

ITEM 732 TRAFFIC SIGNAL MATERIAL

732.01 Vehicular Signal Heads, Conventional. Provide vehicular traffic signal heads conforming to the ITE "Vehicle Traffic Control Signal Heads" standard. In conformance with the above standard, provide signal heads cast of nonferrous corrosion resistant metal with plastic or glass lenses. When provided, use ultraviolet stabilized, weather and impact resistant, and heat resistant plastic lenses, preventing crazing, cracking, deformation, color change, or other changes in physical properties.

Traffic signals consist of specified assemblies of optical sections containing 8 or 12-inch diameter colored lenses, a housing, a door frame with stainless steel hinge pins and latching device, gasketing, visor, wiring, and LED module in accordance with Section 732.04. Provide the standard wide angle type twelve-inch lenses.

Supply the housing with a five pair (for 3- or 4-section heads or six pair (for 5-section heads) barrier-type terminal block (no quick-disconnect slip-on connectors acceptable), screw-mounted at each end and located in the red section. Provide the terminal block meeting UL E62622, CSA LR15364; IEC compliant; containing #10-32 x 1/4 inch (min) zinc-plated steel phillslot screws installed between barriers with a nominal height 0.45 inch above the terminal plate and with a nominal opening width of 0.41 inch.; rated for 30 amps; and having a breakdown voltage of 7500 volts RMS. Provide stainless steel bolts and washers for securing sections together, lens mounting hardware, door latching bolts, and hinge pins. Use door latching bolts fitting through a slot in the door. Fabricate the green and/or yellow indication doors on all 4- and 5-section heads to open in book-like fashion.

Fit each optical section with a cutaway type visor unless the City specifies other type visors or louvering. Provide visors at least 7 inches long for 8-inch lenses and visors at least 9 1/2 inches long for 12-inch lenses.

Design optical sections for assembly with all 8-inch, all 12-inch, or intermixed arrangements. Assemble using suitable hardware forming weatherproof joints with no light leakage from one section to another. Provide assembly arrangements containing the specified number of optical sections, lens size, lens color, and circular or arrow configuration. Assemble from one to a maximum of five sections as specified to form a signal face.

Provide multi-way heads with appropriate top and bottom brackets with an opening in the center of the top bracket provided for mounting purposes. Correct signal face height inequalities for multi-way heads for proper accommodation between top and bottom brackets by the use of pipe spacers.

Provide signal heads with required mounting hardware. Provide signal face orientation to traffic by serrated rings or other devices on housing sections and mounting hardware. Permit adjustment in increments not greater than 5 degrees of rotation and not affected by wind gusts when locked. Provide galvanized steel or aluminum spacers and drop pipes 1 1/2 inches nominal pipe size (1.90 inch actual diameter).

Provide an aluminum, weatherproof tri-stud single wire entrance with three (3) 5/16-inch x 1 7/16-inch stainless steel studs, lock washers, and hex nuts with each signal head. Provide the weather head entrance with a minimum inside diameter opening of 1 1/2 inches, including any rubber or plastic grommet protecting the cable. The opening at the tri-stud end may be irregularly shaped, but it must have a minimum opening of 1 1/2

732.02

inches at its widest point and a minimum opening of 11/16 inch at its narrowest point. Use a tri-stud washer having the same opening at the entrance. Provide the top of the entrance with only one (1) clevis hole to accommodate a 5/8-inch stainless steel clevis pin. Provide the clevis attachment, measured at the center of the clevis hole, with dimensions no greater than 5/8 inch thick or greater than 1 3/4 inches in width. For span wire mounted installations, coat the wire entrance the same color as the vehicular signal head. For use on mastarms, coat the wire entrance the same color as the mastarm structure.

Fabricate the span wire hanger, provided with each signal head, with aluminum having a 5/8 inch stainless steel clevis pin capable of mounting to span wires up to 1/2 inch in diameter. Provide the hanger with two (2) U-type stainless steel mounting bolts with hex nuts and lock washers. Fabricate the hanger spacer with cast aluminum. Provide the clevis pin hole with a stainless steel bushing insert located a minimum of 2 1/2 inches from the top of the outside of the hanger.

For mastarm structures, use a 90-degree 3/4-inch clevis hanger with pins to allow the signal head swing freely on the arm. Coat the clevis hanger the same color as the mastarm structure. Fabricate the bushing with stainless steel.

Coat the signal head housing, doors, and outside surfaces of visors with yellow matching Federal Standard 595B, Color #13655 specifications. Coat interior surfaces of visors flat black.

Provide materials in accordance with the City's QPL.

732.02 Vehicular Signal Heads, Optically Programmed, 12-inch Lens. Provide optically programmed signal heads with an optical system projecting an indication programmed for visibility only within boundaries of a specific area. Provide the optical system capable of veiling anywhere to within 15 degrees of the optical axis using procedures and opaquing material in accordance with the manufacturer's instructions.

Provide the signal sections conforming to applicable portions of the ITE standard and Section 732.01. Provide and mount optical sections with a 12-inch lens size alone or in combination with additional sections of optically programmed or conventional optics types to form signal faces and heads. Provide an optically programmed signal section that includes an LED module.

Provide balance adjusters, if specified, having a splined eyebolt design and splined external clamping body. Fabricate all assembly hardware with stainless steel.

Provide a visor with each signal section.

Provide cable entrance adapters of the tri-stud type with stainless steel hardware. Seal the entrance adapter on the signal with a neoprene gasket having a minimum thickness of 3/32 inch placed under the clamp washer in the top signal section to make a weatherproof connection.

Provide materials in accordance with the City QPL.

732.03 Vehicular Signal Heads, Optically Programmed, 8-inch Lens. Optically programmed signal heads with 8-inch lenses consist of a conventional 8-inch signal housing, door, and an extension portion attached in place of a conventional lens and containing a lens system capable of optical programming. Provide the conventional

signal housing with wiring, and the optical programmable extension portion in accordance with the applicable requirements of Section 732.01 and Section 732.02.

Provide a cutaway visor with each signal section and including an LED module.

Programming the 8-inch lens type head requires the use of an extender tool as recommended by the manufacturer to move the extension portion to the side to expose the optics for programming purposes.

Provide materials in accordance with the City QPL.

732.04 Vehicular and Pedestrian Light Emitting Diode (LED) Modules.

Provide LED signal modules meeting or exceeding all the requirements of the current Institute of Transportation Engineers (ITE) publications - Vehicle Traffic Control Signal Heads (VTCSH) - Light Emitting Diode (LED) Circular Signal Supplement 2005; Pedestrian Traffic Control Signal Indications (PTCSI) - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules and Vehicle Traffic Control Signal Heads - Part 3: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Modules, unless otherwise stated in this section. Provide an LED module certified by the Intertek LED Traffic Signal Module Certification Program.

All LED signal modules shall be the latest model currently in production and new. The City will not accept equipment no longer manufactured, even if it meets the following specifications.

Provide LED signal modules conforming to the following criteria:

A. Physical and Mechanical Requirements

1. Identify each LED signal module on the back side with the following:
 - 1) Manufacturer's name and trademark
 - 2) Part number
 - 3) Serial number
 - 4) Voltage rating
 - 5) Power consumption (watts and volt-ampere)
 - 6) Vertical indexing indicator (i.e., "up arrow", or the word "UP" or "TOP") if the City requires specific orientation of the module.
 - 7) Date of manufacture (minimum information required - month & year)

Provide single units with identification markings showing the type and color of the module. Mark Bi-Modals with module type.

Place a label on each LED signal module certifying compliance to ITE standards for color and luminance.

2. Provide the LED traffic signal module as a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing.

3. Use an assembly and manufacturing process for the LED traffic signal module assembly that provides support for all internal LED and electronic components to withstand mechanical shock and vibration from high winds and other sources.

4. Provide the lens of the LED signal module capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.

732.04

5. Provide lenses a minimum of 1/8 inch thick, free of bubbles and imperfections capable of withstanding a 3.5 foot drop test. Provide lenses smooth on the outside with no external facets to prevent dirt and debris build up.

6. Provide each LED traffic signal module comprised of a UV stabilized polymeric outer shell, multiple LED light sources, and a regulated power supply.

7. Match the red or yellow tinted lenses to the wavelength (chromaticity) of the LED. Do not furnish green tinted lenses.

8. Use an optical assembly to diffuse the light output and provide uniform illumination across the entire surface of the lens and eliminate the visibility of the individual LEDs to the observer. Use the optical assembly for all ball modules. The City will consider use of the optical assembly on arrow and pedestrian modules as optional.

9. Design the LED traffic signal module for universal installation in both span wire and standard/stationary pole mount applications.

10. Provide the "Arrow" pattern produced by the Arrow LED traffic signal modules conforming to the VTCSH standard for color, size and shape. The City will not require Arrow LED traffic signal lamp units having a specific orientation or having a variance in light output, pattern or visibility for any mounting orientation.

11. Design the single pedestrian module to display a full "HAND" icon and a full "WALKING PERSON" icon complying with PTCSI standards for this (icon) symbol for the size specified.

12. Provide LED traffic signal modules visible at 450 feet during sway conditions (extended view) until obscured by the visor.

13. Design the LED module to detect catastrophic loss of the LED load. Design the LED module to sense a loss of the LED load and present a resistance of at least 250K Ohms across the input power leads within 300 msec.

14. Design the Turn-On and Turn-off time at less than 75 msec and the low voltage Turn-Off at less than 35 Volts.

B. Photometric Requirements

1. Manufacture the red, yellow, and orange modules using AlInGaP (Aluminum-Indium-Gallium-Phosphide) technology or use other LEDs with lower susceptibility to temperature degradation than AlGaS (Aluminum-Gallium-Arsenic). The City will not allow AlGaS LEDs. Manufacture green modules using Indium Gallium Nitride.

2. Provide each LED traffic signal module meeting minimum laboratory light intensity values, color (chromaticity), and light output distribution as described in ITE VTCSH – LED Circular Signal Supplement of the specifications 4.1, and 4.2 as a minimum. Table A-1 provides the minimum maintained luminous intensity values for the VTCSH LED Circular Signal. Perform environmental tests including an expanded view for the red and green ball indications with the following minimums for a period of 60 months.

TABLE A-1				
Minimum Luminous Intensity Values (In Candelas)				
Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
-17.5	2.5	51	127	67
	17.5	15	36	19
-12.5	2.5	110	273	143
	17.5	37	91	48
-7.5	2.5	281	701	366
	17.5	91	228	119
-2.5	2.5	358	892	466
	17.5	117	291	152
+2.5	2.5	150	373	195
	7.5	124	309	162
	12.5	84	209	109
	17.5	47	118	62
+7.5	2.5	69	173	90
	7.5	55	137	71
	12.5	40	100	52
+12.5	2.5	37	91	48
	7.5	29	73	38
-22.5	2.5	37	91	48
	7.5	29	73	38
	12.5	22	55	29
	17.5	11	27	14
-27.5	2.5	26	64	33
	17.5	18	46	24

Notes:

The same luminous intensity values apply to equivalent left and right horizontal angles.

Tabulated values of luminous intensity rounded to the nearest whole value.

ARROW INDICATIONS (IN CANDELAS/M²)

Yellow	Green
11,000	11,000

3. Evenly spread the LEDs for arrow indications across the illuminated portion of the arrow area. Provide Arrow LED traffic signal lamp units meeting VTCSH – Part 3: LED Vehicle Arrow Traffic Signal Modules, March 2004. Design Arrow LED traffic signal lamp units to operate over the specified ambient temperature and voltage ranges and provide a clearly visible signal attracting attention for a distance of at least 1300 feet under normal atmospheric conditions. Design Arrow LED traffic signal modules having 3 rows of LEDs only.

4. Provide measured chromaticity coordinates of LED traffic signal modules conforming to the chromaticity requirements of the following table, for a minimum period of 60 months, over an operating temperature range specified in section “D.”

732.04

Provide LED traffic signal lamp units meeting the minimum requirements for light output for the entire range from 80 to 135 volts.

CHROMATICITY STANDARDS	
Red	Y: not Y: not greater than 0.308 or less than 0.998 - x
Yellow	Y: not Y: not less than 0.411 nor less than 0.995 - x nor less than 0.452
Green	Y: not Y: not less than 0.506 - 0.519x nor less than 0.150 + 1.068x nor more than 0.730

5. Design LED pedestrian signal modules to operate over the specified ambient temperature and voltage ranges and attract the attention of, and readable by, a viewer (both day and night) at all distances from 10 feet to the full width of the crossing area.

6. Design the measured chromaticity coordinates of LED pedestrian signal lamp units to conform to the chromaticity requirements of Section 5.3, Color and the associated Figure C of the PTC SI standard, for a minimum period of 60 months, over an operating temperature range specified in section “D.” Provide LED traffic signal lamp units meeting the minimum requirements for light output for the entire range from 80 to 135 volts.

C. Electrical

1. Incorporate a regulated power supply into each unit engineered to electrically protect the LEDs and maintain a safe and reliable operation. Design the power supply to provide capacitor-filtered DC regulated current to the LEDs per the LED manufacturer’s specification. Design the power supply to prevent the failure of an individual component or any combination of components to cause the signal to remain illuminated after AC power removal.

2. Provide the LED traffic signal module to operate on a 60 Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS. Install circuitry to prevent flickering over this voltage range. Use a nominal rated voltage for all measurements of 120 ± 3 volts RMS.

3. Design and provide all unit types for operational compatibility with intended traffic signal equipment interfaces. This equipment includes all controllers, conflict monitors, current monitors, switch pack and flashers currently in use by the City of Columbus. Provide the LED traffic signal module operationally compatible with all TS-2/A2 controllers and NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection) currently used by the City of Columbus.

4. Wire the individual LED light sources to prevent the loss of more than one LED light source in the LED signal module during a catastrophic failure of one LED light source.

5. Provide two, captive, color coded, 600 V, 20 AWG minimum jacketed wires, 3 feet long, conforming to the National Electric Code, rated for service at 221°F, for an electrical connection.

6. For LED modules, use spade-type terminals securely attached to the units' lead wires.
7. Provide the LED signal capable to operate with a minimum 0.90 power factor.
8. Design the LED signal module to induce a total harmonic distortion (current and voltage) into an AC power line not exceeding 20 percent.
9. Design LED signal modules and associated on-board circuitry to conform to the requirements in Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.
10. Design the LED signal modules incorporating circuitry to show no evidence of illumination for input voltages below 35 volts. Illuminate (unregulated illumination) LED signal modules for all input voltages higher than 45 volts AC, but less than 80 volts AC. Provide for fully regulated illumination for applied voltages of 80 volts through 135 volts AC. Show proof of the intended function of this circuitry by connecting the lamps to a variable voltage source and slowly raising the applied voltage from zero volts up to 135 volts, and then slowly lowering the applied voltage from 135 volts to zero volts.
11. Provide proposed LED signal lamp units using less than or equal to the base wattage shown below at 77 °F.

Retrofit	Wattage
12@ R 12" Red Ball	12 or less
12@ Y 12" Yellow Ball	22 or less
12@ G 12" Green Ball	15 or less
12@ Y 12" Yellow Arrow	10 or less
12@ G 12" Green Arrow	19 or less

D. Environmental Requirements

1. Provide green and red LED traffic signal lamp units rated for use in the ambient operating temperature range of -40 °F to +166 °F. Provide yellow signal lamps rated at a range of -13 °F to +77 °F.
2. Provide a unit consisting of a housing creating a sealed watertight enclosure eliminating dirt contamination and allowing for safe handling in all weather conditions. Seal the LED signal module against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal LED and electrical components.

E. Documentation Requirements. Provide each LED traffic signal lamp unit with the following documentation:

1. Installation instructions.
2. The manufacturer name, brand and model number of all LEDs used, the LED manufacturer's recommended drive current, and degradation curves.

F. Warranty. Require the manufacturer to repair or replace the LED signal module, if it exhibits a failure due to workmanship or material defects within the first 60 months of field operation.

732.05

Require the manufacturer to repair or replace the LED signal module if, when operating over the specified operating ambient temperature and voltage ranges, the unit fails to meet or exceed all minimum luminous intensity requirements as defined in the ITE (Institute of Transportation Engineers) LED Purchase Specification - Vehicle Traffic Control Signal Heads (VTCSH), Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules dated June 2005 during the first 60 months of field operation.

Provide LED signal modules with measured chromaticity coordinates conforming to the requirements for chromaticity in Section 4.2 and Figure 1 of the ITE VTCSH and the PTCSI over the temperature range provided in this section for the duration of the warranty period.

Provide a written warranty from the manufacturer against defects in materials, workmanship, and luminous intensity for LED signal modules for a period of 60 months after installation of LED signal modules. Provide replacement LED signal modules within 10 days after receipt of failed LED signal modules, at no additional cost to the City, except for the cost of shipping the failed units.

Require the manufacturer to repair or replace an LED pedestrian signal module if the signal module fails to attract the attention of a viewer or a that a viewer cannot read, (both day and night) at all distances from 10 feet to the full width of the crossing area when operated over the specified operating ambient temperature and voltage ranges.

Provide materials in accordance with the City QPL.

732.05 Pedestrian Signal Heads. Provide pedestrian signal heads that conform to the *ITE Pedestrian Traffic Control Signal Indications*. Provide signal heads including complete 16-in. x 18-in., symbolic LED countdown units with full upraised hand and walking person symbols, made up of two optical compartments with no leakage of light from one compartment to another. Provide the left side of the signal head with an integral hand/walking person display, and the right side compartment with the countdown display. Provide the display numeral segments comprised of two rows of discrete LEDs. Design the signal heads to alternately display the symbol of an upraised hand in portland orange and the symbol of a walking person in white light. Do not provide outline style symbols. Provide material for housings consisting of cast or sheet, corrosion resistant, non-ferrous metal. Adequately reinforce the housings. Provide non-ferrous metal or polycarbonate material lens frames.

Provide glass or ultraviolet and impact-resistant plastic lenses displaying the legend with translucent symbols within an opaque black background.

Seal the lens to the door frame using a weatherproof seal. Provide an elastomeric gasket between the door frame and housing to ensure a dust and weatherproof seal.

Use a signal head design providing adequate dissipation of heat to ensure rated lamp life.

Provide a black grid sunshade fabricated of high impact resistant plastic with a nominal depth of 1 1/2 inches and consisting of horizontal members spaced at not more than 1/2-inch and vertical members spaced appropriately. Provide pedestrian signal heads with two-piece hinged type brackets that support the signal head close to the pole.

Provide two-piece, two- hinged brackets of cast aluminum with stainless steel hinge pins, secured by a tamperproof bolt in the closed position. Provide hinged brackets to

allow the pedestrian heads to swing away from each other. Provide a hex head type latch bolt for the mounting. Include a terminal block in the mounting for quick disconnect of field wiring. Design the mounting to allow attachment to the pole by banding (two (2) bands per bracket), bolting, or by lag screws for wood poles only.

Paint the exterior surfaces of the pedestrian signal head and the two-piece hinged bracket black. Paint interior surfaces of visors flat black.

Provide materials in accordance with the City's QPL.

A. Operation.

1. Design the display driver to allow individual LED failures without affecting other LEDs in the same display.

2. Provide the countdown timer of the "smart" type, capable of continuously sampling the timing intervals presented by the pedestrian signal load switch driver(s) to "learn" the programmed timing used by the controller.

3. During interval sampling time, make the countdown timer numerical display a blank.

4. Provide for a sampling time to determine interval settings taking a maximum of two complete signal cycles.

5. Provide the unit capable of displaying a countdown commencing at the onset of the pedestrian clearance interval and reaching zero at the end of the pedestrian clearance interval.

6. For any interruption of the flashing pedestrian clearance display, e.g., preemption or timing plan change, during a countdown, make the display immediately cause blanking of the countdown numerals. Require the countdown timer to "re-learn" the pedestrian clearance interval upon return to normal service after preemption or immediately following a change in walk clearance time associated with a timing plan change.

Provide materials in accordance with the City QPL.

732.06 Pedestrian Pushbuttons. Provide pushbuttons of sturdy construction and with components providing a pushbutton with normally open contacts and including all electrical and mechanical parts required for operation. Provide a sturdy and resistant design of the pushbutton and its associated contacts and housing capable of withstanding mechanical shocks and abuse. Design the pushbuttons to withstand a concentrated force of 50 pounds applied to the buttons or any exposed portion with no damage the unit or misadjustments to the contacts.

Provide a housing circular in shape with a curved back surface for mounting on poles of various diameters. Integrate the curved surface with the housing or supply an adapter with a flat back type housing. Attach the adapter to the housing by stainless steel machine screws. Provide the pushbutton with a barrier-type lug terminal for the attachment of field cable. Provide a hole threaded for a 1/2-inch pipe in the housing for conduit attachment purposes. Paint external surfaces yellow with enamel paint of Color 13655, Federal Standard 595B.

732.08

Provide activation of the pushbutton by a Piezo-driven solid state switch with no moving parts. Design the pushbutton for a maximum required operational force of 3 pounds per foot). Design the pushbutton to emit a two (2) tone beep and display a momentary LED illumination when activated. Provide a raised or flush pushbutton with a minimum of 2 inches (50 mm) at its smallest dimension.

Provide pedestrian pushbutton signs of a minimum of 0.07-inch steel or 0.10-inch aluminum. Provide the legends and backgrounds with baked enamel paint for steel signs and enamel paint or non-reflective sheeting for aluminum signs.

Provide materials in accordance with the City QPL.

732.08 Loop Detector Units, Delay and Extension Type. Provide loop detector units complying with the requirements of NEMA TS-1, section 15, with the following modifications. Provide two-channel, shelf-mounted loop detector units powered from 120 volts. Provide delay and extension type loop detector units. Use solid state isolated output units for all controller applications where directly connected to a solid state digital controller unit. Provide conductors twisted three to five times per 1 foot in the cable harness for loop input pins.

Provide loop detector units with detector settings adjusted by the use of switches, dip switches, thumbwheels, or dials. Do not incorporate the use of any LCD type display in the loop detector units for the purpose of making changes to detector settings.

Provide materials in accordance with the City QPL.

732.09 Foundations. Use steel anchor bolts conforming to ASTM F1554, Grade 105 and galvanized in accordance with 711.02. Provide galvanizing extending at least 2 inches beyond the threads. Provide bent ends or a drilled and tapped steel plate as shown on the plans.

732.10 Sleeve for Anchor Base Foundation. Use a galvanized corrugated pipe or a cardboard-like concrete form with the same diameter and depth dimensions as the specified foundation, as directed by the Engineer or as called for in the plans. Properly backfill around the sleeve, using a compactable granular material compacted in 4" lifts or a controlled density fill rated at 150 psi.

732.11 Signal Supports. Provide signal poles and mast arms with tapered tubes of a true continuous taper. Provide circular tubes or regular polygon tubes with six or more sides. Provide circular tubes with measurements of diameter at a specific point along the longitudinal axis not varying by more than 3/16-inch. Provide a tube taper between 0.54 and 1.3 percent.

Fabricate mast arms of the true continuous taper type in two portions joined by overlapping of sections, with the overlap measuring at least 1 1/2 diameters as determined by the largest diameter of the outer portion. Assemble the sections with a 5/8-inch minimum stainless steel or galvanized steel hex head through-bolt.

Provide no more than one longitudinal, automatically electrically welded seam on circular poles. Provide welded seams neat and uniform in appearance and having a thickness not less than the base material and a bead height not exceeding 1/16-inch. Provide a uniform thickness at each pole or arm cross-section, except at weld beads. Do not place transverse seams or welds on true continuous taper type poles or arms. Weld in accordance with 513.17.

After fabrication, hot-dip galvanize poles and arms in accordance with Section 711.02.

Do not use guy rods or truss-type arms. Provide poles and mast arms with attachment plates and gussets. Assemble using high-strength bolts with the connection developing the full moment-resisting capability of the arm. Do not allow the butt diameter of mast arms to exceed the nominal diameter of the pole at the point of attachment.

Fit poles with a welded-on cast or plate steel base designed to mount on an anchor bolt foundation.

Provide poles with a handhole near the base, oriented as required. Reinforce the handhole with a welded-on steel frame with a grounding lug fit with a cover plate fastened by stainless steel screws. Provide the poles with a cable and wire support J-hook welded near the top and a removable pole cap. Design poles and arms for the interiors to conceal wiring and their mast arms include grommets wire outlets for the signal heads. Provide hanger clamps with clevises on the mast arms for the signal heads as required. Provide arm caps made of steel and covering at least 50 percent of the end area.

Provide signal poles combining provisions for roadway lighting with an additional handhole located opposite the mast arm flange with the poles' J-hook located above.

When specified in the plans, provide blind half couplings for controllers. Plug any unused holes.

Provide materials in accordance with City QPL.

732.12 Strain Poles. Provide signal strain poles for the attachment of span wire made of steel tapered tubes in accordance with the requirements of Section 732.11. Provide all poles with a removable pole cap, and messenger wire clamps with clevis and shackle, unless otherwise specified.

Provide anchor bolt foundation type strain poles including a welded-on cast or plate steel base, bolt covers, a handhole, and a J-hook, as required by Section 732.11, and also including at least one 2-inch (50 mm) cable entrance with a weatherhead and a welded blind half-coupling.

Provide materials in accordance with City QPL.

732.13 Wood Poles. Provide wood poles conforming to ANSI 05.1 "Specifications and Dimensions for Wood Poles", made of Southern Pine or Western Red Cedar full-length pressure treated in accordance with Section 725.19.

732.14 Down Guy Assemblies. Provide down guy assemblies in accordance with Section 725.19. Provide insulators and hardware that conform to Section 732.18. Provide expanding or screw type anchors capable of withstanding a guy tension of 8000 pounds (35 kN) when installed in firm moist soil.

Provide materials in accordance with the City QPL.

732.15 Pedestals. Fabricate pedestals for the support of traffic control equipment of 4-inch schedule 40 steel or aluminum pipe. Fit the steel pipe with a welded-on base of plate or cast steel, or if specified, thread the steel pipe into a gray cast iron transformer type base. Provide galvanized steel pedestals in accordance with 711.02. Thread

732.16

aluminum pipe into an aluminum cast transformer type base. Design pedestals to mount on an anchor bolt foundation.

Provide materials in accordance with the City QPL.

732.16 Conduit Risers. Provide risers with conduit and fittings in accordance with 725.04 and a weatherhead made of aluminum or galvanized ferrous metal and threaded.

732.17 Cable Support Assemblies. Use a cable grip with cable support assemblies of the proper size and strength for the cables made of the flexible “closed” or “split with rod” type, of stainless steel or tin coated bronze, and equipped with a single “U” eye bale. Provide the smallest cable grip meeting a minimum rated breaking strength of 250 pounds.

Provide slings for cable supports made from copper clad or galvanized multi-strand steel wire with an overall diameter of not less than 1/8-inch and a breaking strength of at least 400 pounds. Use thimbles to form eyes at each end of the sling with grooves to match the wire. Adjust the sling to the proper length with the wire at each thimble lapped and secured with split bolt clamps.

Provide materials in accordance with the City QPL.

732.18 Messenger Wire. Provide Utilities Grade messenger wire, twisted strand galvanized steel wire in accordance with ASTM A 475, Class B, except the City will not require tags in accordance with Section 19.2 on lengths less than 1000 feet, and will require high-strength for the 1/4-inch seven-strand wire. Provide all accessories having a rated loading strength equal to or greater than the messenger wire minimum breaking strength. For breakaway tether installations, provide accessories having strength equal to or greater than 3000 pounds. Provide galvanized steel helical lashing rods in 5-foot lengths.

Provide materials in accordance with the City QPL.

732.185 Tether Wire. Provide Utilities Grade tether wire, 1/4-inch (6 mm), twisted strand galvanized steel in accordance with ASTM A475, Class B, except the City will not require tags in accordance with Section 19.2 on lengths less than 1000 feet (300 m). Provide all accessories except S-hooks having rated load strength equal to or greater than the tether wire minimum breaking strength. Make S-hooks of mild low-carbon galvanized steel and of the wire size indicated on the plans. Do not substitute larger wire sizes and higher-strength steel S-hooks. Provide safety tie wire of 304 or 316 stainless steel, 1x19 stranded, 1/8-inch (3 mm) with stainless steel wire rope clips. Provide lead sheet to wrap tether wire in breakaway anchors of commercially pure lead of thickness 0.030 to 0.042 inches (0.75 to 1.0 mm).

732.19 Cable and Wire. Provide cable and wire meeting the requirements of Table 732.19-1 and rated at 600 volts with conductors of copper unless otherwise specified. Indelibly mark the cable or wire jacket at intervals of not more than 6 feet (2 m) with nomenclature stating the size, the type, the organization specifying the type, and the manufacturer’s name or trademark.

Provide materials in accordance with the City QPL.

732.22 Backplates. Provide backplates constructed of wrought sheet aluminum, in accordance with ASTM B 209 (B 209M), 6061-T6, .050 inch (1.3 mm) minimum thickness. Anodize the backplate base metal to maximize paint adhesion in accordance

with Mil-A-8625, Type II or Type I. Provide backplates painted on both sides with at least two coats of flat black alkyd enamel paint or polyester powder coat (no epoxy) closely matching FED-STD-595b-37038. Provide a backplate extending 5 inches (125 mm) beyond the outside of the signal assembly on all sides. The overall outside shape of the installed backplate shall be rectangular. Fabricate the backplate allowing no gaps between the backplate and the signal head or between signal sections. Apply a 2-inch (50 mm) wide continuous outside border of yellow or fluorescent yellow reflective sheeting to the front face of the backplate. Use Type H or Type J reflective sheeting listed on the City's Qualified Products List. Provide all assembly and mounting hardware of stainless steel conforming to Section 730.10. If used, provide machine nuts of the thread-deforming or nylon locknuts types. Do not use rivets for mounting the backplate to the signal head. Use a minimum of four mounting points on each signal section for attaching the backplate. Provide all mounting hardware.

TABLE 732.19-1 CABLE AND WIRE

Cable or Wire	Number of Conductors	Wire Gage	Specification or type	Conductor Type	Notes
Signal Cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
Interconnect cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
	Twisted pairs as specified	As specified	RUS PE-39 IMSA 19-2 IMSA 20-2	Copper, color coded, solid	
Loop detector wire	Single conductor	14 AWG	IMSA 51-5	Copper, stranded	
Loop detector lead-in cable	Two conductor	14 AWG	IMSA 50-2	Copper, twisted pair, stranded, shielded	
Power cable	Two conductor	As specified	UL: RHH/RHW/US E or XHHW, cross linked polyethylene w. an insulation thickness of 0.045 in(1.14 mm) (min.)	Copper, stranded	The specification may call for three-conductor cable. Permitted substitution: 2 (or 3) single conductor cable
Service cable	Two conductor (duplex)	As specified		Aluminum, [1] twisted, stranded	
Ground Wire	Single conductor		UL: RHH/RHW/US E or XHHW, cross linked polyethylene	Copper, stranded	Minimum size the greater of either the power or service cable.
[1] The Contractor may substitute copper conductors.					