions of roadway such that only one
362 indication will be simultaneously apparent to viewer. Projected
363 indication shall conform to ITE transmittance and chromaticity
364 standards.
365

366 **(3) Construction.** Die cast aluminum parts shall conform to ITE
367 alloy and tensile requirements and have chromate preparatory
368 treatment. Exterior of signal case, lamp housing, and mounting
369 flanges shall have finish of high-quality baked enamel prime and finish
370 paint (dark green exterior enamel). Lens holder and interior of case

371 shall be optical black.
372

373 Signal case and lamp holder shall be predrilled for backplates
374 and visors. Hinges and latch pins shall be made of stainless steel.
375 Access openings shall be sealed with weather-resistant rubber
376 gaskets.
377

378 Visors shall conform to ITE material requirements and include
379 chromate-preparatory treatment and optical black on surfaces.
380 Cutaway-type visors shall be 9-1/2 inches.
381

382 **(4) Electrical.** Lamp fixture shall include separately accessible
383 housing and integral lamp support, indexed ceramic socket, and
384 self-aligning, quick-release lamp retainer. Electrical connection
385 between case and lamp housing shall be made with interlock
386 assembly that disconnects lamp holder when opened. Each signal
387 section shall have covered terminal block for clip or screw attachment
388 of lead wires. Sections shall be interconnected with concealed No. 18
389 AWM, stranded and coded wires.
390

391 **(5) Photo Controls.** Each signal section shall have integral
392 means for regulating intensity between limits as function of individual
393 background illumination. Lamp intensity shall have more than 97
394 percent of uncontrolled intensity at 1,000 foot-candles, and reduce to 15
395 percent ± 2 percent of maximum at less than one foot-candle.
396 Response shall be proportional and essentially instantaneous to
397 detectable increase of illumination from darkness to 1,000
398 foot-candles, and damped for decrease from 1,000 foot-candles.
399

400 Intensity controller shall include an integrated directional light-
401 sensing and regulating device interposed between lamp and line
402 wires. Intensity controller shall be compatible with 60 Hz input and
403 responsive within range of 105 to 135 volts. Output may be phase
404 controlled, but device shall provide nominal terminal impedance of 1,
405 200 ohms open circuit and corresponding holding current.
406

407 **(6) Mounting.** Signal shall be mounted to standard 1-1/2-inch
408 fittings as single section, multiple section face, or in combination with
409 other signals. Signal section shall have adjustable connection that
410 permits incremental tilting from 0 degree to 10 degrees above or
411 below horizontal axis while maintaining common vertical axis through
412 couplers and mounting.
413

414 Terminal connection shall permit external adjustment about
415 mounting axis in 5-degree increments. Signal shall be mountable with
416 ordinary tools and serviceable without tools.
417

418 Pedestal adapter shall fit Type I signal standard with each

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419 programmed visibility signal. Four-section heads shall be mounted
420 using Type IA mounting.

421

422 Visor shall conform to existing mounting surfaces and fasten to
423 existing mounting surfaces without affecting water and light integrity of
424 signal.

425

426 **(7) Miscellaneous.** Roll of optical masking tape, applicator, and
427 instruction manual shall be furnished with each face.

428

429 **770.03 Dual Indication Unit (Fiberoptics).**

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431 **(A) Functional Requirements.** Dual indication unit shall conform to the
432 following:

433

434 **(1)** Display two alternately colored legends of green arrow or
435 yellow arrow. Color filters installed shall be changed in unit to provide
436 combinations of colors.

437

438 **(2)** Have clearly visible legend under all lighting conditions. Visor
439 shall be furnished with unit.

440

441 **(3)** Be visible at full intensity everywhere within 20-degree cone
442 centered about optical axis.

443

444 **770.04 Pedestrian Signal.** Pedestrian signal shall be designed to fit mountings
445 provided for vehicular signals as specified.

446

447 **(A) Features.** Provide the following features:

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449 **(1)** Elimination of sun phantom.

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451 **(2)** Improved light output.

452

453 **(3)** Protection from vandalism.

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455 **(4)** Simplified maintenance.

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457 **(5)** Improved low-temperature operation.

458

459 **(6)** Simplified handling.

460

461 **(7)** Elimination of high-tension leads.

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463 **(8)** Operation at 90-volt applied line voltage.

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465 Neon tubing shall be enclosed in single plug-in plastic module. Neon
466 tubing shall be protected from shocks generated during shipping, handling,

467 and installing.

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Maximum overall signal dimension shall be 19 inches wide, 19 inches high, and 9-1/4 inches deep, including egg-crate-type visor and hinge. Signal shall be furnished complete with transformers and tubing installed. Installation and maintenance of signal shall be facilitated by designing signal door that provides front access to components

(B) Messages. Messages shall be Portland orange "HAND" and Lunar white "WALKING PERSON" illuminated by multiple configuration neon tubes encased in molded plug-in plastic message module.

"HAND" and "WALKING PERSON" symbols shall be minimum 12 inches in height, 7 inches in width, and uniformly illuminated with no dark spots.

Inside face of message lens shall be painted except where desired symbols are formed. First coating of paint shall be black. Second coating of paint shall be white.

(C) Message Module. Message module shall have two neon gas tubes enclosed. Message module shall be protected by housing made of white acrylonitrile butadiene styrene or polycarbonate plastic and screened message lens made of polycarbonate plastic. Ten-millimeter diameter tube shall be used for "HAND" symbol. Tube used on inside shall be coated with fluorescent material producing desired Portland orange output. Nine-millimeter diameter tube shall be used for "WALKING PERSON" symbol. Tubing shall be coated on inside with fluorescent material producing desired Lunar white output. Tubing shall be formed to approximate shape of "WALKING PERSON" and positioned for maximum Lunar white intensity.

Two neon tubes shall be mounted to plastic housing via resilient rubber adhesive to prevent transfer of mechanical strain to glass tubing and to provide effective shock absorbing mounting. Plastic housing shall be molded to provide positive location of neon tubing in relation to screened message lens.

Message lens shall be of 1/8-inch minimum thickness, clear, U.V. stabilized, refract-type, and polycarbonate plastic with outer prisms. Lens shall be weather-resistant, craze-resistant, and heat-resistant. Prism pattern (designed as C-4) shall be one that faces outside of module with screened message enclosed within module.

Message module shall be sealed into integral assembly with one-piece sponge, neoprene gasket fitted around perimeter to provide positive protection of neon tubing from handling, weather, and moisture.

Message module shall have electrical contacts that plug directly into

515 recessed contacts in transformer enclosure when module is in proper
516 position. Message module shall not require use of tools for insertion or
517 removal.

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519 **(D) Case.** Case shall be one-piece, corrosion-resistant, die-cast
520 aluminum alloy that is complete with integrally cast top, bottom, sides, and
521 back. Four integrally cast hinge lug pairs shall facilitate operation of swing
522 open door.

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524 Case for pedestrian signals shall be dust-proof, weatherproof, and
525 corrosion-resistant. Case shall provide for easy access and replacement of
526 components.

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528 Case shall be suitable for post-top or bracket mounting.

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530 Top and bottom of case shall have opening to adjust standard 1-1/2
531 inch pipe brackets. Bottom opening of signal case shall be furnished with
532 "Shurlock" boss integrally cast into the case. Dimensions of "Shurlock" boss
533 shall be as follows: outside diameter – 2-5/8 inches, inside diameter –
534 1-31/32 inches, number of teeth – 72, angle of teeth – 90 degrees, depth of
535 teeth – 5/64 inch. Teeth shall be clean, sharp, and provide full engagement.

536 Radial angular grooves of "Shurlock" boss, when used with "Shurlock"
537 fittings, shall provide positive positioning of entire signal to eliminate rotation
538 or misalignment of signal.

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540 **(E) Door Frame.** One-piece corrosion-resistant, aluminum alloy casting
541 doorframe shall be furnished complete with two hinge lugs and two latch slots
542 for each door. Door shall be attached to case by two Type 304 stainless
543 steel spring pins. Two stainless steel hinged bolts with captive stainless steel
544 wing nuts and washer shall be attached to case with use of stainless steel
545 spring pins. Latching or unlatching of door shall require no special tools.

546

547 **(F) Z-Crate Visor.** Each signal shall be furnished with Z-crate type visor
548 designed to eliminate sun phantom. Z-crate type sunshield shall be installed
549 parallel to face of "HAND" and "WALKING PERSON" messages. Z-crate
550 visor assembly shall be held in place by stainless steel screws. Z-crate
551 assembly shall be furnished with minimum of 20 straight horizontal louvers
552 and 21 horizontal louvers, each one formed in zigzag pattern.

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554 Every other formed louver shall be reserved to form cells 1-inch
555 square but rotated 45 degrees from horizontal to provide diamond-shaped
556 cells when assembled. Each diamond shall be bisected by insertion of
557 straight louver interspersed between each pair of formed zigzag louvers. If
558 each apex of each formed louver comes in contact with interspersed straight
559 louver, entire length of joint shall be chemically welded. Basic material used
560 in construction of Z-crate visor shall be nominally 0.030 inch thick and 100
561 percent impregnated black polycarbonate plastic processed with flat finish on
562 both sides.

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Assembly shall be enclosed in mounting frame constructed of minimum 0.040-inch-thick aluminum. Frame shall be 1-1/2 inches deep and contain mounting holes for direct insertion in pedestrian signal doorframe.

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(G) Transformers. Two transformers shall be furnished with recessed secondary contacts and integral Pyrex glass electrode housing. Transformers shall be mechanically locked together, requiring four mounting bolts for mounting entire transformer assembly. Both transformers shall be furnished with 4000-volt, 30-milliampere secondary.

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Each transformer shall be furnished with 120-volt (nominal) primary windings and power factor of 90 percent, minimum. Transformers shall nominally require only 39 watts each at 115VAC.

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(H) Fused Switch. Fused switch shall be furnished inside case on terminal blocks for de-energizing transformer primary circuit. Fused switch shall include two cartridge fuses and lever for disconnecting fuses.

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(I) Painting. Before final assembly, case, doorframe, and Z-crate visor (aluminum portion only) shall be cleaned and a chromate conversion coating applied inside and out, in accordance with Military Specification MIL-C-5541E. Synthetic enamel, alkyd, semi-gloss, low VOC content, conforming to Master Painters Institute (MPI) Standard No. 94, shall be applied electrostatically. Color shall be same as standard traffic signal head. Finish shall be oven-cleaned for minimum of 20 minutes at 350 degrees F.

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(J) Pedestrian Signal Push Button with Integral Sign. Pedestrian push buttons shall be tamperproof, weatherproof, and constructed to prevent electrical shocks.

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One-half-inch threaded opening shall be furnished at bottom of housing for conduit connection. Raised drip shield shall be furnished around push button.

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Sign shall be non-reflectorized and shall conform to requirements of Section 631 – Traffic Control Regulatory, Warning, and Miscellaneous Signs.

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770.05 Controller Equipment.

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(A) Controller Assembly. Controller assembly shall include Model 170E controller, cabinet, and auxiliary equipment. Unless otherwise indicated in the contract documents, only manufacturers and products listed for Model 170E Controller Unit on State of California Department of Transportation (CALTRANS) “Qualified Products List (QPL) for Controller Assemblies for the Model 170/2070 Traffic Controller” shall be acceptable. Copy of QPL is available from City & County of Honolulu, Department of Transportation Services, phone (808) 527-6988.

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Testing and quality control requirements shall be as specified in Subsection 623.03(G)(2)(a).

Controller assemblies are described and shall be supplied as follows:

(1) Model 170E controller assembly and Model 332A controller cabinet refers to latest Model 170E controller assembly and Model 332A controller cabinet listed on CALTRANS QPL.

(2) Each controller assembly listed in Table 770.05-1 - Controller Assembly Requirements contains sufficient equipment for full 8-vehicle, 4-pedestrian, and 4-preemption phase intersection, even though the contract documents may not require it.

TABLE 770.05-1 - CONTROLLER ASSEMBLY REQUIREMENTS	
Item	Quantity
Model 170E controller	1
Model 412D prom module	1
Model 400 modem	1
332A aluminum cabinet	1
Model 200 load switches	12
Model 204 flasher	All
Model 242 isolators	4
Model FS/ST isolator	All
Flash transfer relays	All
Model 210 conflict monitor	1
Model C\170 detector amplifiers (Non QPL)	8
Model M762 preempt. card (Non-QPL) with 758 AIP	2
Model UTS (Non-QPL)	1

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(B) Model 170E Controller. Model 170E controller shall meet the following additional requirements:

- (1) Model 412D PROM module shall include 27256 EPROM chip.
- (2) Supercap shall replace battery as standby power supply to keep detector amplifier (DTA) and RAM on CPU board powered for at least eight hours during AC power loss.
- (3) Controller boards shall be mounted vertically.
- (4) One installation manual shall be submitted with each controller.
- (5) Documented validation testing shall be performed in accordance with CALTRANS test specifications.
- (6) Display panel shall be menu-driven.

(C) Cabinet. Each 332A cabinet shall meet the following additional requirements:

- (1) Cabinets shall be wired for minimum eight vehicle phases, four pedestrian phases, and four preemption phases.
- (2) Cabinets shall be fabricated from 0.125-inch-thick anodized aluminum.
- (3) Cabinet's main breakers shall be rated at 50 amps.
- (4) Entire output file copper hard-wire shall be of sufficient gage to withstand current surges before circuit breakers or surge protectors trip.
- (5) LED display for modem transmit, receive, and carrier-detect status shall be clearly visible after opening cabinet's front door. Indicators mounted on 0.75-inch by 2-inch aluminum assembly shall be attached to top center of cabinet's rack. Indicators shall derive signals from C2 ACIA. Wires shall be bundled with protective jacket.
- (6) C2 terminal blocks shall be protected from current surges by EDCO PC642 or equal.
- (7) Input file and field terminal blocks shall be wired for 3M 752 Opticom Priority Module EVA, EVB, EVC, and EVD.
- (8) Power supply surge protector shall be furnished.

- 674 (9) Front and back fluorescent lights shall be activated upon
 675 opening either door.
 676
- 677 (10) Convenience ground-fault circuit interrupter (GFCI) receptacles
 678 shall be provided.
 679
- 680 (11) Door locks shall be of solid brass rim Best Lock Series
 681 516RL3XA7559-606 and includes two keys.
 682
- 683 (12) Labeling shall be by silk screening only.
 684
- 685 (13) Output file terminal blocks shall be labeled in reference to its
 686 assigned phase and signal indications.
 687
- 688 (14) One each 24-inch by 36-inch cabinet print shall be attached in
 689 weatherproof plastic jacket to front and back cabinet doors.
 690
- 691 (15) Documented validation testing of cabinet and conflict monitor
 692 shall be performed in accordance with CALTRANS test specifications.
 693
- 694 **(D) Auxiliary Equipment.** Controller unit shall be delivered supplied with
 695 the following auxiliary equipment:
 696
- 697 **(1) Model M752 Optical Preemption Module.** M752 shall be
 698 card-type and shall interface with Model 170E cabinet preemption
 699 slots of input file. Each M752 Module shall have two channels of
 700 preemption. M752 shall include firmware to discriminate between two
 701 valid priority signals, to prioritize valid same priority signals on a first
 702 come, first served basis, and to override low priority signal if high
 703 priority is received. M762 Module shall receive input signals (9.639
 704 and 14.035 Hz) to permit priority preemption operation within 170E
 705 local intersection program. M762 shall optically isolate output signals
 706 and shall trigger active low signal to controller for high priority and
 707 pulsed active low signal for low priority. The State's preemption
 708 systems employ the 3M Opticom System. New preemption
 709 equipment shall be 3M Opticom or accepted equal that is fully
 710 compatible with 3M Opticom.
 711
- 712 **(2) Universal Time Standard (UTS) Module.** UTS Module shall
 713 be a stand-alone precision clock, located in controller cabinet. UTS
 714 Module shall be used to update internal clock of Model 170E controller
 715 by decoding five broadcast frequencies (2.5, 5, 10, 15, 20 MHz)
 716 transmitted by WWVH (radio station) of the U.S. National Institute of
 717 Standards and Technology. Hardware and software of UTS
 718 equipment shall be compatible without modification to Model 170E
 719 hardware or software. UTS Module shall meet the following
 720 specifications:
 721

- 722 (a) 1.5 ms time accuracy.
- 723 (b) 2 to 4 minutes time to acquire.
- 724 (c) Minimum 5 Frequency, AM, crystal-controlled, dual
725 conversion, super heterodyne receiver, automatic scan 5
726 frequencies.
- 727 (d) Data output RS-232C, 1200 and 2400 baud rate, no
728 parity, 8 data bits, 1 stop bit.
- 729 (e) One-hour selectable time zones and daylight saving
730 time option.
- 731 (f) 24-hour time format.
- 732 (g) Month, day, and year date.
- 733 (h) DB25-RS232 and BNC antenna connector.
- 734 (i) DB25 to Model 170E C2 cable and connectors.
- 735 (j) 2-foot outdoor whip antenna with pole adapter bracket.
- 736 (k) 100 linear feet of RG-58 coaxial cable with connectors.
- 737 (l) Approximate size: 1-1/2-inch high x 8-inch wide x 9-inch
738 deep; and weight 1-1/2 pounds.
- 739 (m) 24 VDC.
- 740 (n) Traconex / Multisonics UTS Model 1010 or equal.
- 741

742 **770.06 Conductors and Cables.** Cables shall conform to IMSA Specification
743 Reference and be certified in writing by IPSA as meeting requirements of the
744 contract documents.

745
746 **(A) Type 1 - Signal-Loop Cable for Load Circuits from the Cabinet**
747 **Looped to Field Pullboxes.** Polyethylene insulated, stranded, 14 AWG
748 copper; 26 conductor cable; polyethylene jacketed; color-coded; IMSA
749 Specification No. 20-1 certified.

750
751 Use one - 26C #14 cable for five phases or less. Use two - 26C #14
752 cables for six or more phases.

753
754 **(B) Type 2 - Home-Run Cable Tie-In Loop Detector Stubs or**
755 **Pedestrian Push Buttons to the Cabinet.** Polyethylene insulated,
756 stranded-tinned-copper 14 AWG; two conductor cable; polyethylene
757 jacketed; 600 Volts rated; IMSA Specification No. 50-2 certified.

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(C) Type 3 - Inter-Connect Cable Tie-in One Signalized Intersection to Another. Polyethylene insulated, solid copper, 19 AWG; 24 conductor (12 twisted pairs) cable; copper shielded with polyethylene jacketed; 300 volts rated; color-coded; IMSA Specification No. 40-2 certified.

Use one - 12 pairs, #19 continuous run from one controller to the next controller. Splicing between controllers will not be allowed.

(D) Type 4 - Detector-Loop Cable for Installation into the Roadway Sawcut. 12 AWG stranded THHN conductor; 600 volts; inserted into polyethylene tube, 0.25-inch maximum diameter; IMSA Specification No. 51-5 certified.

(E) Type 5 - Signal-Drop Cable from 3-Section, RYG Traffic Signal Heads and FDW-W (Pedestrian Signal Head) Dropped from Signal Head on Traffic Signal Standard to Pullbox for Splicing. Polyethylene insulated, stranded; 14 AWG copper; four conductor cable; 600 Volts, color-coded; IMSA Specification No. 20-1 certified.

Use one - 4C #14 cable for 3-section traffic signal head, programmable signal head, and pedestrian signal head.

Use two - 4C #14 cables for fiber optic signal head.

(F) Type 6 - Electrical Service Cable from Electrical Company Secondary Lines to Traffic Signal Meter to Controller Cabinet. RHW-USE; neoprene insulated; three conductors each; size as indicated in the contract documents; BRW color-coded.

(G) Type 7 - Preemption Detector (Opticom) Cables. Preemption detector (Opticom) cables are specific cables that run continuously from optical detectors mounted on traffic signal standards to terminal blocks for M752 phase module located in controller cabinet. Each detector shall be furnished with its own cable running back to controller cabinet. 3M's M138 Optical Detector Cable shall be furnished for detector cable because it is compatible and consistent with requirements for Opticom Preemption System. M138 cable shall be furnished that is BerkTek Type B, shield jacket, three - insulated conductor cable, 20 AWG, one - 20 AWG bare stranded ground, 600 Volts, orange-blue-yellow color coded and 5/16 inch diameter.

(H) Ground Wire. Ground wire shall be single conductor, sized as indicated in the contract documents, solid electrolytic bare copper medium-hard-drawn, weighing approximately 49.9 pounds per 1,000 feet, and suitable for grounded wire. Conductor shall conform to ASTM B 2.

804 **(I) Overhead Construction.** Messenger for overhead interconnect
 805 system shall be 0.25-inch, 7-wire strand conforming to ASTM A 475, extra
 806 galvanized Siemens-Martin grade with breaking strength of 6,000 pounds.
 807 Messenger hangars shall be universal type suitable for 0.25-inch bolts. Use
 808 0.045-inch diameter stainless steel lashing wire. Conductors shall be as
 809 indicated in the contract documents.

810

811 **770.07 Epoxy Sealer.** Epoxy sealer shall be high-viscosity, liquid epoxy
 812 formulated primarily for use in sealing inductive wire loops and leads imbedded in
 813 HMA and portland cement concrete for traffic signal controls and vehicle counters.
 814 Epoxy sealer shall be used for repair work on existing spalls, cracks, and other
 815 deformations in and around saw cuts, housing inductive loops, and leads. Epoxy
 816 sealers shall cure rapidly. Sealant shall be placed on grades up to 15 percent
 817 without excessive flow of material.

818

819 **(A) Composition.**

820

TABLE 770.07-1 - EPOXY SEALER COMPONENTS	
Component A	Parts by Weight
Epoxy Resin ¹	85.00
Orthocresol Glycidyl Ether ²	15.00
Titanium Dioxide (ASTM D 476 Type III or IV)	2.00
Colloidal Silica ³	1.50
Glycerine (ASTM D 1257)	0.50
Silicone Anti-Foam, Type Q	0.01
Component B	Parts by Weight
High Functionality Polymercaptan Hardener ⁴	40.00
N-Aminoethyl Piperazine ⁵	10.00
2, 4, 6-Tri (Dimethyl-aminomethyl) Phenol ⁶	4.00
Polysulfide Polymer ⁷	48.94
Colloidal Silica ³	1.00
Glycerine (ASTM D 1257) ⁸	0.50

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TABLE 770.07-1 - EPOXY SEALER COMPOSITION (CONTINUED)	
Carbon Black	0.10
Silicone Anti-Foam, Type Q	0.01
<p>¹ Di glycidyl ether of bisphenol A, viscosity, 100-160 poise at 25 degrees C; epoxide equivalent 180-200. Color, Gardner 1933, 3 max.</p> <p>² Viscosity at 25 degrees C., 5-10 Centipoise. Weight per gallon 9.00-9.10 pounds. Epoxide equivalent 180-200.</p> <p>³ SiO₂, (moisture-free basis), 99 percent minimum; refractive index, 1.46; surface area, 175-225 square meters per gram; particle size 0.015 microns; pH (4 percent aqueous dispersion), 3.5-4.2; pour density, 2.3 lbs./cu. ft. maximum; free moisture at 105 degrees C., 1 percent maximum.</p> <p>⁴ Liquid polymercaptan resin, viscosity 100-130 poise at 25 degrees C; specific gravity 1.14-1.16; mercaptan value, 3.6 meg/gram. Color, Gardner 1933, 1.</p> <p>⁵ Color (APHA) 50 maximum, amine value 1250-1350 based on titration that reacts with the 3 nitrogens in the molecule; appearance clean and substantially free of suspended matter.</p> <p>⁶ Formula weight 265; specific gravity at 25 degrees C; distillation range 96 percent at 130 degrees C to 160 degrees C (0.5-1.5 mm.); flash point, Tag Open Cup, 300 degrees F minimum; water content 0.06 percent maximum.</p> <p>⁷ Specific gravity, 1.24-1.30 at 20 degrees/20 degrees C; viscosity, 700-1200 centipoises, Brookfield at 25 degrees C; pH water extract, 6.0-8.0; moisture content, 0.1 percent maximum; pour point, -15 degrees F; average molecular weight, 1000; flash point, degrees F, Cleveland Open Cup, 390 minimum; sulfur content, percent, 36-40; color, Hellige, 9-12. The product shall be difunctional mercaptan made from 8 mole percent of bis (2-chloroethyl) phenol and 2 mole percent of trichloropropane.</p> <p>⁸ Surface area, square meters/gram, 80-150; particle diameter millicrons, 18-30; pH, 7.0-8.5; fixed carbon (moisture free), percent, 96-98; volatile matter, 1-4; oil absorption, stiff past endpoint, cc/gram, 0.75-0.90.</p>	

823
824**(B) Characteristics of Components.**

TABLE 770.07-2 - EPOXY SEALER COMPONENT CHARACTERISTICS		
Characteristics	Component A	Component B
Viscosity, Poise, Brookfield	100 – 250	100 - 250
Shear Ratio (minimum)	2.0	1.8

825
826
827**(C) Characteristics of Combined Components.**

TABLE 770.07-2 - EPOXY SEALER COMBINED COMPONENT CHARACTERISTICS	
Gel Time, minutes (minimum)	13 to 18
On 1/8-inch cast sheet, cured 18 hours at 77 degrees F \pm 5 hours at 158 degrees F.	
Tensile Strength, psi (minimum)	400
Elongation, percent (minimum)	90
Shore D Hardness (minimum)	45
Color of Mixed Components	Color No. 26081 to Color No. 26173 of Federal Standard No. 595B

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(D) Directions for Use. Sawcuts shall be cleaned and dried with compressed air to remove excess moisture and debris. For repairing damaged sawcuts, loose, spalled material shall be cleaned away from saw cut, chipping back to sound asphalt concrete or portland cement concrete, and loose material shall be cleaned from loop wires. Mixing ratio by volume shall be one part of Component "A" to one part of Component "B". Only the amount that can be used within 10 minutes shall be mixed from the time mixing operation starts.

770.08 Hot Applied Rubberized Sealant. Hot applied rubberized sealant shall be flexible and suitable to seal inductive wire loops imbedded in HMA and portland cement concrete pavements for traffic signal work and vehicle counters. Sealant shall be non-tracking under traffic; and at application temperatures, sealant shall be

770.08

842 a thin, free-flowing fluid that penetrates saw cuts and self-levels to permit uniform
843 applications. Sealant shall be melted and applied to pavements using pressurized
844 application unit. Sealant shall be relatively stiff but remain flexible at low pavement
845 surface temperatures. Test results shall conform to the following:
846

TABLE 770.08 - 1 - HOT APPLIED RUBBERIZED SEALANT	
TESTS	SPECIFICATIONS
Penetration, 77 degrees F (maximum)	25 to 35
Flow, 140 degrees F, mm (maximum)	0 to 5
Resilience, 77 degrees F, percent (minimum)	40
Softening Point, degrees F (minimum)	180
Ductility, 77 degrees F, cm, (minimum)	30
Mandrel Bend, 0 degrees F, 180 degrees 5s, 1/2-Inch Diameter	-
Recommended Pour Temperature, degrees F	380
Safe Heating Temperature, degrees F	410
Viscosity, 375 degrees F, poise	30
Unit Weight, pounds/gallon	10.0
Coverage, 1/2-Inch x 1/2-Inch Crack, pounds per 100 foot	13.0

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848

848 **770.09 High Performance Detector Loop Sealant.** Sealant shall provide
849 environmental protection for loop vehicle detection system wires. Sealant
850 material shall have sufficient compressive yield strength to withstand normal
851 vehicular traffic and shall have sufficient flexibility to withstand normal movement
852 in asphalt and concrete road pavements. Sealant material shall protect loop wire
853 from moisture, penetration, fracture, and shear forces.

854
855 **(A) General.** Sealant shall have the following characteristics:

856
857 **(1)** One-part elastomeric compound requiring no mixing,
858 measuring, or application of heat prior to or during its installation.

859
860 **(2)** Cure only in presence of moisture when within its stated shelf
861 life and when contained in original undamaged packaging. Rate of
862 cure depends upon temperature and relative humidity at time of
863 installation. Cool, dry weather will slow curing; warm, humid weather
864 will accelerate curing.

865
866 **(3)** Flow characteristics that ensure complete encapsulation of
867 wires.

868
869 **(4)** Viscosity such that sealant remains in detector sawcut in
870 sloped roadbed areas during or after application.

871
872 **(5)** Enables vehicular traffic to pass over properly filled 1/4-inch- to
873 3/8-inch-wide sawcut immediately after installation. Sealant shall not
874 pull out of sawcut during curing.

875
876 **(6)** Exhibits minimal shrinkage during curing.

877
878 **(7)** Sealant shelf life, in undamaged containers when stored below
879 80 degrees F, shall be as follows:

880
881 **(a)** Liter ply packs: Nine months after receipt.

882
883 **(b)** Five gallon pails (containing 4.5 U.S. gallons): 12
884 months after receipt.

885
886 **(c)** Gallon drums (containing 50 U.S. gallons): 12 months
887 after receipt.

888
889 **(8)** Permits cleanup with cleaner that shall not threaten or cause
890 harm to workers or environment.

891
892 **(B) Retention Test.** Percent by weight retention test used to measure
893 non-flow properties of one-component sealant shall conform to the following.

894
895

770.09

- 895 (1) Equipment and Materials:
896
897 (a) Balance.
898
899 (b) Tongue Depressor.
900
901 (c) Two ounce ointment cans or equivalent.
902
903 (d) One-inch wide masking tape.
904
905 (e) Percent retention (aluminum) test fixture.
906
907 (f) Becton Dickinson (B-D) 10 c.c. syringe.
908
909 (g) Sample of sealant to be tested.
910
911 (2) Procedure:
912
913 (a) Put strip of masking tape on both ends of test fixture
914 completely covering slot.
915
916 (b) Weigh fixture with masking tape.
917
918 (c) Stir sample for one minute prior to testing. Test sample
919 of sealant at 75 to 79 degrees F.
920
921 (d) Fill syringe with sample and inject sample into test
922 fixture slot.
923
924 (e) Scrape off excess sealant from top of test fixture with
925 tongue depressor. Sealant shall fill test fixture slot and shall be
926 level with top of test fixture.
927
928 (f) Re-weigh test fixture with sample material filling slot.
929
930 (g) Put fixture on top of two-ounce ointment cans and
931 remove masking tape from sides.
932
933 (h) Wipe off and discard sealant on pieces of masking tape.
934 Do not discard pieces of masking tape.
935

936 **770.10 Approach-Only Microwave Vehicle Detector.** Approach-Only
937 Microwave Vehicle Detector is vehicle detection unit for computerized signals.
938 System shall detect motion of every vehicle type, including mopeds moving in only
939 one direction, utilizing very low-power microwave beam.
940

941 Detector shall have range of 3 feet to 100 feet or greater. Base cone of
942 detector on 16-degree field of view with maximum width of 18-1/2 feet at 60 feet.

943 Detector shall have field adjustment controls for range control and time delay
944 extension.

945

946 Extension timer shall be capable of extending detector output from at least
947 0.5 to 7.5 seconds. Extension shall begin with termination of detected vehicle output
948 and continue for duration of selected extension time interval.

949

950 Microwave unit shall have Federal Communication Commission (FCC)
951 certification. Detector shall operate at frequency of 10.525 Ghz as allowed under
952 FCC Rules, Part 15. Detector shall be self-contained, except for power source that
953 shall operate at both 10 VAC to 24 VAC and 12 VDC.

954

955 Unit shall have electro-mechanical two-amp, single-pole, double-throw
956 (SPDT) relay that sends signal to controller. The unit shall employ power-failure
957 circuit that closes relay (recall) during power failure.

958

959 Detector shall have monitoring circuit for transceiver (Gunn diodes) that shall
960 failsafe relay to closed position (recall). Except for range adjustment, tuning shall be
961 automatic. Five-minute warm-up period for diodes will be allowed. There shall be
962 no tuning controls of any kind that require an operator.

963

964 Detector shall function while installed on side of pole, on top of pole, or
965 overhead, at height between 12 to 18 feet above pavement. Each detector shall be
966 encased in finished fabricated aluminum case with no larger than 4-inch square,
967 high-impact plastic opening in front of antenna.

968

969 Each detector case shall be water-resistant without use of silicone gels or
970 other materials that deteriorate with ultra-violet rays. Maximum size of detector shall
971 be as follows:

972

973	Height:	4-1/2 inches
974	Width:	4-1/2 inches
975	Depth:	7-1/2 inches

976

977 Mounting bracket shall be furnished for side, top, or overhead mounting.
978 Detector shall be capable of continuous operation over temperature range of -35
979 degrees F to 165 degrees F.

980

981 Detector shall be temporarily mounted on side of existing traffic signal
982 standard, highway light standard, or location accepted by the Engineer. The
983 Contractor shall ensure that detectors are operational before disabling existing
984 pavement loop detectors. Required conductors shall be installed in existing conduits
985 and controller or at location accepted by the Engineer. After permanent pavement
986 loop detectors become operational, microwave detectors and conductors shall be
987 removed and delivered to location accepted by the Engineer. Holes and damage
988 caused by mounting detector to existing traffic signal and highway lighting standards
989 shall be repaired.

990

770.10

991 The Contractor shall test microwave units to meet FCC specifications. The
992 Contractor shall provide medical statement as to safety of unit to general public,
993 specifically to persons with pacemakers.
994

995 **770.11 Preemption Detectors.**
996

997 **(A) Description.** Preemption Detectors shall be located on traffic signal
998 standards to convert optical signals emitted from an emergency vehicle to
999 electrical pulses for emergency preemption of traffic signals. Electrical
1000 signals from optical detector shall be transmitted by 4-conductor cable to
1001 preemption module M752 located in input slot of controller cabinet. M752
1002 preemption module shall direct and hold controller in preemption mode until
1003 signal disappears. Preprogrammed selection of phases and signal displays
1004 shall be controlled by Local Intersection Program. The State's preemption
1005 system employ 3M Opticom System. New preemption equipment shall be by
1006 3M Opticom or equal accepted by the Engineer, that is fully compatible with
1007 3M Opticom. Astro-mini brackets or similar device for attaching preemption
1008 detector to poles shall be included.
1009

1010 **(B) Materials.**
1011

1012 **(1) Type 7 Cable.** Type 7preemption detector (Opticom) cables
1013 shall be specific cables that run continuously from optical detectors
1014 mounted on traffic signal standards to terminal blocks for M752 phase
1015 module in controller cabinet. Type 7 preemption detector cable shall
1016 be compatible with 3M's M138 Optical Detector cable and shall be
1017 consistent with requirements for Opticom Preemption System. M138
1018 cable shall be BerkTek Type B, shield jacket, 3-insulated conductor,
1019 20AWG stranded copper, 1-20AWG bare stranded ground, 600 volts,
1020 orange-blue-yellow color coded, and 5/16-inch diameter.
1021

1022 **(2) M752 Optical Preemption Module.** M752 Module shall
1023 conform to Subsection 770.05(D) - Auxiliary Equipment.
1024

1025 **(3) Model 711 Preemption Detector.** Optical detector shall be
1026 designed and installed for uni-direction signal reception and single
1027 channel-phase operation. Signal reception shall be adjustable up to
1028 2500 feet. Detector shall be constructed from high-impact
1029 polycarbonate.
1030

1031 **END OF SECTION 770**
1032