Item 1325 Street Lighting Luminaires

1325.01 Luminaires.

A. General. Install luminaires of the type the plans specify and consisting of a complete lighting device, including housing, supporting hardware, reflector (as plans require in the specified type) refractor, socket, lamp, integral ballast (or where plans specify remote ballast), disconnection devices, terminal block for external wiring connections, photo-electric cell receptacle and incidentals as required. Provide the luminaire to be capable of operating the specified lamp in a completely sealed optical system (as required in the specified type) at the line voltage specified. The luminaire to provide the ANSI-IES Type distribution and cut off as specified.

The light source for the luminaire to be specified.

B. Luminaire Types.

1. Standard Roadway Type: indicates a cobra head style housing designed for mounting on bracket or mast arms.

2. Underpass Type: indicates a "wallpack" type housing designed for wall mounting.

3. Post Top Mounted Type: indicates a decorative "colonial" or "modern" style luminaire for post top mounting.

4. Spherical Roadway Type: indicates a decorative, classic, spherical shaped fixture resembling an "eye ball" for use with high (40 foot [12 m] or more) mounting heights and mounted on short slip-fitter arms.

C. Interchangeability. The refractor interchanges with the "standard" refractor of the same wattage and type luminaire. "Standard" refractors are manufactured by the General Electric Company, Westinghouse Electric Corporation, Holophane Company, McGraw-Edison Company, and J. H. Spaulding Company.

D. Supply Voltage. The luminaire operates as specifications require herein when the primary voltage has the specified nominal value, or is within tolerances the specified ballast requires. The primary voltage is normally 240 volts, unless otherwise specifications indicate otherwise, for all luminaire types except the spherical roadway type, which is 120 or 240 volts or multitap as plans specify.

E. Housing. Provide luminaire enclosures that conform to the construction and material specified herein for the type luminaire plans specify.

1. Standard Roadway Type. These are luminaires of cast aluminum with natural finish or a painted finish in light gray. The housing for the luminaire has a two or three piece design consisting of the upper housing and a refractor holding lower door. Where the luminaire is of a three piece design, the third piece has a lower access door for access to internal

components independent of the refractor door and is located to the rear of the refractor door toward the house side. Ensure that lower door assemblies hinge away from the upper half on the house end.

Ensure that the lower door assemblies include latching mechanisms located on the street side and closeable with one hand.

Ensure that the refractor holding door permits easy removal of the refractor without the use of tools and has a safety catch to prevent accidental removal.

Provide an access door for access to internal components or mount the components on the door.

Make the slipfitter adjustable to fit pipe brackets from 1-1/4 inch to two-inch pipe (30 mm to 50 mm) brackets. Ensure that the slipfitter permits an adjustment in the vertical plane of plus or minus 5 degrees and the luminaire has a slipfitter stop which allows an engagement of at least 4-1/2 inches (115 mm) of the bracket arm.

2. Underpass Luminaire. Install housing for the underpass type luminaire as cast aluminum with natural finish or a painted finish in light gray; provide with conduit mounting holes for wire entry and secure to a wall or vertical surface with two each 3/8 inch (10 mm) bolts through the rear of the fixture. Ensure the fixture opens easily with a quick snap hinged ring or approved latching device. Protect the refractor by means of an approved guard or shield.

3. Post Top Luminaire. Ensure that housing for the post top mounted type luminaire is cast aluminum with a slip-fitter suitable for a three-inch (75 mm) O.D. tenon, unless plans specify otherwise. Provide three sets of screws or two bolts to facilitate leveling and securing the fixture on the pole. Hinge the luminaire on one side (colonial style) and secure with a captive screw on the opposite side. Where plans call for the modern style luminaire, use a captive hand nut to allow easy (no-tool) assembly and disassembly of the canopy.

Paint the luminaires black, pole green or other (per Item 1317) as plans indicate.

4. Spherical Roadway Luminaire. Make one piece seamless spun aluminum housing for the semi-spherical roadway type luminaire. Luminaire size varies by location. Furnish fixtures for installation in the downtown core approximately 26 inches (660 mm) in diameter and 17-1/2 inches (445 mm) high with a 750 watt metal halide light source. Provide Spaulding number WN3-A-P75-H3F-Q-CC or approved equal.

Furnish fixtures for installation in the Downtown perimeter (frame) approximately 22 inches (560 mm) in diameter and 14 inches (356 mm) high with a 400 watt metal halide light source. Provide Gardco number MA22-1-4X-400PSMH-QUAD-SC or approved equal.

Construct door of formed aluminum with clear flat tempered glass lens. Provide door that is fully gasketed and hinged to housing. All access hardware and screws are to be captive variety.

Furnish segmented anodized aluminum reflector capable of providing IES Type III light distribution for horizontal lamp orientation.

Incorporate between the bottom of the housing and the reflector portion of the optical system a low brightness baffle designed to minimize visibility of the light source from a horizontal distance greater than five mounting heights from the luminaire.

Make the housing support an extruded ten inches (254 mm) aluminum arm and 5RPA adapter. Firmly support complete luminaire and all its parts. Provide a mechanical adjustment to allow about the axis adjustment as well as vertical adjustment of up to 25 degrees. Completely seal the optical system.

Make all parts of the luminaire assembly weatherproof and capable of withstanding winds to 100 mph (160 kph).

5. Painting. Ensure that all exposed parts of luminaire are factory painted. Paint aluminum parts after anodizing.

a. Prime coat (submarine epoxy) – 4.6 wet mils (117 µm) thickness.

b. Intermediate coat – 7.0 wet mils (178 µm) thickness.

c. Final coat - Cincinnati MALT Pole Beige: Federal Standard Color 20372; or Foy-Johnson No. 29842 or equal by Porter, Wilson, or Pratt & Lambert - spread at rate of 300 ft^2/gallon (7 m^2/L) or 5.3 wet mils (135 µm) thickness.

6. Make all type housings complete with components weatherproof, and mount all components including ballast internally unless otherwise specified. Ensure that the refractor, reflector and ballast system are easily removable. Ensure that the luminaire will withstand winds to 100 miles per hour (160 kph).

F. Reflector. Make the reflector readily detachable and removable and in spherical roadway type luminaires supported from its top, the reflector to consist either of pressed prismatic heat resisting glass with sealed and spun-on cover, or a spun aluminum diffused material with aluminum-coated (Alzak) finish. Ensure that the inner surface of the reflector is smooth, non-porous and easily cleaned.

Provide reflectors in all type luminaires except the post top mounted type.

G. Refractor. Make the refractor of heat and high impact resistant material of polycarbonate or a heat resistant borosilicate glass or approved equal and design it so that it can be installed only in the correct position in the refractor holder. Ensure that glass is well annealed and free from imperfections and striations.

Ensure that refractors for lamp of 250 watts or greater are constructed from heat resistant borasilicate glass or approved equal.

Ensure that the refractor is embossed to clearly indicate the street side and house side prisms.

Ensure that panels used with the colonial style post top mounted luminaire are white frosted.

Ensure that for spherical roadway type luminaires the bottom of the reflector is covered with a gasketed door containing a large refractor.

Type A Refractor: Make this a clear non-prismatic crystal glass for resisting breakage due to heat and mechanical stresses, well annealed and free from imperfections and striations. When in place and with the luminaire operating, the window should withstand a heavy sprinkling of ice water.

Type B Refractor: Make this a convex refractor with prisms meeting the requirements previously specified for refractor material of polycarbonate or glass.

H. Optical seal. This consists of compressible, heat resisting nonlatex, resilient gasketing material to seal out insects, dust, dirt and water effectively. The material must provide a complete sealing of the optical system at the point of entry of the socket into the reflector and between the reflector and the refractor. Make the gasket readily removable from the reflector.

Post top mounted type luminaires do not require an optical seal.

Provide standard roadway type luminaires with a carbon filter to eliminate accumulation of dirt and other foreign matter in the optical system.

I. Ballast. Furnish each luminaire with a single-lamp ballast. Mount the ballast internally unless plans specify otherwise. Provide a ballast with a high power factor of at least 90 percent. Ensure the ballast is capable of starting lamps in temperatures as low as -20° F (-30° C), and is rated for the circuit voltage and size of lamp plans specify.

Attach a nameplate identifying the electrical and mechanical characteristics of the ballast as a permanent part of the ballast.

Provide a ballast that has the wattage rating of the lamp specified and the weight of the internal ballast that does not exceed 30 pounds (14 kg). Allowable ballast losses listed in Table 1326.02 are considered average losses.

Where multi-tap or "quad" voltage ballasts are specified, supply ballasts internally wired for connection to the circuit voltage specified in the Contract and plan sheets.

Where plans specify, furnish epoxy encapsulated external ballasts, suitable for aerial, post top, pole base or vault installation and enclose them in a corrosion free weathertight aluminum tank. Provide the ballast with a minimum of 12 inch (300 mm) long leads for external connection and lead wiring insulation rated for such service.

In addition to the foregoing general characteristics, provide ballasts that conform to the following characteristics for the type specified:

Ballasts for Mercury Vapor Lamps. Furnish and install the constant wattage or regulator type with separate primary and secondary windings delivering rated lamp current at circuit voltage variations of plus or minus 13 percent.

Ensure that the regulation output of lamp wattage does not exceed a total range of four percent for lamps rated 400 watts or less or six percent for lamps rated in excess of 400 watts.

Ballasts for Metal Halide Lamps. Furnish and install the peak load auto regulator type delivering rated lamp watts within plus or minus ten percent with plus or minus ten percent variations in applied voltage.

Ballasts for High Pressure Sodium Lamps. Furnish and install the regulator type with isolated primary and secondary windings for up through 400 watts. For 1,000 watt lamps, make ballasts the auto regulator type. In both cases the ballast delivers rated lamp current at circuit voltage variations of plus or minus ten percent.

Include starter components in ballasts. Make the starter component of solid state devices capable of withstanding ambient temperatures of 212° F (100° C). Make the starter to provide timed pulsing with sufficient follow-through current to completely ionize and start all lamps meeting published ANSI standards. Provide field replaceable starters completely interchangeable with no adjustment necessary for proper operation. They will have push on-type electrical terminations to provide good electrical and mechanical integrity and ease of replacement.

Treat the starter circuit board in an approved manner to provide a water and contaminant resistant coating. Ensure that the starter circuit-ballast combination is designed to consistently provide the following parameters:

1. Lamp wattage must be maintained within the trapezoid recommended by lamp manufacturers within the full rated input voltage range.

2. Amplitude of the pulse 2,500 volts minimum and 4,000 volts maximum. Operation of the pulse at spike voltage levels near minimum is desirable.

3. Minimum pulse width one microsecond at 2,250 volts, applied within 20 electrical degrees of the peak of the open circuit voltage wave, with a minimum repetition rate of one pulse per cycle of the 60 cycle wave.

4. Ensure that pulses are present when ballast is correctly wired when applying nominal voltage less 15 percent to the ballast windings.

5. Protect the high pressure sodium ballast, including starting aids, against normal lamp failure modes. Ensure that ballast operates with the lamp in an open or short circuit condition for six months without significant loss of ballast life. Ensure that the luminaire Manufacturer supplies ballast electrical data and lamp operating volt-watt traces for nominal

and plus or minus ten percent rated line voltage to verify ballast performance and compliance with ANSI lamp specifications, for the rated life of the lamp.

J. Socket. Make the socket of a rugged high grade porcelain body with a mogul screw shell type base and rated for 600 volts (5,000 volt impulse for high pressure sodium lamps). Make the socket shell from nickel or nickel plate and having lamp grips to prevent the lamp from loosening. Ensure that when the lamp is in its normal operating position, the porcelain of the socket body covers all metal on the lamp base.

Make the socket adjustable in standard roadway type luminaires to provide other ANSI-IES type distributions. Provide a means of identification to associate each lamp position with each distribution. For socket adjustment, provide positive positioning by means of index holes, lugs or notches. The City will not accept slots with infinite settings. In underpass type luminaires make the socket position to be adjustable to give a 60 or 70 degree beam angle.

K. Lamp. Furnish a lamp with each luminaire of the type source and wattage specified in accordance with Item 1326.

Make lamps for the spherical roadway type luminaire of 1,000 watt Metal Halide.

L. Fastening, Wiring and Disconnecting Devices. Make all required hardware of approved non-corrosive material.

Use slotted head type fastening devices in standard roadway type luminaires.

Disconnect devices are designed to prevent electrical hazard to personnel servicing the fixture before approval by the City.

Connect the end of each conductor not connected to the socket to a terminal block by spade terminals or other suitable removable connectors.

Provide a terminal block with enough terminals for incoming service wires, ground wire for safety, socket connections, and ballast connections for both internal and remote ballast location. Make the terminal block easily accessible.

M. Wiring Diagram. Provide a schematic wiring diagram and attach it to the interior of the luminaire in a permanent manner.

N. Photometric Data. Ensure that the luminaire reflector and refractor give an IES distribution for the type luminaire specified unless otherwise.

1. Provide a standard roadway type. Medium-Semi cutoff and Type II or Type III as plans specify.

2. Provide an underpass type designed to direct all useful light below the normal viewing angle, resulting in high utilization of lumen output.

3. Post top mounted type (Type V unless plans specify otherwise)

4. Spherical roadway type (Type A refractor)
(Type B refractor)

Spherical roadway type luminaire photometrics:

With Type A (Clear) Refractor - Beam Spread = 122° vert. x 122° horiz.
Max candle power = 31,751

With Type B (Prism) Refractor - Beam Spread = 134° vert. x 167° horiz.
Max. candle power = 17,121

O. Photo-Electric Receptacle. Provide all standard roadway and post top mounted type luminaires with a receptacle with shorting cap for City-wide interchangeability purposes. Ensure that the receptacle meets EEI-NEMA standards and is a twist-lock type. Wire the receptacle for 120 volts and provided it with an easy adjustment for orienting to the north. Maintain weather sealing, moisture and dust proofing.

P. Weight and Area. Make luminaires complete and ready for service to comply with the following weight and projected area requirements:

Table 1325

	Luminaire Type	Size by Wattage	Maximum Projected Area in ft^2 (m^2)	Maximum Weight in Pounds (kg)
1	Standard Roadyway Type	100-175	1.6 (0.15)	35 (16)
		200-400	1.6 (0.15)	55 (25)
		700-1,000	2.5 (0.25)	60 (27)
2	Underpass Type (Not Applicable)			
3	Post Top Mounted Type (Colonial and Modern Types)	70-175	2.0 (0.20)	35 (16)
		200-400	3.8 (0.35)	55 (25)
4	Spherical Roadway Type	up to 1,000	4.4 (0.40)	50 (23)

Q. Installation. Install luminaires mounted on poles to adjust vertically and horizontally to provide the required mounting height and specified alignment with the roadway. Where the profile grade exceeds 4 percent, orient the luminaires so that the vertical axis of the luminaire is perpendicular to the longitudinal centerline of the roadway at that location.

Mount luminaires on walls level. Where mounting more than one luminaire on the same wall, mount them at the same elevation so as to present a straight line appearance.

Mount luminaires mounted on post tops level and in line with the vertical axis of the post.

1325.02 Method of Measurement. Measure luminaires as a complete unit in place, including lamp and all components and testing.

1325.03 Basis of Payment. The City will make payment at the Contract unit price bid for each luminaire, by type, and as full compensation for all labor, materials, tools, equipment, and incidentals necessary to furnish and install each luminaire complete, connected, tested and accepted.

Item	Unit	Description
1325	Each	Luminaire, ___ watt, ____ +volt, ___ (light source), ___ type.

Item 1326 Lamps

1326.01 Traffic Signal Lamps. Include a lamp in each traffic signal optical section that conforms to the ITE specification "A Standard for Traffic Signal Lamps", with the following exceptions and qualifications:

A. Furnish and install brass screw bases with a rotational adjustment feature.

B. Install lamps with the base rotated so the open portion of the lamp filament is in an upward position.

C. Provide lamps with a minimum rated life of 8,000 hours with the exception of 135 and 150-watt lamps which shall have a minimum rated life of 6,000 hours.

D. Provide 60-, 90- and 135-watt lamps that are Krypton gas filled.

Provide lamps for the respective signal equipment in accordance with Table 1326.01 (on following page).

Include the cost of furnishing and installing lamps in the bid price of each signal item.

Table 1326.01
Traffic Signal Lamps

	Size/Type	Watts	Rated Volts	Light Center	Industrial Lamp Number	Rated Life (Hours)
Vehicular Traffic Signal Heads	8 Inch Sections	60	120/125	2-7/16" (62 mm)	60AT19 or 60A19TS Clear	8,000
	12 Inch Arrow Indications	90	120/125	3" (75 mm)	90AT19 or 90A19/1/TS Clear	8,000
	12 Inch Sections	135	120/125	3" (75 mm)	135AT19 or 135A19TS Clear	6,000
Pedestrian Signal Heads	12 Inch 2 Section Type A2	90	120/125	3" (75 mm)	90AT19 or 90A19/1/TS Clear	8,000
	18 Inch 3 Line Type D2	60	120/125	2-7/16" (62 mm)	60AT19 or 60A19TS Clear	8,000
Optically Programmed Signal Head	12 Inch Sections	150	115		M-123/131 Sealed Beam	6,000

Include the cost of furnishing and installing lamps in the bid price of each signal item

1326.02 Lamps for Street Lighting Luminaires. Furnish a lamp with each luminaire that conforms to ANSI Specifications C-78 for all HID (Hi Intensity Discharge) type lamps. Make all lamps first line, high quality having heat resistance clear glass envelopes, except make all mercury vapor lamps the deluxe white type.

Where plans specify incandescent type lamps, install lamps meeting the requirements of Federal Specification number W-L-101.

Ensure that HID lamps by size conform to the following characteristics of the Table 1326.02.

Provide high pressure sodium lamps with a ceramic arc tube interior. Ensure that lumen output at end of economic life (67 percent of rated life) is not less than 80 percent of initial lumen rating. Ensure that rated life for high pressure sodium lamps is at ten hours start, and all high pressure sodium lamps are 100 volt lamps. Initial lumens shown are for horizontal burning.

All performance data in Table 1326.02 reflect normal operating conditions.

Ensure that metal halide lamps have a quartz arc tube interior. Provide lamps that have lumen output at the end of their economic life not less than 65 percent of the initial lumen rating.

The rated life for metal halide lamps is at 10 hours start.

Lamp Warm-Up Time to 80% Light:

Mercury Vapor .....five to seven minutes.
High Pressure Sodium.....three to four minutes.
Metal Halide.....three to five minutes.

Lamp Re-Strike Time:

Mercury Vapor .....three to six minutes.
High Pressure Sodium.....one minute.
Metal Halide.....ten to 15 minutes.

Table 1326.02
High Intensity Discharge Lamps and Ballast Losses

Lamps					Ballasts
Type	**Lamps (Watts)**	**Industrial Lamp No. by ANSI Code and Spec. No.**	**Rated Horizontal Initial Lumens**	**Rated Life (Hours)**	**Loss (Watts)**
Mercury Vapor	100	H38JA-100/DX-C78.1300	4,000	24,000	27
	175	H39KC-175/DX-C78.1308H	8,150	24,000	35
	250	H37KC-250/DX-C78.1301	11,150	24,000	42
	400	H33GL-400/DX-C78.1305	21,500	24,000	60
High Pressure Sodium	70	S62	5,800	20,000	35
	100	S54	9,500	20,000	44
	150	S55 (55 Volt)	16,000	24,000	54
	150	S56 (100 Volt)	16,000	24,000	54
	200	S66	22,000	24,000	54
	250	S50	27,000	24,000	65
	310	S67	37,000	24,000	70
	400	S51	50,000	24,000	85
	1,000	S52	140,000	24,000	90
Metal Halide	70	M98	5,000	5,000	16
	100	M90	8,500	10,000	20
	175	M57	14,000	7,500	35
	250	M58	19,500	7,500	44
	400	M59	32,000	15,000	62
	1,000	M47	100,000	10,000	90

Item 1327 Traffic Signals

1327.01 Vehicular Traffic Signal Heads.

A. General. Provide signal heads that are in conformance with ANSI No. D10.1 or the latest revised ITE standard for "Adjustable Face Vehicle Traffic Control Signal Heads", whichever is more recent, except as noted otherwise herein. This specification also provides the minimum performance requirements for 12 inch (300 mm), eight inch (200 mm) and 12 inch (300 mm) arrow traffic signal modules. It is not intended to impose restrictions upon specific designs and material that conform to the purpose and intent of this specification. The specification refers to definitions and practices described in "Vehicle Traffic Control Signal Heads" published in the Equipment and Material Standards of the Institute of Transportation Engineers, referred to in this document as "VTCSH". The multiple LED light source should be the latest technology available on the market. Utilize LED's manufactured with AlInGaP technology for red, amber and yellow indications or InGaN for green indications.

All LED traffic signal lamps must meet or exceed all the requirements of the current Institute of Transportation Engineeers 9ITE PUBLICATION ST-011B Pedestrian Traffic Control Signal Indications (PTCSI) and the current ITE specifications for Vehicle Traffic Control Signal heads (VTCSH), Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Module, unless otherwise stated in the specifications herein.

Gelcore, Dialight or pre-approved equal LED traffic signal lamps on the current ODOT QPL are acceptable as well as pixilated described herein. Provide only new LED lamps of the latest model currently in production. Equipment no longer being manufactured will not be accepted even if it meets the following specifications.

Furnish the signal heads in the arrangements shown on the plans and details.

B. Design. Provide signal assemblies consisting of eight inch or 12 inch (200 mm or 300 mm) units rigidly fastened together in various combinations as specified. Ensure that the signal assembly is made in accordance with the Manual of Uniform Traffic Control Devices (MUTCD). Assemble the sections in such a manner as to prevent dirt or moisture entering into the unit, or the possibility of rotation or misalignment. Construct signals in such a way as to allow assembly or disassembly of individual sections with the aid of standard tools.

Make traffic signals capable of both vertical and horizontal mounting. Ensure that each signal section, electrical unit and optical unit is interchangeable with other signal heads of the same Manufacturer.

C. Housing. Provide the signal head, including the door and visor, of polycarbonate material, or as otherwise specified. If plans specify no material, furnish signal heads in any of the above approved materials. Provide all parts, including hardware, of non-corrosive materials.

Normally, make eight inch signal head size ten inch by ten inch (250mm x 250mm) and 12 inch signal head size 14 inch by 14 inch (356 mm x 356 mm). The City will not accept signal heads exceeding these dimensions by more than 1/2 inch (12 mm).

Polycarbonate Construction. Make the housing of each signal section one-piece virgin ultra-violet stabilized polycarbonate resin black in color. Make the unit by injection molding and have a minimum wall thickness of 0.100 inches (2.5 mm). Equip all sections with metal inserts in the housing to prevent stripping of threads in areas that require constant removal of fastening devices (such as the door) on a regular maintenance basis. Connect no electrical wiring or terminal block to the housing by use of self-taping screws in such a manner as to allow the connections to loosen if terminal generates heat resistance. Make the polycarbonate material strong enough to withstand a 70 foot-pound (95 Nm) impact without fracture or permanent deformation.

Alternate Construction (Aluminum). Where specified, construct the housing of each signal section of one piece dense cast aluminum.

Housing General. Make the area around the upper and lower openings ribbed or reinforced so as to be capable of handling breaking strengths that the ITE Standards (Section 3.01-6) specify.

Provide each housing with serrated round bossed openings at the top and bottom so that it rotates about a vertical line and is capable of being securely fastened at increments of no more than seven degrees.

After assembling the unit, drill a 3/8 inch (10 mm) hole for water drainage.

D. Door. Attach the door to the housing with stainless steel hinge pins and design it in a manner that does not allow the door to become accidentally detached when mounted in either a vertical or horizontal position. Design the door's locking device so that technicians do not require tools to open and close the door. Make the color of the door yellow.

E. Visor. Make visors as one molded piece in the "Tunnel" style, NOT the angle type. Make the visor with a longitudinal rectangular cutout in the bottom. Tilt the visor at an eight degree angle and equip it with four lugs, each with stainless steel or brass machine screws to hold it in place. Locate the lugs to permit rotating of the visor 90 and 180 degrees relative to the door. Securely fasten the visor to the door with the lugs, but make it removable with simple tools. Make the visor color black.

The length of the visor will vary depending on the signal specified on the plansheets.

1. For eight inch (200 mm) traffic signal heads, make the length seven to eight inches (175 mm to 200 mm).

2. For 12 inch (300 mm) traffic signal heads, make the length ten to 12 inches (250 mm to 300 mm).

F. Optical Unit. Equip each signal section with a neoprene or other approved resilient gasket, adequately sealing the lens to the door to assure a dust and moisture tight optical system. Install units in the optical system in a manner permitting easy replacement.

1. Reflector. Make the reflector of the Alzak process, or approved equal, highly polished specular finished aluminum type. Make it easily replaceable without replacing the reflector holder. Make the reflector holder easily replaceable and hinged to the signal housing to allow easy access for replacing lamp.

2. Lamps. Lamps will come with each signal section. Table 1326.01 indicates size and characteristics.

3. Lamp Receptacle. Make the lamp receptacle of a heat resisting material and designed to properly position a medium screw base traffic signal lamp. Provide the receptacle with an antivibration device and a positive locking device so that the socket will not turn when installing the lamp. Make provision on the receptacle and/or the reflector to permit rotation of the lamps so that the leadin wires are in the upward position, and to secure the lamp in this position. Make the lamp receptacle the fixed prefocus type designed for a lamp light center length of 2-7/16 inches (62 mm) for eight inch (200 mm) signals and three inch (75 mm) for 12 inch (300 mm) signals.

4. Lens, Incandescent. All lenses are the circular convex type in eight inch (200 mm) or the 12 inch (300 mm) size. The "ARROW" lenses are always 12 inch in size. Equip each 12 inch (300 mm) signal section with the wide angle type lens. Ensure that lenses are fabricated of durable polycarbonate impact-resistant plastic, or approved equal. Provide a neoprene gasket between the reflector and the lens to assure a dust and weatherproof seal between these components when the door is closed and latched to the housing. Fasten the lens to the door by use of machine screws and lugs and make it removable with simple tools. Ensure that all lenses conform to ITE and ANSI standards.

G. Physical and Mechanical Requirements, LED Optical Units. Provide LED traffic signal modules with expanded view (the module) designed as retrofit replacements for existing signal lamps that do not require special tools for installation. Provide retrofit replacement LED modules that fit into existing traffic signal housings built to VTCSH standard without modification to the housing.

Provide retrofit replacement LED signal modules that can be installed by simply removing the following existing components: lens, lamp module, gaskets. Provide replacement modules that fit securely and are weathertight in the existing housing and connect directly to existing electrical wiring.

Removal of the existing incandescent lamp reflector is optional. Provide LED optical units that retrofit to Peek Traffic/TCT, NO TCPSS83K300P, Peek Traffic/TCT NO ESS83K300P or LFE TRAFFIC CONTROL DIVISION, Eagle Signal No. SIG. 103A1111BYB or LFE TRAFFIC CONTROL DIVISION, Eagle Signal No. SIG. 130A1111BYB or approved equal traffic signal housing units.

1. LED Signal Module.

a. Tinting (Optional) – Tint lens or use transparent film or materials with similar characteristics.

b. The LED module lens may be a replaceable part without the need to replace the complete LED module.

c. The configuration of the LED arrow is illustrated in Figure 1327.01.

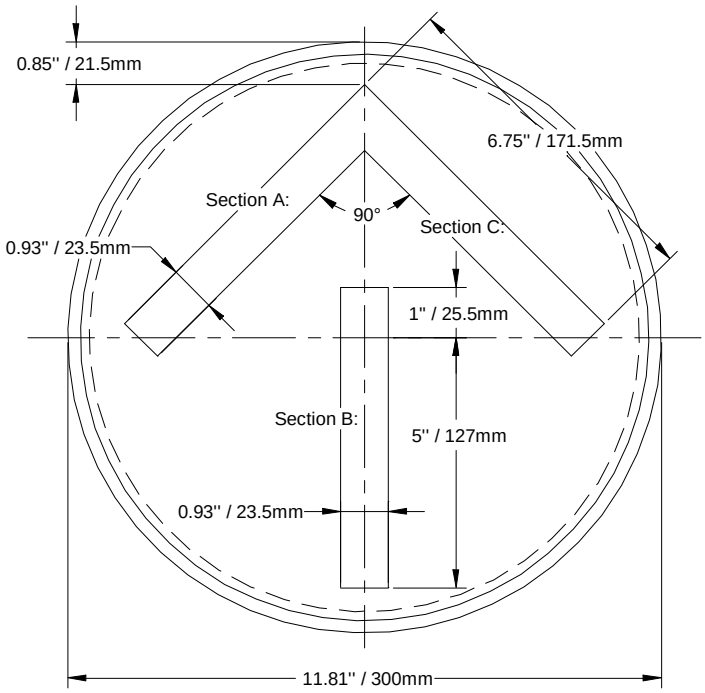

Figure 1327.01 – LED Arrow Configuration

2. Environmental Requirements.

a. Provide LED module rated for use in the ambient operating temperature range of –40° F to +165° F (-40° C to +74° C).

b. Protect the LED module against dust and moisture intrusion as per NEMA Standard 250-1991 requirements for Type 4 enclosures. Protect all internal LED, electronic and electrical components.

c. Provide LED signal module lenses that are UV stabilized.

d. Provide LED signal module lenses that are smooth on the outside and specifically designed to reduce sun reflections (sun phantoms).

e. Supply the LED module with an installed gasket.

3. Construction.

a. Provide LED modules that are single, self-contained devices, not requiring on-site assembly for installation into existing traffic signal housings. The power supply must fit and mount inside the LED module.

b. Design the assembly and manufacturing processes for the LED assembly to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

4. Materials.

a. Conform to applicable ASTM specifications for materials used in the lens and LED module construction/manufacture.

b. Construct enclosures containing the power supply and electronic components of the LED module of UL94VO flame retardant materials. The lens of the LED module is excluded from this requirement.

5. Module Identification.

a. Identify each LED module on the back side with the Manufacturer's name and the unit's serial number.

b. Indentify the following operating characteristics: nominal operating voltage, power consumption, and volt-amperes.

c. Provide all LED modules with prominent and permanent vertical indexing indicators (i.e., Up Arrow or the word "Up" or "Top") for correct indexing and orientation inside the signal housing.

H. Photometric Requirements – LED Optical Units.

1. Luminous Intensity and Distribution.

a. Furnish LED modules that provide the maintained minimum luminous intensity values shown in Tables 1327.A, B and C throughout the warranty period under the operating conditions defined in sections 1327.01.G.2.a and 1327.01.N.4.b.

b. Furnish LED modules that provide measured chromaticity coordinates between 500 nm and 650 nm when operating within the temperature range specified and conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

c. Furnish LED modules whose optical assemblies diffuse the light output and provide uniform illumination across the entire surface of circular lenses. Provide LED modules whose individual LED's are not visible to the observer of indications displayed.

Table 1327.A – Maintained Minimum Luminous Intensity for Expanded View LED Signal Modules – 12-Inch Signal

Vertical Angle (Degrees)	Horizontal Angle (Left & Right) (Degrees)	12-Inch Signal		
		Red	Yellow	Green
-17.5	17.5	3	7	7
	2.5	10	20	20
-12.5	17.5	14	27	27
	2.5	20	41	41
-7.5	17.5	20	41	41
	2.5	54	108	108
-2.5	17.5	58	115	115
	2.5	220	441	441
+2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178
	22.5	38	77	77
	27.5	16	32	32
+12.5	2.5	50	101	101
	7.5	48	97	97
	12.5	44	89	89
	17.5	34	69	69
	22.5	22	44	44
	27.5	16	32	32
+17.5	2.5	22	44	44
	7.5	22	44	44
	12.5	22	44	44
	17.5	22	44	44
	22.5	20	41	41
	27.5	16	32	32
+22.5	2.5	10	20	20
	17.5	7	14	14

Table 1327.B – Maintained Minimum Luminous Intensity for Expanded View LED Signal Modules – 8-Inch Signal

Vertical Angle Down (Degrees)	Horizontal Angle (Left & Right) (Degrees)	8-Inch Signal		
		Red	Yellow	Green
2.5	2.5	133	267	267
	7.5	97	194	194
	12.5	57	113	113
	17.5	25	48	48
7.5	2.5	101	202	202
	7.5	89	178	178
	12.5	65	129	129
	17.5	41	81	81
	22.5	18	37	37
	27.5	10	20	20
12.5	2.5	37	73	73
	7.5	32	65	65
	12.5	28	57	57
	17.5	20	41	41
	22.5	12	25	25
	27.5	9	16	16
17.5	2.5	16	32	32
	7.5	14	28	28
	12.5	10	20	20
	17.5	9	16	16
	22.5	6	12	12
	27.5	4	9	9

Table 1327.C – Maintained Minimum Luminous Intensity for the LED Vehicle Arrow Traffic Signal Modules

Vertical Down (Degrees)	Horizontal Angle (Left & Right) (Degrees)	12-Inch Signal		
		Red	Yellow	Green
2.5	2.5	60	150	90
	7.5	44	110	66
	12.5	25	62	38
	17.5	14	35	21
7.5	2.5	40	100	60
	7.5	36	90	54
	12.5	26	65	39
	17.5	16	40	24
	22.5	7	17	11
	27.5	3	7	4
12.5	2.5	9	23	14
	7.5	9	22	14
	12.5	8	20	12
	17.5	6	15	9
	22.5	4	10	6
	27.5	3	7	4
17.5	2.5	4	10	6
	7.5	4	10	6
	12.5	4	10	6
	17.5	4	9	6
	22.5	4	8	5
	27.5	3	7	4

2. Chromaticity.

a. Provide LED modules with measured chromaticity coordinates between 500 and 650 nm, conforming to the chromaticity requirements of section 8.04 and Figure 1 of the VTCSH standard.

I. Electrical Requirements – LED Optical Units.

1. General.

Furnish wiring and terminal blocks that meet the requirements of section 13.02 of the VTCSH Standard. Provide two secured, color coded, 36 inch (914 mm) long 600 volt, 20 AWG minimum jacketed wires, conforming to the NEC, rated for service at +220° F (+105° C) for electrical connection.

2. 15.2 Voltage Range.

a. Furnish LED modules capable of operating from a 60 ± 3 cycle AC line power over a voltage range from 80 to 135 volts AC RMS. The current draw must be sufficient to ensure compatibility and proper triggering and operations of load current switches and conflict monitors in the signal controller that the procuring traffic authority customer has in use.

b. Nominal operating voltage for all measurements is 120 ± volts RMS.

c. Furnish units whose luminous intensity is not affected by more than ± ten percent by fluctuations in line voltage over the range of 80 to 135 volts AC.

d. Furnish LED circuitry that prevents flickering at less than 100 Hz over the voltage range specified in Section 15.2.1.

e. Low Voltage Turn Off. Furnish modules that do not illuminate when the applied voltage is less than 45 volts AC. Test for this condition by first fully illuminating the unit at the nominal operating voltage. Then, reduce the applied voltage to the point that there is no illumination. That point must be greater than 45 volts AC. The same requirement applies to raising the voltage from 0 to 45 volts AC with no visible illumination.

f. Turn-On and Turn-Off Time. Furnish modules that reach 90 percent of their full illumination (turn-on) within 100 msec (± 10 msec) after the application of the nominal operating voltage. Furnish modules that are not illuminated (turn-off) within 100 msec (± 10 msec) after the removal of the nominal operating voltage.

3. Transient Voltage Protection.

Furnish LED modules containing on-board circuitry that includes voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992.

4. LED Drive Circuitry.

a. Wire the individual LED light sources so that the catastrophic failure of one LED will result in the loss of the light from only that one LED.

b. Provide current regulated power supply.

5. Electronic Noise.

Provide LED modules and associated on-board circuitry that meets Federal Communication Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

6. Power Factor (PF) and AC Harmonics.

a. Provide LED modules that have a power factor of 0.90 or greater when operated at nominal operating voltage and at 77° F (25° C).

b. Provide LED signal modules that do not induce total harmonic distortion into an AC power line exceeding 20 percent at nominal operating voltage at 77° F (25° C).

7. Wattage.

Provide LED modules that are less than or equal to the base wattages shown below at 77° F (25° C).

Type	Wattage
12" (300 mm) Red Ball	10 or less
12" (300 mm) Yellow Ball	22 or less
12" (300 mm) Green Ball	14 or less
12" (300 mm) Yellow Arrow	10 or less
12" (300 mm) Green Arrow	7 or less
8" (200 mm) Red Ball	6 or less
12" (200 mm) Yellow Ball	14 or less
12" (200 mm) Green Ball	8 or less

J. Terminal Block. Equip the signal head assembly with a barrier type terminal block having five poles for three or four section signal heads and seven poles for five section signal heads. Terminate wiring from the lamp sockets and external cable connections at the terminal block.

Make the terminal block easily accessible and removable. Mount he terminal block to the interior of the signal assembly with approved nuts, bolt and washers. City will not accept sheet metal screws.

K. Wiring. Make wiring of the signal head assembly color coded, No. 18 stranded copper fixture wire rated at 300° F (150° C), 300 volts, types PF, SF, or equal per Article 310-2(a) and 402 of NEC for incandescent units.

L. Color. Impregnate the color into the resin material to make the color of the polycarbonate signals permanent. The color is as follows:

1. The back and visors are black.

2. The front or doors are yellow.

M. Weight. The maximum weight of each signal head is as follows:

Product	Maximum Weight in Pounds (kg)
12 Inch (300 mm) Sections Polycarbonate Type	8 (3.5)
8 Inch (200 mm) Sections Polycarbonate Type	4 (1.8)
12 Inch (300 mm) Sections LED Type	10 (4.5)
8 Inch (200 mm) Sections LED Type	6 (2.7)

N. Quality Assurance for LED Optical Units.

1. General.

a. Quality Assurance Program. Manufacture LED modules in accordance with a Vendor quality assurance (QA) program. Furnish only products from Vendors whose QA programs include two types of quality assurance: (1) design quality assurance, and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of LED modules built to meet this specification.

b. Record Keeping. Keep QA process and test result documentation on file for a minimum period of seven years.

c. Conformance. Do not label, advertise or sell LED module designs as conforming to this specification if they do not satisfy design qualification testing and the production quality assurance testing performance requirements of Sections 21.3 and 21.4

2. Manufacturer's Serial Numbers. Indentify each LED module with the Manufacturer's serial number for warranty purposes.

3. Production Quality Assurance (QA) Testing. Test all new LED modules in accordance with the following Production Quality Assurance testing regimen prior to shipment. Reject any LED module that does not meet the requirements of these QA Tests. Maintain QA test results per the requirements of Section 21.1.2.

a. Module Burn-In. Energize all LED modules or the electronic circuitry sub-assemblies, including all LEDs for a minimum of 24 hours at 100 percent on-time duty cycle at an ambient temperature of +140° F (60° C).

b. Maintained Minimum Luminous Intensity. Test all LED modules for maintained minimum luminousity after burn-in. A single point measurement with a correlation to the intesnsity requirements of Tables 1, 2 or 3 in Section 14.0 may be used. Operate the LED modules at nominal operating voltage and at an ambient temperature of 77° F (25° C).

c. Power Factor. Test all LED modules for power factor after burn-in per the requirements of Section 15.6.1. A commercially available power factor meter may be used to perform this measurement.

d. Current. Measure all LED modules for current flow in amperes after burn-in. Compare the measured current values against current values resulting from design qualification measurements in Section 21.4.4.1. Reject LED modules exhibiting measured current values in excess of 120 percent of the design qualification current values.

e. Visual Inspection. Visually inspect all LED modules for any exterior physical damage or assembly anomalies.

4. Design Qualification Testing. Perform design qualification testing on new LED module designs, and when a major design change has been implemented on an existing design. The minimum sample quantity of LED modules shall be as stated for each test. Failure to meet requirements of any of these tests shall be cause for rejection.

Perform testing once every five years or when the module design or LED technology has been changed. Retain test data at the testing laboratory and at the LED module Manufacturer for a minimum period of five years.

a. Burn-in. Energize LED modules for a minimum of 24 hours, at 100 percent on-time duty cycle, in an ambient temperature of +140° F (60° C) before performing any design qualification testing.

b. Maintained Minimum Luminous Intensity.

I. After burn-in, test a random sample of six LED modules for maintained minimum luminous intensity at each of the 44 points indicated in Tables 1, 2 and 3 in Section 14.0. Take and record these measurements at an ambient temperature of 77° F (25° C) after the signal has been operated for 60 minutes.

II. After burn-in, test a random sample of six LED modules for maintained minimum luminous intensity. Mount signals to be tested in a temperature testing chamber so that the lensed portion of the signal is outside the chamber and all portions behind the lens are within the chamber at a temperature of 165° F (74° C). Maintain the air temperature in front of the lens of the signal lens at a minimum of (120° F (49° C) during all tests.

Test red and green LED modules for luminous output at 165° F (74° C). Allow the modules to achieve thermal equilibrium for 60 minutes, while the modules are energized at nominal operating voltage, at a 100% duty cycle. Take and record a single luminous intensity measurement.

Test yellow LED modules for luminous output at 77° F (25° C). Allow the modules to achieve thermal equilibrium for 60 minutes, while the modules are energized at nominal operating voltage, at a 8.3 percent (or 1/12) duty cycle or (5 sec On/55 sec Off).

Make a single point correlation measurement, accounting for measurement variables, at 77° F (25° C). Make a measurement for red and green at 165° F (74° C) with the lens at 120° F (49° C). Correlate the 165° F (74° C) measurement factored to the 77° F (25° C) measurement to the requirements of Table 1, 2 & 3 in Section 14.0. Reject LED modules not meeting this correlation.

III. Chromaticity. Measure a sample of two LED modules for chromaticity per the requirements of Section 14.2. Use a spectroradiometer for this measurement. Make this measurement at an ambient temperature of 77° F (25° C).

IV. Electrical.

i. Current. Measure a sample of six LED modules for current flow in amperes. Use the measured current values for quality comparison of Production Quality Assurance current measurements on production modules.

ii. Power Factor (PF). Measure a sample of six LED modules for power factor per the requirements of Section 15.6.1. Use a commercially available power factor meter to perform this measurement.

iii. Total Harmonic Distortion (THD). Measure a sample of six LED modules for total harmonic distortion per the requirements of Section 15.6.2. Use a commercially available total harmonic distortion meter to perform this measurement.

iv. Electronic Noise. Test a sample of one LED modules per the requirements of Section 15.6, with reference to Class A emission limits referenced in FCC Title 47, SubPart B, Section 15.

v. Controller Assembly Compatibility. Due to the low load current draw and high off-state impedance of LED modules, perform the following design qualification tests to ensure the module design is compatible and operates properly with load current switches and conflict monitors in NEMA and Type 170 traffic signal control units.

α. Load Switch Compatibility. Test a sample of six LED modules for compatibility and proper operation with load current switches. Connect each LED module to a variable AC voltage supply. Monitor the AC line current into the LED module for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80 volts RMS to 135 volts RMS. Reject LED modules whose current draw fails to ensure proper load current switch operation.

β. Signal Conflict Monitor Compatibility. Test a sample of six LED modules for compatibility and proper operation with signal conflict monitors. Operated each LED module from a 135 volt AC voltage supply. Wire a 19.5 kΩ resistor in series in the hot line between the LED module monitor and the AC power supply. Wire a single-pole-single-throw switch in parallel across the 19.5 kΩ resistor. Wire a 220 kΩ shunt resistor between the hot line connection and the neutral line connection and the neutral line connection on the LED module. Test conflict monitor compatibility by measuring the voltage decay across the 220 kΩ shunt resistor as follows: Close the single-pole-single-throw switch, shorting out the 19.5 kΩ resistor,

allowing the AC power supply to illuminate the LED module. Next, open the switch and measure the voltage across the 220 kΩ shunt resistor for a decay to a value equal to or less than ten volts RMS within a time period equal to or less than 100 milliseconds. Repeat this test a sufficient number of times to ensure testing occurs at the peak of the AC line voltage cycle.

vi. Nondestruct Transient Immunity. Test a sample of six LED modules for transient immunity using the procedure described in Section 2.1.8, NEMA Standard TS 2-1992.

V. Environmental.

i. Temperature Cycling. Perform temperature cycling on a sample of three LED modules per MIL-STD-883, Test method 1010. Make the temperature range in accordance with Section 2.3. Perform a minimum of 20 cycles with a 30-minute transfer time between temperature extremes and a 30-minute dwell time at each temperature. LED modules under test shall be non-operating. Reject any LED module that fails to function properly or exhibits any evidence of cracking of the LED module lens or housing after temperature cycling.

ii. Moisture Resistance. Perform moisture resistance testing on a sample of three LED modules per NEMA Standard 250-1991 requirements for Type 4 enclosures.

iii. Mechanical Vibration. Perform mechanical vibration testing on a sample of three (3) LED modules per MIL-STD-883, Test Method 2007, using three four-minute cycles along each x, y, and z axis, at a force of 2.5 Gs, with a frequency sweep from two Hz to 120 Hz. Reject any module that exhibits loosening of the lens, of any internal components, or other physical damage.

See ODOT Supplemental Spec. 872, Light Emitting Diode, Traffic and Pedestrian Signal Lamp Units, dated April 21, 2006, for additional quality assurance for LED optical units.

O. Warranty for LED Optical Units.

1. Replace or repair LED modules if an LED module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.

2. Replace or repair LED modules which exhibit luminous intensities less than the minimum values specified in Table 1 Section 3.0 within the first 60 months of the date of delivery.

P. Mounting. Include all mounting hardware for signal heads with the item furnished, as indicated in Table 1327 for the signal mounting or as indicated on the plans. The hardware will conform to City requirements as details show.

In accordance with the plans, mount signal heads alone, forming a one-way head, or combine with additional heads to form two-way, three-way, or a maximum of four-way heads. Furnish multi-way heads with appropriate top and bottom brackets with an opening in the center of the top bracket provided for mounting purposes. Using pipe spacers, correct signal

face height inequalities for multi-way heads for proper accommodation between top and bottom brackets.

Observe the requirements that the bottom of all signals and signs on a span shall be level with one another, with a minimum of 17 feet (5.2 m) clearance between the equipment and the roadway. This is usually measured at the crown of the roadway.

Table 1327
Sign and Signal Mounting Hardware

Mounting Type *S = Span Wire* *M = Mast Arm* *B = Bracket Arm* *P = Pedestal Top*	**Sign and Signal Equipment**			
	Traffic Signal Head	**Pedestrian Signal Head**	**Internally Illuminated Signs**	**Lane Use Control Signal Head**
Mounting Hardware	**Mounting Type**			
6 inch (150 mm) cast aluminum suspension clamp.	S		S	S
Adjustable clevis.	SM			SM
Combination galvanized cast iron balance adjuster and cast aluminum weatherhead	SM		SM	SM
Mast arm hanger or clamp	M		M	M
Pole clamps	B		B	
Clamshell Hardware		BP		
Post top reducer and coupling			P	
1-1/2 inch (40 mm) galvanized steel for mast arms, span wire assemblies and pedestal top mountings. 1-1/2 inch (40 mm) aluminum for bracket arms or polycarbonate for bracket arms of 15 inches (380 mm) or shorter.**	SMB		SMB	SM
1-1/2 inch (40 mm) lock nuts, washers and all other incidentals necessary to make the Assembly complete, dust and watertight.	SMB		SMBP	SM
Required clearance from bottom of Equipment to grade.	17 feet (5.2 m)	Minimum 8 feet (2.5 m)	17 feet (5.2 m)	17 feet (5.2 m)

** All pipe and fittings are aluminum schedule 40.

Q. Aiming of Signals. The light distribution of the traffic signal reflector and lens will give the greatest intensity straight in front and slightly down from the signal face.

Aim the signals as follows:

Vertical Aiming. For level approaches, mount all traffic signals so as to hang plumb. Where the approach has an angle, signal housing tilt 1/4 inch per 24 inches (10.4 mm per m) of elevation above grade for each one percent of approach grade.

Horizontal Aiming. Unless the traffic signal plan indicates otherwise, aim traffic signal heads horizontally, based on the following:

1. Two Signal Heads on Approach.

a. Aim left signal head horizontally with the beam of maximum intensity directed at a point five feet (1.5 m) to the right of the center line of the approach roadway, at a distance of 200 feet (61 m) from the stop line.

b. Aim right signal head horizontally with beam of maximum intensity directed at a point five feet (1.5 m) to the left of the right hand edge of the approach roadway, at a distance of 200 feet (61 m) from the stop line.

2. Two Through Traffic Signal Heads and One Left Turn Signal Head.

a. Aim left turn signal horizontally with beam of maximum intensity directed at the center of the left turn storage lane, if present, at a distance of 200 feet (61 m) from the stop line. If the storage lane is in excess of 200 feet (61 m) long, or otherwise on the center line at a distance of 200 feet (61 m) from the stop line.

b. Aim left signal head for through movement horizontally with the beam of maximum intensity directed at the center of the farthest left lane available for through traffic at a distance of 200 feet (61 m) from the stop line.

c. Aim right signal head as 1.b indicates above.

3. Aim horizontal point for auxiliary signal heads for special advance visibility conditions and/or signal heads facing curved approaches as the traffic signal plan indicates, or as the City Traffic Engineer directs.

1327.02 Optically Programmed Signal Heads. Furnish optically programmed signal heads in the arrangements the plans show. Incorporate in each signal section an optical system projecting an indication programmed to be visible only within boundaries of a specific area shown on the plans. Ensure that the optical system is capable of being veiled anywhere to within 15 degrees of the optical axis using procedures and opaquing material in accordance with the Manufacturer's instructions.

Signal sections conform to applicable portions of the ITE standard and the foregoing specifications for conventional optics traffic signal heads. Make optical sections of the 12 inch (300 mm) lens, and mounted alone or in combination with additional sections of optically programmed or conventional optics types to form signal faces and heads in the arrangements shown.

Make the components of the optical system:

1. Lamp
2. Lamp Collar
3. Optical Limiter-Diffuser
4. Objective Lens

Ensure that lamps have three prongs, a sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours. Couple the lamp to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter. Ensure that the optical limiter provides an accessible imaging surface that focuses on the optical axis for objects 900 to 1,200 feet (275 m to 365 m) distance, and permits an effective veiling mask to be variously applied as the desired visibility zone determines. Provide the optical limiter with positive indexing means and make it of heat resistant glass. Make the objective lens a high resolution planar incremental lens hermetically sealed within a flat laminant of weather resistant acrylic or approved equal. Make the lens symmetrical in outline; the lid may be rotated to any 90 degree orientation about the optical axis without displacing the primary image. Ensure that the optical system accommodates projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer. Ensure that the projected indication conforms to ITE transmittance and chromaticity standards.

Construct the housing of optically programmed sections to include a plus or minus ten degree tilt adjustment from the horizontal while maintaining a fixed mounting axis. Rigidly mount optically programmed signal heads to prevent visibility boundary movement due to high winds or truck movement. Mount signals mounted on span wire and tie to a tether cable by a breakaway clamp installed in the lower section mounting opening.

Include an incandescent lamp in each optical section and of the type Table 1326.01 indicates.

Make the housing of die-cast aluminum parts conforming to ITE alloy and tensile requirements, and having a chromate preparatory treatment. Finish the exterior of the signal case, lamp housing and mounting flanges with a high quality baked enamel prime and finish paint. Make the final color black. Paint the lens holder and interior of the case optical black. Predrill the signal case and lens holder for backplates and visors. Construct the hinge and latch pins of stainless steel. Seal all access openings with weather-resistant rubber gaskets. Ensure that sheet metal parts, including visors and backplates, conform to ITE material requirements, and include a chromate preparatory treatment and optical black on all surfaces.

Include mounting hardware in the Item furnished and as Table 1327 indicates or the signal mounting plans indicate. Ensure that hardware conforms to the requirements in the details. Make the tether cable 1/8 inch (3 mm) braided stainless steel cable.

1327.03 Lane Use Control Signal Heads.

A. General. The unit consists of a single housing containing optical parts, lamps and accessories for displaying by artificial illumination either a "Red X" or a "Green (Down) Arrow" indication as plans specify. Make the indications on an opaque background.

Ensure that testing conforms to the applicable provisions of Item 1313 - Testing.

B. Dimensions (Face Size).

Size	Type	Dimension				Strokes Of Indication	
		Width		Height			
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
12 inches (300 mm)	Single Indication	12 inches (300 mm)	14 inches (350 mm)	12 inches (300 mm)	14 inches (350 mm)	1-1/2 inch (40 mm)	3 inches (75 mm)

C. Colors and Dimensions. Ensure that colors and indication dimensions comply with the latest ITE Standard for "Adjustable Face Vehicle Traffic Control Signal Heads". The "RED X" cross bars have a minimum length of 15 inches (380 mm).

D. Optical Performance. Ensure that the color of lane use control signal indications is clearly visible for 1,320 feet (400 m) at all times under normal atmospheric conditions, unless otherwise physically obstructed. Ensure that the visibility angle of the lane use control signal is at least as great as plans specify for the standard circular traffic signal head. Design the signal to minimize the effect of sun phantom (i.e., reflection of incident [outside] light rays) to provide the maximum blankout effect of any indication not illuminated.

E. Single Indication Type. Ensure that lane use control signals of the single indication type meet the latest ITE Standards for "Adjustable Face Pedestrian Signal Heads" with the following supplements. Plans specify the indication.

1. Make the reflectors highly polished specular finished aluminum.

2. Make lens of prismatic glass diffusing type with fired on legends with opaque masking on back of lens to maximize blankout effect.

3. Make lamps the clear type and installed with the open portion of the filament in the upward position.

4. The lamps and rating for the signal head is:

Signal Size	Minimum Life (Hours)	Rated Watts	Light Volts	Center	Industrial Lamp Number
12 inch (300 mm) Signal	8,000	121	125	3 inches (75 mm)	121 A/TS
18 inch (450 mm) Signal	1,000	200	130	6 inches (150 mm)	200 PS 30/34

F. Housing. Make the housing of sheet aluminum, a corrosion-resistant aluminum, or aluminum-alloy die casting of sufficient strength of virgin ultraviolet stabilized polycarbonate resin. Weld all metallic joints continuously to prevent the entrance of moisture.

Make all screws, nuts, bolts and fastening devices used in the signal housing stainless steel. Mount all components in the housing(s) so they are easily accessible without de-energizing or disassembling the signal.

G. Visor. Make the visor 18 gage (0.05") (12 mm) minimum aluminum or polycarbonate, securely attached to the housing, as paragraph G indicates. Ensure that the visor attached to the door does not interfere with the opening of the door.

Construct the visor so that the indication is shielded from direct sunlight when the sun is 45 degrees or more above the horizon.

H. Wiring. Wire the signal heads assembly with a minimum of 300° F (150° C), 600 volt, No. 18 AWG stranded copper fixture wire per articles 310-2 (a), 402 and 410 of the N.E.C.

Provide terminal strip rated at 600 volts with each pole rated at 15 amps for wiring connection to external control cable.

I. Painting. Paint aluminum equipment in accordance with Item 1317 and the following:

1. First coat (all surfaces) - Epon Oxide Baking Primer, Federal Spec. TT-P-636.

2. Second coat (all Surfaces) - Medium Gray Alkyd Urea Exterior Baking Enamel, Federal Spec. TT - E-480B.

3. Third coat (yellow surface) - Federal Yellow Alkyd Urea Exterior Baking Enamel, Federal Spec. TT-E-489F, Color 13538.

4. Third coat (green surface) - Dark Green Alkyd Urea Exterior Baking Enamel, Federal Spec. TT-E-489, Color 14062.

5. Third coat (flat black surface) - Alkyd Urea Black Synthetic. Heat-resisting Glyceryl Phyhalate Type 4, instrument black military Spec.E-5557.

J. Installation. Include mounting hardware in the Item furnished as indicated in Table 1327 for the signal mounting plans indicate. Ensure that the installation and all hardware conform to detail requirements.

Position signals over the center of the lane(s) plans specify except where plans indicate offset positioning.

Include the cost of furnishing and installing lamps in the bid price for the respective signal head.

1327.04 Pedestrian Signal Heads. Furnish pedestrian signal heads conforming to the ITE Specification "Adjustable Face Pedestrian Signal Head Standard," except as may be otherwise indicated below. The signal heads display alternately the legends "Hand" symbol in Portland Orange light and "Walking Man" in Lunar White light (with or without countdown display).

A. Housing. Type D2 Pedestrian Signal – Make the housing single piece cast aluminum with 1-1/2 inch (40 mm) reinforced mounting hubs on the top and bottom with serrated bossed openings. Make the door frame of one piece cast aluminum. Door fastens with a captive stainless steel wingnut, and latching or unlatching of the door requires no tools. Access to the lamps is direct by opening the door. Use stainless steel for all screws, nuts, bolts, and fastening devices used in each type signal housing.

Make all gaskets in each type housing which are exposed to the atmosphere dust and moisture tight. Make the gaskets of neoprene or an approved equivalent. The City will not accept cork gaskets.

B. Dimensions. Table 1327.03 indicates signal head face dimensions.

Table 1327.03

	Face				Legend	
Signal Type	**Width**		**Height**		**Symbol Height**	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Nominal**	**Tolerance**
16" LED Type D2	13 inches (330)	16 inches (400 mm)	15-1/2 inches (395 mm)	18 inches (460 mm)	4-1/2 inches + 1/8 inch (115 mm ± 3 mm)	5/8 inch -1/32 inch +3/32 inch (16 ± 1 mm)

C. Arrangement of Symbols and Colors. The color for the "Walking Man" symbol is Lunar White and the color for the "Hand" symbol is Portland Orange. The colors are to comply with the color standards of the ITE Specification.

1. Type D2 Single Section LED Type Signal. The "Hand"symbol is in the left half and the "Walking Man" symbol on the right half of the lens. Make the face of 0.250 inch (6.5 mm) polycarbonate plastic and textured on outside surface. The "Hand" message is Portland orange when illuminated and the "Walking Man" message is Lunar white when illuminated.

Make the symbols cutout type with black background; these produce bright and uniform messages even in strong ambient lighting condition. When an optical section is not energized, that section blanks out so that the message is not readable even under very strong ambient lighting conditions.

2. Type D2 Single Section LED Countdown Type Signal. The "Hand" and "Man" symbol shall be integral and on the left side of the display. The right side shall consist of the countdown display. The countdown display shall have a "ON/OFF" switch to disable the countdown portion of the display.

D. Visor.

Make the visor of the "Eggcrate" design in one-piece injection molded polycarbonate plastic. Make the visor 1-1/2 inch (40 mm) deep with horizontal members spaced 1/2 inch (12 mm) apart. Place enough vertical members to assure holding the horizontal members parallel. Install the visor parallel to the face and mount to the door frame with stainless steel screws.

E. Painting. Paint the aluminum signal head in accordance with Item 1317 and the following:

Clean the unit properly and give the exterior of the housing and the entire visor one coat of chromate primer and two coats of automotive baking enamel. Bake each coat individually to a hard finish before applying the next coat.

F. Optical. The purpose of this specification is to provide the minimum performance requirements for the LED "Walking Man" and "Hand" icon pedestrian signal modules (hereafter called module or modules). This specification requires the following size (nominal message bearing surface): 16 inch by 18 inch (406 mm x 457 mm). This specification is not intended to impose restrictions upon specific designs and materials that conform to the purpose and the intent of this specification. This specification refers to definitions and practices described in "Pedestrian Traffic Control Signal Indications" published in the Equipment and Materials Standards of the Institute of Transportation Engineers, referred to in this document as "PTCSI" and in the Manual on Uniform Traffic Control Devices (MUTCD). This specification applies to modules purchased after the effective date of these specifications.

G. Physical and Mechanical Requirements LED Modules. Provide modules designed as retrofit replacements for existing pedestrian signal indication lamps that do not require special tools for installation. Provide retrofit replacement modules that fit into existing pedestrian signal housings built for the PTCSI sizes listed in Section 1 of the "Walking Man" and "Hand" icon pedestrian signal indication Standard without modification to the housing. See PTCSI 4.2.1 for housing sizes.

Provide retrofit replacement modules that only require the removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector, for installation into existing pedestrian signal housing. Additionally, provide retrofit replacement models that are weather tight, fit securely in the housing, and connect directly to existing electrical wiring.

1. The Module.

a. Provide retrofit modules capable of replacing the optical unit.

b. The module lens may be a replaceable part without the need to replace the complete module.

c. Provide modules that include full "Walking Man" and "Hand" icons (not outlines). The configurations of the "Walking Man" and "Hand" icons are illustrated in Figure 1 and Figure 2, respectively.

Figure 1

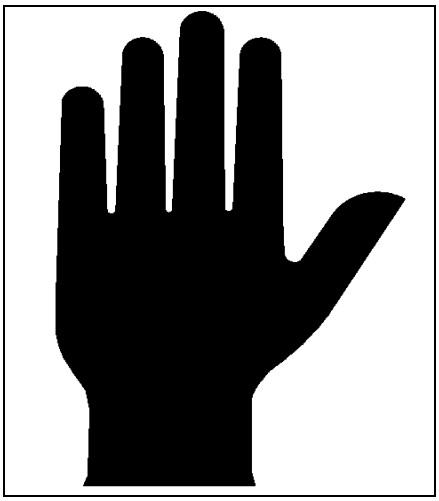

Figure 2

2. Dimensions for Figure 1 and Figure 2. For the nominal message bearing surface (module) size, use the corresponding height and width:

Height = 11 inches (280 mm)
Width = 7 inches (180 mm)

H. Environmental Requirements.

1. Provide modules rated for use in the ambient operating temperature range (measured at the exposed rear of the module) of -40° F to +165° F (-40° C to +°75 C).

2. Design the pedestrian module to meet NEMA 250 Hose down Test. Conduct the test on a stand-alone unit. Do not use protective housing.

3. Provide modules with UV stabilized lens.

I. Construction.

1. Provide modules that are single, self-contained devices, not requiring on-site assembly for installation into an existing traffic signal housings. Design the power supply to fit and mount inside the pedestrian signal module.

2. Design the assembly and manufacturing process for the module to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

J. Materials.

1. Use materials for the lens and LED module construction that conform to ASTM specifications where applicable.

2. Construct enclosures containing the power supply and electronic components of the LED module of UL94VO flame retardant materials. The lens of the LED module is excluded from this requirement.

K. Module Identification.

1. Indentify each module on the backside with the Manufacturer's name, model number(s) and serial number(s).

2. Identify the following operating characteristics: nominal voltage, power consumption, and Volt-Ampere.

L. Photometric Requirements.

1. Luminance, Uniformity & Distribution.

a. Provide modules capable of maintaining the minimum luminance values listed in Reference 1 and Reference 2 under the operating conditions defined in Sections 2.3.1 and 4.2.1 for a minimum period of 60 months. Make measurements perpendicular to the surface of the module at nine separate points on the icon. These values may decrease up to 50 percent from these table values beyond 15 degrees from the perpendicular in either to the left or right on a horizontal plane.

Reference 1 - Maintained Minimum Luminance Value
"Walking Man" icon of the Module
5,300 candelas/square meter

Reference 2 - Maintained Minimum Luminance Value
"Hand" icon of the Module
3,750 candelas/square meter

b. Provide modules with the uniformity of the "Walking Man" and "Hand" icons' illumination meeting a ratio of not more than one to five between the minimum and maximum luminance measurements (in Cd/m2).

2. Chromaticity. The standard colors for the LED Pedestrian Signal Module shall be Lunar White for the "Walking Man" and Portland Orange for the "Hand" icon. The colors for these icons shall conform to the CIE chromaticity diagram x, y coordinates as follows:

The white area is defined by the sum of these two areas that are contiguous, and are defined by the following lines:

	First Area	**Second Area**
Yellow Boundary	x = 0.400	x = 0.450
Blue Boundary	x = 0.280	x = 0.400
Green Boundary	y = 0.7917x + 0.0883	y = 0.7917x +0.0483
Purple Boundary	y = 0.4600x + 0.1810	y = 0.4600x + 0.2210

The Portland Orange area is defined as:

	First Area
Red Boundary	y = 0.331
Yellow Boundary	y = 0.390
White Boundary	y = 0.997 – x

M. Electrical.

1. General. Furnish wiring and terminal blocks that meet the requirements of Section 13.02 of the VTCSH Standard. Provide two secured, color coded, 36-inch (914 mm) long 600 volt, 16 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +220° F (+105°C), for electrical connection.

2. Voltage Range.

a. Provide LED modules that operate from a 60 $\pm$ 3 Hertz AC line power over a voltage range from 80 volts AC RMS to 135 volts AC RMS. Provide modules that have sufficient current draw to ensure compatibility and proper triggering and operation of load current switches and conflict monitors.

b. Nominal operating voltage for all measurements shall be 120 $\pm$ 3 volts RMS.

c. Provide LED modules whose luminous intensity is not affected by more than + ten percent by fluctuations in line voltage over the range of 80 volts AC to 135 volts AC.

d. Provide LED modules with circuitry that prevents flickering at less than 100 Hz over the voltage range specified in Section 4.2.1.

e. Low Voltage Turn Off. Provide modules that do not illuminate when the applied voltage is less than 35 volts AC RMS. Test each icon for this condition by first fully illuminating it at the nominal operating voltage and then reducing the applied voltage to the point where there is no illumination. This point must be greater than 35 volts RMS AC.

f. Turn-On and Turn-Off Time. Provide modules where each icon of the module reaches 90 percent of its full illumination (turn-on) within 100 msec. of the application of the nominal operating voltage. Provide modules that do not illuminate (turn-off) after 100 msec. of the removal of the nominal operating voltage.

g. Provide pedestrian signal units that default to the "Hand" symbol during abnormal conditions when nominal voltage is applied to the unit across the two-phase wires (rather than being applied to the phase wire and the neutral wire).

3. Transient Voltage Protection. Provide modules whose on-board circuitry includes voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1998, or the latest version.

4. Electronic Noise. The modules and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.

5. Power Factor (PF) and AC Harmonics.

a. Furnish modules that provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 77° F (25º C).

b. Provide modules that when operated at nominal operating voltage induce total harmonic distortion into an AC power line of 20 percent or less.

N. Quality Assurance.

1. General. Unless otherwise specified, conduct all of the required tests at an ambient temperature of 77° F (25° C) and at the nominal operating voltage of 120 volts AC RMS.

a. Manufacture modules in accordance with a Vendor quality assurance (QA) program. Furnish only products from Vendors whose QA programs include two types of quality assurance: (1) design quality assurance, and (2) production quality assurance. Include statistically controlled routine tests as part of the production quality assurance to ensure minimum performance levels of LED modules built to meet this specification.

b. Keep QA process and test result documentation on file for a minimum period of seven (7) years.

2. Conformance. Do not label, advertise or sell as conforming to this specification any module design(s) not satisfying design qualification testing and production quality assurance testing performance requirements.

3. Design Qualification Assurance.

a. Perform Design Qualification testing on new module designs, and when a major design change has been implemented on an existing design.

Unless otherwise specified, conduct all of the tests on the same set of randomly selected modules, hereafter called the sample set, at an ambient temperature of 77° F (25° C) and at the nominal operating voltage of 120 volts AC RMS.

b. Perform testing once every five years or when the module design or LED technology has been changed. Retain test data (by the module Manufacturer) for a minimum period of seven years and for a period of at least five years beyond the last date of manufacture of that model type.

4. Production Quality Assurance.

a. Subject all new modules to Production Quality Assurance testing prior to shipment. Reject any module that fails to meet requirements of the QA tests. Maintain QA test results for a period of four years.

5. Warranty. Provide the following warranty provisions from Manufacturer: LED signal modules(s) that fails to function as intended due to workmanship or material defects within the first 60 months from date of deliver will be replaced or repaired at no cost to the City of Cincinnati.

O. Optical Performance. Ensure that it is possible to discern which message is illuminated and that the message is readable to normal eyesight from a distance of 100 feet (30 m) on a bright, clear day, in direct sunlight, with the visor(s) removed.

P. Wiring. Provide each lamp receptacle with two coded No. 18 or larger insulted copper lead wires connecting the lamps to the terminal strip. Ensure that wiring has approved 600 volt insulation, capable of withstanding 221° F (105° C) and is long enough to provide easy accessibility without disconnection wires when opening the unit for service.

Q. Terminal Block. Locate a terminal block having a minimum of seven terminals so as to be easily accessible when opening the unit. Terminate wires for interior connections to the external wiring on this terminal block. Provide entry for external wiring through both the top and bottom mounting hubs to the terminal block.

R. Installation. Include mounting hardware in the item furnished, as indicated in Table 1327 for the signal mounting plans indicate.

Provide mounting hardware of "Clamshell" design, constructed of cast aluminum alloy, black finish. Dimensions not to exceed: 11-1/4 inches (286 mm) high by 5-1/2 inches (140 mm) wide by 2-3/4 inches (70 mm) deep. Design hardware to allow thru-bolt, lag screw or steel band mounting.

Secure the closed signal half of the assembly to the pole half of mounting hardware by use of a flathead socket bolt and tighten using a 3/16 inches (5 mm) Allen wrench.

Terminate field wiring on a horizontally mounted three-position terminal block located on the upper half of the signal mounted section of the mounting hardware.

Provide mounting hardware with a neoprene gasket to provide a weather tight seal.

Provide warranty for clamshell mounting bracket and hardware for two years from the date of shipment covering all materials and workmanship.

Ensure that the installation and all hardware conform to the detail requirements.

S. Manufacturer.

1. The D2 type Pedestrian signals are the Indicator Controls Corporation model 7037 without the clamshell mounting hardware or approved equal.

2**.** Pedestrian signals are the McCain model 1000 with the McCain clamshell mounting hardware or an approved equal.

1327.05 School Flasher, Installation Only. The work of this item consists of installing the school flasher assembly (the sign face, flashing amber beacons and illuminated speed numeral). City will furnish all equipment except mounting hardware.

Furnish and install the bracket arms of the length plans specify, and all pole mounting hardware and all accessories required to install the complete school flasher assembly.

Make all bracket arms 1-1/2 inch (40mm) schedule 40 galvanized steel pipe. Use galvanized pole plates with through bolts and leg screws on wood pole installations. Use galvanized pole clamps on steel pole installations.

Make the installation in accordance with the plans and details.

Furnish the school flasher time control where plans require under Item 1324.07.

1327.06 Covering of Traffic Signals. Not in Service - New: Keep all Signal heads installed but not in operation completely covered at all times with burlap, heavy corrugated cardboard, or other approved material, so that the signal lenses are not visible from any point. Remove or de-energize lamps in signal heads covered with cardboard, burlap, etc., until the covering is removed and the signals are put into operation. If the covers come off for any

reason, the Contractor must recover them within 24 hours of notification. If the Contractor does not recover them, the City will do the work and charge the Contractor.

To Be Removed or Temporarily Disconnected: Cover the existing signal heads when removed or temporarily disconnected from operation with burlap, heavy corrugated cardboard, or other approved material and remove or de-energize lamps until the Contractor removes or restores the signal heads. Do not remove existing signal heads until the new equipment is in operation. If the covers come off for any reason, the Contractor must recover them within 24 hours of notification. If not, the City will do the work and charge the Contractor.

City will make payment for covering of traffic signals incidental to the various items of the bid, which require new, removed or temporary signal equipment.

Provide coverings for vehicular, lane use and pedestrian signal heads as the City directs.

1327.07 Five Section Traffic Signal Assembly. Ensure that all traffic signal heads comply with the requirements of section 1327.01, Vehicular Traffic Signal Head. Construct the assembly as shown in the TRAFFIC AND ROAD OPERATION STANDARD DRAWING ES-3-5. The Traffic Services Bureau supervisor, phone number 513-352-3712, must approve the completed signal assembly before installation.

1327.08 Method of Measurement. Signal heads are measured as complete units in place and accepted, including all support and mounting hardware, optical programming as plans specify, aiming, lamps, tether cable as specified and covering.

1327.09 Basis of Payment. City will make payment at the Contract unit price bid for each signal head as plans specify; payment includes all labor, material, tools, equipment, and incidentals necessary to furnish and install the item complete, tested and accepted.

Item	Unit	Description
1327	Each	Vehicular Signal head, assembly ____ Section, ____ inch lens, ____ way.
1327	Each	Optically programmed Signal head assembly ____ Section, 12 inch lens, ____ way.
1327	Each	Lane Use Control Signal head assembly ___ Controlled ___ face.
1327	Each	Lane use control signal head assembly, ____ inch ____ lens, ____ way.
1327	Each	Pedestrian Signal head assembly, ____ type ____.

ITEM 1328 Traffic Signal Detectors

1328.01 Detector Amplifier, Installation Only. The work of this item consists of hauling and installing detector amplifiers as plans specify, as the City of Cincinnati furnishes, in accordance with the plans and details. Install the amplifiers in the traffic signal controller cabinet, or separate cabinet if plans specify, and make all wiring connections in accordance with the details.

1328.02 Detector Pavement Cutting. Saw slots in the pavement for installation of wire for vehicle detector loops in accordance with the configuration dimensions, and combinations plans show. Chamfer all corners with a full depth cut to eliminate sharp corners. Overlap the intersection of saw cuts so that the slots have full depth and a smooth bottom. Install the detector loop in clear, dry weather and ensure that the sawed slot is completely clean of dust and debris and thoroughly dry. Cut an extension from the loop to the pavement edge to permit wire routing to an adjacent pullbox or conduit fitting. When going through curbs, use Item 1321.04 PVC conduit to take the wire from the pavement edge through the curb and on into the pullbox or conduit fitting. Where no curb is present, end the sawcut six inches (150 mm) before the pavement edge. From that point, route the wire through Item 1321.04 PVC conduit to an adjacent pullbox or conduit fitting.

Make the slot width 3/8 inch (10 mm) and slot depth four inches (100 mm) in asphalt, and two inches (50 mm) in concrete, with the minimum depth providing a covering above the uppermost wire in the slot of no less than one inch (25 mm) in concrete and three inches (75 mm) in asphalt. If floating of the wire occurs, bend one inch (25 mm) of 1/4 inch (6 mm) O.D. vinyl tubing and wedge it into the slot at two-foot (600 mm) centers to keep the wire down.

Following pavement cutting and cleaning, install the detector wire according to Item 1323.01.

Where the saw cut crosses any construction joint or cracks in concrete or asphalt pavement, drill a 1-1/2 inch (40 mm) diameter hole at the joint and provide a relief loop for the detector wire. Use installation methods and materials as details indicate.

Seal slots with a flexible embedding sealant approved by the City Traffic Engineer and as details indicate. Make the sealant an epoxy type and must be on the ODOT QPL. Before applying sealant, brush or blow clean all slots of loose material, and dry completely. Mix and place the sealant according to the Manufacturer's instructions. Fill the slots completely and leave them undisturbed until cured. Remove any excess or spillage.

Saw detector wire installations in new asphalt and embed with sealant in an undersurface course with subsequent covering by the surface course, subject to the Engineer's approval. Do not make detector wire installations in existing brick or unstable bituminous roadways.

Test the loop detector wire in accordance with Item 1313 before and after applying loop sealant.

City will include payment for the sealant in the Item of Saw Cutting.

1328.03 Loop Detector Installed In Duct. The Work of this item consists of installing conduit in areas trenched for this purpose or under new concrete roadway, whichever plans specify.

Where the plans require installation of duct in trenched areas, the work includes Item 1321.02 trenching in paved areas to the depth and width specified, and installing Item 1321.04 PVC conduit Type I concrete encased, formed in the dimensions plans specify. For loop detector wire, use multi-conductor traffic signal cable, as plans and details specify, installed in the conduit and spliced to form multi-turn loops in the specified pullbox or conduit fitting. Item 1323 Loop detector wire shall be a separate pay item. This work also includes restoration of the paved area in accordance with Item 1334.

Where the plans require installation of duct under new concrete roadway, include Item 1321.04 - two inch (50 mm) PVC conduit Type II - formed in the dimensions plans specify, and include the applicable Item 202 for removing and disposing of existing pavement and Item 451 for installing new concrete pavement without reinforcing where these items are not included under roadway items. Additional items may be required contingent on the conditions and shall be specified.

City may make payment for each item required or on a lump sum basis as specified.

1328.04 Overhead Microwave Detector, Installation Only. The work of this item includes installing overhead detectors with cable, which the City furnishes in accordance with the plans, and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of Contract.

1328.05 Overheight Infrared Detector. The work of this item includes installing overhead detectors with cable, which the City furnishes in accordance with the plans and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of the Contract.

1328.06 Video Detection. The work of this item includes installing overhead detectors with cable in accordance with the plans and details. The Contractor may make field adjustment of equipment as the Engineer directs. The cost associated with this adjustment is incidental to the overall cost of Contract.

A. General.

1. This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using only video images of vehicle traffic utilizing video transmission between the camera sensor and video detection processor.

2. Provide video detection system consisting of video cameras, a video detection processor and odd numbered phase extension modules which mount in a standard input file of a 170 controller, a pointing device, cabling, and camera attachment mounting hardware.

3. Include software that detects vehicles in multiple lanes using only the video image. Define detection zones using only an on board video menu and a pointing device to place the

zones on a video image. Provide system with up to 24 detection zones per camera available. Provide system that does not require a separate computer to program the detection zones.

B. Functional Capabilities.

1. Furnish processor that detects the presence of vehicles in up to 24 detection zones per camera. A detection zone is approximately the width and length of one car.

2. Furnish system that permits the programming of detection zones via an on board menu displayed on a video monitor and a pointing device connected to the processor. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. Provide system that does not require a separate computer for programming detection zones or viewing system operation.

3. Provide system with processor capable of storing up to three different detection zone patterns and switching to any of the three different detection patterns within one second of user request via menu selection with the pointing device.

4. Provide system with processor that detects vehicles in real time as they travel across each detector zone.

5. Provide system with processor that has an RS232 port for communications with an external computer. Provide processor RS232 port that is multi-drop compatible.

6. Provide system with processor capable of accepting new detector patterns from an external computer through the RS232 port when the external computer uses the correct communications protocol for uploading detector patterns. Provide Windows-based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability with the system.

7. Provide system with processor capable of sending its detection patterns to an external computer through the RS232 port when requested when the external computer uses the correct communications protocol for downloading detector patterns.

C. Vehicle Detection.

1. Provide system that supports a minimum of 24 detection zones that can be sized to suit the site and the desired vehicle detection region.

2. Provide system where a single detection zone is capable of replacing multiple loops and detection zones may be AND'ed or OR'ed together to indicate vehicle presence on a single phase of traffic movement.

3. Provide system where placement of detection zones is done using only a pointing device and a graphical interface unit built into the processor and is displayed on a video monitor. Provide system that permits drawing detection zones on the video image from the video cameras and does not require a separate computer to program detection zones.

4. Provide system with processor capable of saving a minimum of three detection zone patterns within the processor memory. Provide processor with non-volatile memory that prevents data loss during power outages. Provide processor that continues to operate (e.g. detect vehicles) using the existing zone configuration even when the operator is defining/modifying a zone pattern. Provide system that does not put the new zone configuration into effect until the configuration is saved by the operator.

5. Furnish system that permits the selection of the detection zone pattern for current use through a menu or remote computer via RS232 port. Provide system that allows the activation of a detection zone pattern for a camera from processor memory and displays that detection zone pattern within one second of activation.

a. Provide system where the corners of the detection zone flash on the video overlay display screen to confirm the detection of a vehicle when the vehicle crosses a detection zone.

b. Provide system that is at least 98 percent accurate detecting vehicles in good weather conditions and at least 96 percent accurate under adverse weather conditions (rain, snow, or fog). Detection accuracy is dependent upon site geometry, camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.

c. Place detector so that the distance between the detector and the camera is not more than ten times the mounting height of the camera.

d. Provide system with processor capable of providing up to 24 channels of vehicle presence detection per camera through a standard input file edge connector and one or more extension modules.

e. Furnish system with processor capable of providing dynamic zone configuration to enable normal detector operation of existing channels except the one where a zone is being added or modified during the setup process. Furnish processor that outputs a constant call on any detection channel corresponding to a zone being modified.

f. Provide system such that detection zone setup does not require site specific information such as latitude, longitude, date and time to be entered into the system.

g. Provide system such that the processor outputs a constant call for each enabled detector output channel during the background learning period and if a loss of video signal occurs.

h. Provide system such that detection zone outputs are configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse extend and delay outputs shall be user definable between 0.1 and 25.0 seconds.

i. Furnish system such that up to six detection zones are capable of counting the number of vehicles detected. Furnish system that is capable of storing the count value

internally for later retrieval through the RS232 port. Provide system that allows for the data collection interval to be user definable in periods of five, 15, 30 or 60 minutes.

D. Processor and Extension Module.

1. Design the processor and extension module to mount in a standard 170-type rack using the edge connector to obtain power and provide contact closure outputs. Furnish processor or extension modules that can be mounted in a standard input file without the use of adapters and without rewiring.

2. Provide processors and extension modules capable of operating in a temperature range from –30° F to +165° F (-34° C to +74° C), and a humidity range from 0 percent RH to 95 percent RH, non-condensing.

3. Furnish processors and extension modules powered by 12 or 24 volts DC that automatically compensate for the different input voltages.

4. Furnish processors whose power consumption does not exceed 300 milliamps at 24 volts DC. Furnish extension modules whose power consumption does not exceed 120 milliamps at 24 volts DC.

5. Furnish processors that include a multi-drop compatible RS232 port for serial communications with a remote computer. This port shall be a nine-pin, "D" subminiature connector on the front of the processor.

6. Furnish processors that utilize flash memory technology to enable the loading of modified or enhanced software through the RS232 port without modifying the processor hardware.

7. Furnish processors and extension modules that include detector output pin put out compatibility with industry standard detector racks.

8. Furnish processors whose fronts include detection indications (such as LED's) for each channel of detection that display detector outputs in real time when the system is operational.

9. Furnish processors whose fronts include one or two BNC input connections suitable for RS170 video inputs as required. Provide video input that includes a switch selectable 75 ohm or high impedance termination to allow camera video to be routed to other devices, as well as input to the processor for vehicle detection. Video must be inputted via a BNC connector on the front face of the processor. RCA type connectors/jacks for video input are not allowed. Do not route video via the edge connectors of the processor.

10. Furnish processors whose fronts include one BNC video output providing real time video output that can be routed to other devices. An RCA-type connector/jack for video output is not allowed.

11. Furnish processors and extension modules whose front panel(s) have a detector test switch to allow the user to place calls on each channel. Provide test switch that is capable of placing either a constant call or a momentary call depending on the position of the switch.

E. Camera.

1. Furnish camera that is capable of producing a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from night time to day time, but not less than the range of 0.1 lux to 10,000 lux.

2. Furnish camera that outputs monochrome video with resolution of not less than 350 lines vertical and 500 lines horizontal.

3. Furnish camera that includes auto-iris control based upon average scene luminance and is equipped with an auto iris lens.

4. Furnish camera that includes a variable focal length lens with variable focus that can be adjusted to suit site geometry without opening the camera housing. Adjust the lens iris to minimize image variations.

5. House the camera in an environmentally sealed enclosure. Equip the camera enclosure with a sun shield that prevents sunlight from directly entering the lens. Furnish sunshield that is less than six inches (150 mm) in diameter, less than 26 inches (660 mm) long and weighs less than 12 pounds (5.5 kg) with the camera and lens mounted inside the enclosure. Include a thermostatically controlled heater in the camera enclosure to assure proper operation of the lens iris at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. Furnish camera that operates satisfactorily in a temperature range from –30° F to +130° F (-34° C to +55° C) and a humidity range from 0 percent RH to 100 percent RH when mounted outdoors in the enclosure.

F. Installation.

1. Furnish power cable that is 16 AWG, three-conductor cable based on a per foot price. Provide power cabling rated for 600 volts and RHH/RHW/USE insulated.

2. Provide coax cable that is high frequency, low-loss 75 ohm type with cable loss of no more than .78 dB/100 feet (30.5 m) at 10 MHz. Furnish cable suitable for installation in conduit or overhead with appropriate span wire. Use BNC plug connectors at both the camera and cabinet ends.

3. Furnish each camera unit with mounting brackets suitable for wood, steel pole, and other mast arm type applications. Include the brackets as incidental to the cost of the camera.

G. Warranty. Provide a limited two-year warranty from the Supplier for the video detection system.

H. Maintenance and Support. Include with the cost of the system a Supplier-lead training program consisting of two eight-hour training sessions that include field set up and installation instruction from a Factory Authorized representative. Provide Supplier-furnished trouble shooting and additional operational support by telephone and up to three field visits annually, throughout the duration of this Contract.

1328.07 Pedestrian Pushbutton With Associated Signs. Make pushbuttons of sturdy two-piece construction, consisting of an aluminum base housing and a vandal-resistant removable button/cover assembly with all other parts attached.

Provide button cover with bright red LED that flashes to acknowledge pushbutton activation. Construct button of 316 stainless steel and design to have a maximum operating force of three pounds (1.4 kg). Furnish base housing with captive stainless steel nuts to secure button cover assembly by using 1/4-20 stainless steel mounting bolts. Design and construct pushbutton to be approximately 3.4 inches (86 mm) in diameter and 2.5 inches (64 mm) deep when assembled. Design and construct pushbutton to operate in temperatures ranging from -30° F to 165° F (-34° C to 74° C) at a voltage range of 15 to 36 volts AC or 12 to 28 volts DC.

Ensure that the housing has a curved back surface for mounting on poles of various diameters. The curved surface may be integral with the housing or may be on an adaptor supplied with a flat back type housing. Attach the cover assembly to the housing with stainless steel machine screws, resulting in a weatherproof and shockproof design. Provide a hole threaded for a 1/2-inch (12 mm) pipe in the housing upper and/or lower sides to attach the conduit.

Orient push buttons as plans show. Service pushbuttons mounted on steel poles by wiring inside the poles, as plans detail. Provide holes 3/4 inches (20 mm) in diameter throughout the back of the housing and the pole wall, install an insulated bushing, and route wiring through so that no external wiring is visible. Plug the unused conduit attachment hole(s). Make housing mounting as details show. Service pushbuttons mounted on wooden poles through conduit and mount them as plans show.

Furnish pushbuttons with two instruction signs, one mounted below the pushbutton and one mounted across the street on top of the complemented actuated pedestrian signal. Make mounting details and locations as details and plans show.

Make the sign below the pushbutton an R-73A-MOD-5, nominally five inches by eight inches (125 mm x 200 mm) containing the legend: "TO CROSS STREET PUSH BUTTON WAIT FOR WALK LIGHT" arranged as plans show.

Make the sign above the pedestrian signal an R-73B-MOD-18, nominally 18 inches x 24 inches (450 mm x 600 mm) containing the legend: "PUSH BUTTON FOR WALK LIGHT" arranged as plans show.

Ensure that signs meet the requirements of Item 1329.03.

1328.08 Method of Measurement. Measure detector amplifiers as complete units in place, connected, tested and accepted.

Measure detector pavement cutting as the total number of feet (meters) of slots from the edge of the pavement to the magnetometer probe locations or to the loop and around the loop perimeter using the overall dimensions and making no adjustments for the diagonal corners. The work includes the application of sealant, and cleaning and blowing out the slotted areas.

Measure loop detector installed in duct as more than one specified pay item (i.e. conduit, trenching paved areas, concrete, or conduit, excavation and new pavement). The measurement would then be comprised of each of the items specified

OR

Measure loop detector installed in duct as a complete item per square foot (m^2) of area for installations under new pavement or as linear feet (meters) excavated and restored. For installations in trenched areas, each detector includes all conduit trench-paved areas, excavation, restoration and concrete Class C as required. Payment would be made as "Loop Detector Installation".

Measure overhead Microwave Detectors as a complete unit, including all mounting hardware.

Measure overheight Infrared Detectors (two-eyed) as one complete installation, including all mounting hardware.

Measure pedestrian pushbutton with signs as a complete unit in place, including all hardware, tested an accepted.

1328.09 Basis of Payment. City will make payment at the Contract unit price bid as specified per each item and as full compensation for all labor, materials, tools, equipment and incidentals necessary to furnish and install the items as specified, complete, tested and accepted and in accordance with the details.

Item	Unit	Description
1328	Each	___ detector amplifier, installation Only
1328	Ft (m)	___ detector pavement cutting
1328	Ft^2. (m^2)	___ Loop detector installation, with new pavement
1328	Ft. (m)	Loop detector installation in trenched area
1328	Each	Overhead microwave detector installation
1328	Each	Overheight infrared detector

1328	Each	Pedestrian pushbutton with associated signs
1328	Each	Video Detection

Item 1329 Traffic Control Signs and Installations

1329.01 Internally Illuminated Signs. This work consists of furnishing and installing internally illuminated signs with one or more plastic faces in accordance with these specifications and as plans and details show.

This specification covers the fabrication of internally illuminated signs and includes the sign frame, lamp holders, ballasts, terminals, wiring, and mounting hubs. The nature of the construction of these signs and the need for them to accept lamps and lexan sign faces, requires that samples be provided before an award is made. This specification does require that the sign cabinets have rounded corners and "U" channels to accept lexan sign faces that have two thicknesses, depending on the sign size and also that have 1-1/2 inch (38 mm) radius corners.

Sign that are constructed with square corners and thus that require square sign faces, but otherwise meet the requirements of this specification and specifically that do not have hinged type doors as a means of access, may be considered as meeting this specification. Samples of any square cornered signs shall be made available within two weeks of the bid, with any resubmitted corrections made 30 days after they are requested.

A. Definitions.

Sign - Means the entire assembly including frame, permanently attached aluminum face for single-faced sign, mounting hubs, top frame reinforcement, lamps, lamp holders, ballasts, terminals, and wiring.

Frame - Means the members forming the top, ends and bottom enclosure of the sign.

Faces - The sides of the sign that face traffic.

Plastic Face - The entire assembly of plastic and paint forming the complete sign face.

Background. - The main panel of plastic which slides into the U grooves of the sign case and on which all specified legends are placed.

Legend - Letters, numbers, emblems, route markers, lines and/or arrows forming message.

B. Sign Design. The illuminated sign is an all-aluminum box designed and constructed so the sign, complete with face or faces, will hang plumb when suspended.

1. Cast-Mechanical Construction. All metallic parts are of aluminum of 0.100 inches (2.5 mm) thick at all points. The aluminum is of high strength alloy type at least equal in strength and abrasion resistance to 3003H14.

2. Wind Load. The material, design and construction is such that the case will withstand continuous wind loads up to 30 psf (1,500 Pa).

3. Construction. Construct case to the size shown on the plans and Table 1329.A. A single-faced sign is designed for one plastic face and one permanently attached aluminum face. A double-faced sign is designed for two plastic faces. Plastic faces are retained in "U" shaped tracks designed to permit easy removal of the faces by sliding them out of the case on the side or at the bottom for legend changing and electrical maintenance.

Design and construct sign so that this is accomplished without having to swing open a hinged door, and is instead achieved by removing one side of the channel that holds the actual sign face in place. The sign face thickness tolerance for all signs with a short dimension of 30 inches (760 mm) or less is 0.125 inch to 0.150 inch (3.2 mm to 3.8 mm). The sign face thickness tolerance for all signs with a short dimension of 36 inches (914 mm) or more is 0.187 inch to 0.200 inch (4.7 mm to 5.1 mm). Construct the "U" shaped tracks to allow easy installation of sign faces constructed to these tolerances.

Table 1329.A – Sign Dimensions and Mechanical Data

Size Designation	Case Inside Diameter (Nominal) Modify to Accommodate Tube Length		Frame Cross Section Flange Depth		Overall Thickness of Complete Sign		Number Of Mounting Hubs (C)	Ballast Code Number (a)	Lamp Code (f)	Number of Lamps (b)
	Horizontal	Vertical	Minimum	Maximum	Minimum	Maximum				
24" x 30" (600 mm x 760 mm)	24 inches (600 mm)	30 inches (760 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	1	ASB-0620-24-BL-TP	F24T12CWHO	4
30" x 24" (760 mm x 600 mm) 30" x 24" D	30 inches (760 mm)	24 inches (600 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	1 – SF 0 - DF	ASB-0620-24-BL-TP	F24T12CWHO	4
30" x 36" (760 mm x 900 mm)	30 inches (760 mm)	36 inches (900 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	1	ASB-0620-24-BL-TP	F36T12CWHO	4
36" x 30" (900 mm x 760 mm)	36 inches (900 mm)	30 inches (760 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm)	8 inches (200 mm)	2	ASB-0620-24-BL-TP	F36T12CWHO	4
36" x 36" (900 mm x 900 mm) 36" x 36" D	36 inches (900 mm)	36 inches (900 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	2 - SF 2 – DF	ASB-0620-24-BL-TP	F36T12CWHO	4
48" x 48" (1,200 mm x 1,200 mm) 48" x 48" D	48 inches (1,200 mm)	48 inches (1,200 mm)	5/8 inch (16 mm)	3/4 inch (20 mm)	5 inches (130 mm) 10 inches (260 mm)	8 inches (200 mm) 12 inches (300 mm)	2 - SF 2 - DF	ASB-0620-24-BL-TP (2 each)	F48T12CW	6

(a) Numbers are those of the Advanced Ballast Company stated as a guide only.
(b) Lamps mounted vertically or at 45° from vertical shall have a rubber sleeve at the bottom lamp base.
(c) Mounting hubs are for 1-1/2 inch pipe size. Mounting hubs for mounting on a 4 inch post is required on the bottom and/or bottom corner of the sign.
(d) Measured with plastic at 70° F (21° C).
(e) Diamond shaped signs (with D on size designation) are square turned at 45° angle.
(f) LED light source may be used when evaluated and approved by the City Traffic Engineer.

Table 1329.B - Sign Face Dimensions

Size Designation	Visible Plastic Face Area (Minimum)		Plastic Face Dimensions				Plastic Face Thickness		Plastic Face Corner Radius
			Horizontal		Vertical				
	Horizontal	Vertical	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
24" x 30" (600 x 760)	22-1/2" (572 mm)	28-1/2" (725 mm)	23-11/16" (602 mm)	23-3/4" (603 mm)	29-11/16" (754 mm)	29-3/4" (755 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
30" x 24" (760 x 600 mm)	28-1/2" (724 mm)	22-1/2" (572 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	23-11/16" (602 mm)	23-3/4" (603 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
30" x 36" (760 x 915 mm)	28-1/2" (724 mm)	34-1/2" (876 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
36" x 30" (915 x 760 mm)	34-1/2" (876 mm)	28-1/2" (724 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	0.125" (3 mm)	0.150" (4 mm)	1-1/2" (40 mm)
36" x 36" (915 x 915 mm) 36" x 36" D(a) (915 x 915 mm)	34-1/2" (876 mm)	34-1/2" (876 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
42" x 36" (1,070 x 915 mm)	40-1/2" (1,029 mm)	34-1/2" (876 mm)	41-9/16" (1,056 mm)	41-5/8" (1,057 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 30" (1.220 x 760 mm)	46-1/2" (1,181 mm)	28-1/2" (724 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	29-11/16" (754 mm)	29-3/4" (756 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 36" (1,220 x 915 mm)	46-1/2" (1,181 mm)	34-1/2" (876 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	35-5/8" (905 mm)	35-11/16" (906 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)
48" x 48" (1,220 x 1,220 mm) 48" x 48" D(a) (1,220 x 1,220 mm)	46-1/2" (1,181 mm)	46-1/2" (1,181 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	47-9/16" (1,208 mm)	47-5/8" (1,210 mm)	0.187" (5 mm)	0.200" (5 mm)	1-1/2" (40 mm)

(a) Diamond shaped signs (with D on size designation) are square turned at 45° angle.
(b) Lamps mounted vertically or at 45° from vertical shall have a rubber sleeve at the bottom lamp base.
(c) A mounting hub for mounting on a 4 inch post is required on the bottom and/or bottom corner of the sign.
(d) Measured with plastic at 70° F (21° C).
(e) BO designation indicated blankout type sign.

The frame is of an extrusion, casting, or formed member having one-piece cross section with flanges on both ends. It is at least as rigid as an extrusion of this design. The flanges are of "U" type specified for plastic faces and of either the "U" type of the single-flange type for attachment of the aluminum sheet for the blind side of single-faced signs. The frame and aluminum faces have continuously welded seams and are watertight.

The flanges serving as retainers for all faces have a radius of 1-1/2 inches (40 mm) at each corner of the sign. The top of the case frame is reinforced with a piece of 1/8 inch (3 mm) thick aluminum, continuously welded to the inside of the frame, extending the full width inside the frame flanges and running the full length of the frame top. All 24 x 24D, 36 x 36D and 48 x 48D signs are reinforced with 1/8 inch (3 mm) thick aluminum, continuously welded to the inside of the frame extending the width inside the frame flanges and extending up each side, at least 18 inches (450 mm), from the bottom corner. This welding reinforces the top to prevent deformation caused by the stress induced through the mounting hubs, when installed.

Drill four 1/4 inch (6 mm) weep holes, two on each end of the bottom of the frame, except on the 24 x 24D, 36 x 36D, and 48 x 48D signs, which have two weep holes drilled in the bottom corner.

D. Mounting. Attach to the top of the frame the number of 1-1/2 inch (40 mm) pipe size flanged pipe hubs Table 1329.A specifies for mounting purposes.

Paint the hubs the same color as the frame with the threads unpainted and the cable entrance through the hubs.

E. Fastening Devices. All nuts, bolts, screws, and rivets are of stainless steel or high strength silicon bronze.

F. Brightness. Take brightness readings at 118 input line voltage after the first 100 hours of lamp operation with a white plastic face of ROHM & HAAS Plexiglass No.7328 that will be provided by the City. Divide the plastic face into four inch by four inch (100 mm x 100 mm) rectangles and take one reading in the center of each rectangle. Make readings in foot lamberts (candela per m^2).

AVERAGE BRIGHTNESS - ($\mathbf{B_{AVG}}$) = The sum of the individual brightness readings divided by the number of readings taken.

MAXIMUM BRIGHTNESS - ($\mathbf{B_{MAX}}$) = The largest reading taken.

MINIMUM BRIGHTNESS -($\mathbf{B_{MIN}}$) = The smallest reading taken.

RANGE OF AVERAGE BRIGHTNESS - (**R**) = a percentage calculated as follows:

$$R = 100 \times \frac{B_{MAX} - B_{MIN}}{B_{AVG}}$$

VALUES - THE VALUES ARE AS FOLLOWS:

	Minimum	**Maximum**
Average Brightness (B_{AVG})	130	190
Range of Average Brightness (R)	55%	

G. Component Mounting. Mount components inside the sign so that no shadows or dark spots appear on the sign face when the sign is illuminated.

H. Lamps. (Furnish signs with lamps.) Design signs for use with standard universally available T-12 cool white slimline fluorescent lamps in accordance with Table 1329.A. LED light source may be used when evauated and approved by the City Traffic Engineer.

I. Lampholders. Furnish lampholders constructed of white high-impact plastic with each set consisting of a male and female end. Provide lampholders rated for 660 watts and 600 volts of the two pin, recessed type. Furnish lampholders conforming to Leviton models 465 and 484 or approved equal. Lampholders at the low-voltage end of the lamp are the short-circuiting type, and at the high-voltage end are rated at not less than 600 volts. At the low voltage end, wire the lampholder with the ground conductor so that the primary circuit of the ballast is open when removing any lamp. If the lampholder on only one end of a lamp has a spring, the spring is in the top lampholder for vertically mounted tubes.

J. Ballast. Furnish class P, Type HL, high power factor series ballast that contains no PCB's and is type 2 outdoor compatible. Provide Advance Ballasts System model ASB-0620-24-BL-TP or approved equal. Furnish weather-resistant ballast that gives reliable starting at all ambient temperatures above 20° F (-7° C). Mark the ballast with the following information:

1. Manufacturers' name or trademark and catalog number.

2. Input voltage, frequency and current rating.

3. Open-circuit voltage, power factor and ballast loss (watts).

4. Number of laps, nominal lamp current, lamp length and type.

5. Wiring diagram indicating the correct electrical connection of various leads.

When located on the bottom of the sign, mount ballast on spacers to provide ½ inch (12 mm) clearance with the bottom and bolt it to the bottom of the case using four bolts. When located in other positions in the case, locate the ballast so as to minimize the effect of the weight of the ballast on the balance of the sign and the ability of the sign to hang plumb.

Make lamp and Ballast to be High Output (HO) with F24T12CW/HO tube and 120 volt, 4 tube ballast.

When located on the bottom of the sign, mount ballast on spacers to provide ½ inch (12mm) clearance with the bottom and bolt it to the bottom of the case using four bolts.

K. Terminal Block. Locate a terminal block having a minimum of four terminals near the cable entrance. Terminate wires for interior power connections on this terminal block. No external wires are supplied.

L. Wiring. All wiring shall be appliance Wire No. 18 AWG, with at least 16 copper strands and thermoplastic insulation at least 2/64 inch (0.8 mm) thick, and insulation rated for 221° F (105° C). Color code all wires with white used for the ground wire and color-code wires for the ungrounded wires of the supply circuit. The secondary circuit or high voltage circuit corresponds to the color-coding of the ballast leads. Run wire neatly in an aluminum raceway or flexible aluminum conduit and the edges of the openings in sheet metal or conduit, which offers protection from abrasion by means of a bushing grommet or rolled edge. Securely clamp or reliably hold in place the conduit at all openings and support the wiring so that the bottom of a sign is cleared by not less than 1/2 inch (12 mm).

Make splices mechanically and electrically secure with an acceptable splicing device.

Confine ballast lead splices to the ballast junction boxes and the raceway.

Do not strip the insulation on the wires at connection points any further than is necessary. Bare conductor does not overhang the edge of the base to which it is connected. Make wires fastened to lampholder terminals mechanically and electrically secure.

M. Marking. Mark each sign case on an inside surface with the Manufacturer's name and the date manufactured.

N. Painting. Prime the interior and exterior of the case, and bake the unit after each coat.

1. Exterior: Paint the exterior of the cabinet and the mounting hub black in accordance with Federal Color No. 17038.

2. Interior: Paint the interior a non-yellowing white in accordance with Federal Color No. 17875.

O. Plastic Face.

1. Material. The face is of cast translucent plastic of acrylic resin type matching the following Rohm and Haas Plexiglass numbers in weathering, structural, and optical properties or a Lexan material where plans specify:

White	W 7328
Yellow	2016

Material is of the thickness Table 1329.B specifies.

2. Legend. Apply a painted legend using a brand of paint the plastic Manufacturer specifies, using the silk screen or spray latex process. Over the painted legend, apply a clear protective coating of a brand the plastic Manufacturer specifies. Show face designs and colors as details specify.

Provide black painted legends, when plans specify, that are opaque.

Provide red, green and blue painted legends, when plans specify, that are translucent, and of a type which will transmit an amount and color of light which is not distinguishable from the light transmitted by the materials that the plans specify.

When plans specify red, green and blue painted legends, match the following Rohm & Haas numbers in optical properties:

Red	2214
Green *	2280
Blue	2114

* Except street name signs (see Paragraph "P").

P. Street Name Signs. Make street name sign faces Lexan or approved equal. The text consists of white letters on a dark green background. The white letters and numbers require a vinyl type translucent paint. The background dark green conforms to Federal Color #14109.

Q. Installation. Include mounting hardware in the item furnished and as indicated in Table 1327 for the mounting arrangement plans indicate. Make the installation and all hardware in accordance with the requirements of the details.

Except street name signs (see Paragraph "P").

1329.02 Mechanically Operated Vane Type Signs.

A. General. The sign consists of two electrically driven hinged outer panels (vanes), which close over a center panel or open to expose the sign face. The outer panels open and close through 180°.

Make the "Blank Out Type" a single message type so that when the outer panels close over the center panel, no message is visible. When the outer panels open, both the outer and center panels form the specified sign face.

Make the "Dual-Message Type" a two-message type so that the movable panels when open form one sign face with the center panel as the open blankout type, and when the movable panels close over the center panel form a second message with the extended portion of the center panel. This type requires that the center panel extend to line up with the opened movable panels and with the movable panels painted on both sides.

B. Sign Face Blank and Panels. Make the sign face and panels a minimum 0.125 inch (3 mm) thick 6061-T6 aluminum with radius corners. Properly degrease the aluminum and etch or treat it with a light, tightly adherent amorphous chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B449-67, Class 2, 10-35 mg per ft^2 (110-380 mg per m^2) with a median of 25 mg per ft^2 (270 mg per m^2) as the optimum coating weight. The sign forms an essentially plane surface when opened.

C. Sign Face. The sign when opened, or closed, if bearing dual messages, accommodates the standard designs of Manual on Uniform Traffic Control Devices. Make the sizes 24 inches by 24 inches (610 mm x 610 mm), 24 inches by 30 inches (610 mm x 760 mm), 30 inches by 30 inches (760 mm x 760 mm), 30 inches by 36 inches (760 mm x 915 mm) as plans specify. Message, border and background color conforms to the Manual on Uniform Traffic Control Devices.

The face is reflectorized with the sheeting, painted and sealed with a clear coating.

D. Frame. Make the frame 0.250 inch x 1 inch x 1 inch (6 mm x 25 mm x 25 mm) 6061-T6 aluminum angle with 0.125 inch (3 mm) aluminum brackets with standard hub holes and one wire hole. Make the frame and brackets of welded aluminum construction.

Enclose the sign-activating mechanism in a corrosion-resistant box, constructed of a minimum of .060 inch (1.5 mm) 3003 H-14 aluminum with a housing cover of minimum 0.125 inch (3 mm) 300 H-14 aluminum. The enclosure meets NEMA 3R requirements for raintight applications.

E. Working Mechanism. The mechanical drive mechanism consists of a roller chain drive, cam-driven, self-locking device with positive drive on both cycles with spring override. All working parts are to be cadmium-plated steel. The motor is magnetic brake non-reversing, gear reduction type, 115 volts three amp developing minimum torque of 170 lbs. (230 N-m) at six to eight RPM, with direct drive from output shaft to operating cam. Provide a microswitch rated for 15 amps at 115 volts.

Enclose the motor in a galvanized steel cover positioned below the sign drive mechanism, with the gear reduction drive protruding through the housing to connect with the cam.

Make all screws, bolts, nuts, sprockets and washers cadmium-plated steel.

Make the chain drive 1/4 inch (6.5 mm) pitch cadmium-plated steel-rolled chain.

Hinges consist of three pivot points on each panel. Make pivots of cadmium-plated steel and attach them with bolts to threaded holes to the panels. Pivots have brass bushings.

F. Mounting. The mounting assembly consists of mounting brackets or hubs, with 1-1/2 inch (38 mm) pipe arms and "U" or saddle clamps for securing the sign assembly to a post or drop pipe (with weather head) as plans specify.

Make at least two mounting assemblies with the material constructed as follows:

1. U-Clamp - Construct of 3/16 inch (5 mm) cadmium or zinc-coated steel and bracket with formed radius as plans specify, with 1/2 inch (12 mm) "U" bolt of welded construction or painted cast iron of equal strength and design.

OR

2. Sign Mounting Clamp - Welded construction with 3/8 inch (10 mm) "U" bolt and full grip clamp, with 1-1/2 inch (38 mm) standard tubing and 10-gauge steel plate or cast iron of equal strength and design, with standard hub hole pattern.

3. Hub - Plate is 10 gauge steel or cast iron of equal strength and design, with standard hub hole pattern, welded 1-1/2 inch (38 mm) standard pipe collar or nipple.

Where plans specify span wire or mast arm mounting, provide a 1-1/2 inch (38 mm), schedule 40, galvanized steel pipe of the length required, a weatherhead and balance adjuster and span wire suspension clamp or mast arm bracket. Install the assembled sign as details show.

G. Miscellaneous Requirements.

Provide complete sign units weighing not more than 55 pounds (25 Kg) each.

Construct units so that the open or closure time through 180° is less than six seconds.

Enclose mechanism and protect to function in a wide range of environmental conditions including rain, snow, wind and temperatures from -40° F to 150° F (-40° C-70° C).

Construct units so that the sign does not normally require periodic lubrication, cleaning or seasonal adjustment.

Do not damage the sign by forcing the panels open or closed within normal operating range.

1309.03 Signs, Flat Sheet Type. Signs not required to be internally illuminated are of the flat sheet type fabricated from aluminum, painted and reflectorized in accordance with Item 630; Reflective green sheeting, Type G.

Signs are in accordance with the standard designs of the Manual on Uniform Traffic Control Devices and of the size and legend plans and details indicate.

City will make payment for mounting hardware and installing signs under the specified attachment.

1329.04 Sign Attachments.

A. General. The work of this item consists of furnishing and installing the sign provided under Item 1329.03, with the hardware as specified for the type mounting attachments. Install the sign and attachment assembly in accordance with the plans and details.

B. Span Wire Mounted Sign Attachments. The work of this item includes aluminum drop pipe, cast aluminum span wire suspension clamp, cast aluminum weatherhead and galvanized cast iron balance adjuster, lead slug, pipe cap, and pipe straps and hardware.

C. Mast Arm Mounted Sign Attachments. The work of this item includes drop pipe, lead slug, pipe cap and straps, mast and clamp and hardware.

D. Bridge or Wall Mounted Attachments. The work of this item includes angle brackets, anchoring hardware and miscellaneous hardware.

E. Plaque Attachments. Where plans specify a reflectorized sign (or plaque) attached to an illuminated sign and/or traffic signal head, such sign attachment, which includes all hardware required for the attachment, is incidental to the payment of the illuminated sign and/or traffic signal head.

Sign notes and quantities indicate payment and quantity for the reflectorized sign.

F. Materials. All hardware and materials required are of the non-corrosive materials as details specify.

1329.05 Method of Measurement. Measure internally illuminated and mechanically operated vane type signs as a complete unit in place, including all lamps (for illuminated signs), sign faces with the specified legend(s), all components and mechanisms and all mounting hardware.

Measure signs, flat sheet type, as the actual number of square feet of signs furnished, erected, and accepted. Determine measurement for square, rectangular, circular, or irregular shaped signs by multiplying the largest dimensions of width and height. Determine measurement for triangular shaped signs by multiplying the largest dimension of width and one-half the largest dimension of height.

Measure sign attachment assemblies as complete units by type, furnished and installed complete in place and accepted with the specified sign(s) included but furnished under its own item of payment. This includes all clamps, pipes, hangers, brackets, hardware and incidentals as indicated for each type.

1329.06 Basis of Payment. City will make payment at the Contract unit price bid as each item specifies, and as full compensation for all labor, materials, tools, equipment and incidentals necessary to furnish and install the items as plans specify, complete, tested and accepted.

Item	Unit	Description
1329	Each	Internally illuminated sign, ___ face, _____light source, ___ inches x ___ inches.
1329	Each	Mechanically operated vane type sign, ___ type, ___ inches x ___ inches.
1329	Ft^2 (m^2)	Signs, flat sheet type.
1329	Each	_____ mounted sign attachment.

Item 1330 Pavement Marker Buttons and Longitudinal Channelizing Systems

1330.01 Pavement Marker Buttons. The marker is a snowplowable type unit constructed of cast iron with an acrylic prismatic reflector. Implant the unit in the roadway and secure with an epoxy adhesive.

Provide markers that are Stimsonite Model 96 or 96 LP as plans specify, or approved equals.

The work of this item includes pavement cutting using a concrete saw with a multiple blade arrangement to provide a cut to match the contour of the marker housing.

Clean and dry the sawed excavation using a brush or air blast from a compressed air source.

Pour and mix epoxy adhesive in accordance with Manufacturer's instructions.

1330.02 Longitudinal Channelizing Systems. This specification covers a longitudinal channelizing system that consists of three components. The first component is a series of interlocking, raised separator units that help keep moving traffic along a particular path. The second component is a high target vertical marker that attaches to the separator units. The final component is a profile reflector that enhances the reflectivity of the system. The entire system, when installed, provides a traffic lane barrier that keeps vehicles within their lanes, while allowing an emergency vehicle the ability to go over the barrier at lower speeds.

1330.03 Raised Separator. Provide raised separators consisting of two basic units: a separator unit and an end unit. Fabricate the raised separator of recycled plastic with a sufficiently durable mass to achieve a weight of at least ten pounds per linear foot (15 kg per meter). Provide separators that are a minimum of ten inches (255 mm) and a maximum of 12 inches (305 mm) in width, and a minimum of 3-1/2 inches (90 mm) and a maximum of four inches (100 mm) in height with a cross section that is gently curved so as to provide minimal resistance to vehicle tires, thereby allowing emergency vehicles to cross the separator. To increase target value in daylight hours, provide separator with the entire rounded surface colored white or yellow to conform to the traffic pavement markings that they supplement.

For ease of installation, provide the raised separator units in portable sections, 3.33 feet (1 meter) in length. Furnish units that structurally fasten together securely by bolting each unit to a connecting metal device molded securely into the adjoining unit. Use tapered end units at the beginning and end of each run of separator to form a gradual increase in height from the pavement level to the top of the separator. Provide tapered end units 1.5 feet (460 mm) in length that are capable of receiving a reflecting element. Fix the separator to the roadway by removable expansion anchors spaced as recommended by the separator Manufacturer. Provide the anchors and include their cost in the unit price for the separator units.

Provide individual separator units that have a receptacle for the installation of a bow shaped device with retro-reflectivity on the top and sides facing motorists.

Provide raised separator system capable of being deployed without being anchored to the roadway by fasteners. Furnish molded in metal connecting devices capable of holding the individual separator units together and in position on the roadway without the need for fasteners. Additionally, furnish system capable of being installed, removed and shifted from one lane to the next via a truck mounted conveyor system.

1330.04 High Target Value Channelizers. Affix each high target value channelizer to a detachable flexible rubber boot or other device that supports the channelizer in a vertical position, and is capable of restoring the channelizer to the vertical position if struck by a vehicle. Furnish channelizers composed of high impact plastic that accommodates Type III retro-reflective sheeting. Generally, provide reflective sheeting of the same color as the raised separator units.

Use elliptical channelizers when traffic is moving generally parallel to the traffic separator. Mount elliptical channelizers between 40 and 47 inches (1,015 and 1,195 mm) above the roadway and between eight to ten inches wide. Provide elliptical channelizers that accommodate retro-reflective Type III sheeting between 29 and 30 inches (740 and 760 mm) in height and between 7-3/4 and eight inches (197 and 203 mm) in width providing a reflective area of 230 to 255 square inches (0.15 to 0.16 m^2) facing the traffic. Install markers along the length of the separator system to provide an on-center spacing of approximately 6.7 feet (2 meters).

Provide round channelizers that are between four and six inches (102 and 152 mm) in diameter. Furnish round vertical markers that have an overall round appearance so that reflective sheeting is visible from any direction around the round channelizer. Round vertical markers must accommodate at least two four-inch (102 mm) bands of reflective sheeting

providing a retro-reflective area of 50 to 100 square inches (0.03 to 0.06 m^2) facing traffic. Mount round channelizers at a height of 40 to 44 inches (1.0 to 1.1 meters) above the roadway. Install the round markers along the length of the separator system to provide an on-center spacing of approximately 6.7 feet (2 meters).

1330.05 Reflecting Element. For motorist safety at night, reflecting elements must depict the raised profile of the separator units at night. Thus, design reflecting elements to adhere to the top and both sides of the separator units. Design snap-in arcs with seven reflecting elements on each side to depict the raised profile of the lane separator and install on each separator unit as well as each male end unit. Provide individual reflective "cat's eyes" that have the following photometric performance data in millicandela per lux (mcd/lux) for the inclination angle of 0°:

Angle of Observation α	Entrance Angle β	White (mcd/lux)	Amber (mcd/lux)	Red (mcd/lux)
0.3°	5°	140	70	28
0.5°	10°	90	45	18
1.0°	10°	36	18	7.2
2.0°	15°	4.6	2.3	0.9

1330.06 Warranty. Vendor certifies that the Manufacturer of the system will provide a 100 percent Manufacturer's warranty for damage to the raised separator units, end units and reflecting elements for the first two years against all normal vehicular roadway traffic, and the same pro-rated warranty averaging at least 50 percent of the replacement value for three additional years. The Manufacturer must also warrant the system components to be free from defects in workmanship and material for a period of two years from the date of shipment. Vendor must provide a copy of the Federal Highway Administration (FHWA) approval letter accepting the Longitudinal Channelizer system's NCHRP350 test results. Failure to include these warranties will result in the bid being deemed non-responsive. For the safety of the motoring public and to establish cost worthiness, the separator system must have a minimum of three years of on-road experience.

1330.07 Method of Measurement. Measure pavement marker buttons as a complete unit in place, including sawcutting, cleaning and epoxy adhesive. Measure raised separator unit including tapered end sections by the linear feet (meters) completed and accepted in place. Measure the channelizers (elliptical and round) by the number of each completed and accepted in place.

1330.08 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, furnished and installed and in full compensation for all labor, materials, tools, equipment, and incidentals necessary for a completed and accepted item.

Item	**Unit**	**Description**
1330	Each	Pavement marker button, ___ type
1330	Linear Foot	Raised Separator unit, (white / yellow), including tapered

	(meter)	end sections and matching reflecting element.
1330	Each	Channelizers, elliptical, (white / yellow), including reflective sheeting
1330	Each	Channelizers, round, (white / yellow), (with/without) matching reflective band.

Item 1331 Traffic Island Lighting

1331.01 Traffic Island Lighting. The City will furnish traffic island light equipment. Where plans specify an overhead type, the City will furnish the fixture complete with lamp. Where plans specify the pedestal type, the City will furnish the globe fixture complete with lamp.

Before pouring the concrete for the construction of the traffic island, coordinate the casting of the cone type fixture and/or pedestal anchor bolts, and connection of conduit from the island light to the specified pull box. Install a ground rod in the nearest pullbox as details show.

Include the conduit, ground rod and pedestal (where plans specify) under each item of bid, but include with the pedestal bid item conduit ells where pedestals are located adjacent to pullboxes. Provide pipe fittings and hardware for mounting the pedestal fixture to the post.

1331.02 Method of Measurement. Measure traffic island lights as a complete unit in place, including pipe fittings, nipples and all hardware required to mount the fixtures.

1331.03 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, installed complete, tested and accepted and as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1331	Each	Traffic island light, ___ type, installation only

Item 1332 Relocation of Existing Equipment

1332.01 Relocation of Existing Equipment. Equipment plans specify to be relocated may be poles, signs, signal heads, luminaires, island lights or other. Carefully remove the specified equipment and relocate the equipment where plans indicate.

After removal, equipment shall be inspected and cleaned. Remove any rusted areas, spot prime and paint in accordance with Item 1317.

When relocating poles and posts, provide new anchor bolts conforming to Item 1318 which the payment of the item relocated shall include. Ensure that new foundations for relocated

poles and posts are in accordance with the plans and details. City shall make payment for foundations per Item 1319.

When relocating signs, signal heads or other specified devices, furnish new materials and hardware as required to properly reinstall the equipment complete and in accordance with the details. Contractor may reuse salvageable materials with the Engineer's approval. Redlead the new pipe threading when reusing drop pipe and arms by reducing the length. Where existing drop pipe and arms are too short, furnish new pipe. The City will not permit extension pipe pieces with couplings.

Include new hardware and materials required in the payment for the item relocated and make them of non-corrosive material in accordance with the details.

In rewiring relocated equipment, use entire new cable runs or extensions of existing cable as plans specify. Splice new cable to existing cable using approved splicing as details indicate. Remove or abandon existing cable as plans specify; disconnect abandoned cable completely at both ends. Cut the ends cut so that existing conductor ends are not exposed beyond the insulation. The conductors are then doubled back over the jacket and taped with at least three layers of approved weatherproof electrical tape.

Furnish new cable under the respective Item 1323.

Relamp signal, sign and luminaires after reinstallation. Include lamps with the payment of the item relocated and ensure that they meet the requirements of the application under Items 1326 and 1329.

1332.02 Method of Measurement. Measure relocated equipment as a complete unit by type in place, tested, and accepted and include relocating, rewiring, splicing and new and/or modification of existing hardware, lamps, painting and removal and disposal of unusable materials and equipment and new anchor bolts for poles and pedestals.

1332.03 Basis of Payment. City will make payment at the Contract unit price bid for each item, by type, relocated complete, tested and accepted as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1332	Each	Relocation of existing ___ (specified equipment)

Item 1333 Modification of Existing Lighting Circuits

1333.01 Modification of Existing Lighting Circuits. Where plans specify, provide labor and materials to modify and reconnect the specified lighting circuit complete as plans and details indicate.

Schedule work so as not to disable the existing lighting circuit during the hours when the circuit is normally operative.

Ensure that all materials and equipment used meet the requirements of the items as specified herein.

1333.02 Method of Measurement. Measure modification of existing lighting circuits as complete units in place, tested and accepted, including all materials and equipment as plans specify.

1333.03 Basis of Payment. City will make payment at the Contract unit price bid for each circuit modified complete, tested and accepted and as full compensation for all labor, materials, tools, equipment and incidentals.

Item	Unit	Description
1333	Each	Modification of existing lighting circuit No. _____ .

Item 1334 Restoration of Work Areas

Keep adequate walking areas for pedestrians clear of equipment, materials, supplies and excavated materials at all times.

Move any excavated material obstructing any portion of the sidewalk or street area at the end of the working day so as not to obstruct the sidewalk or street area.

Adequately barricade and light excavated material off of, but not adjacent to the sidewalk area.

Neatly restore sidewalks, driveways, and sodded areas to the satisfaction of the City. Restore concrete sidewalks and driveways from joint to joint. Restore paved areas in accordance with the City of Cincinnati, Engineering Division "Street Restoration Book" as Cincinnati Municipal Code, Section 721-35 stipulates.

Contractor may remove forms in accordance with 511.16. Remove all forms before backfilling. Do not use excavated material as backfill unless the Engineer approves. Place backfill in layers and compacted to prevent future settlement of backfill materials. Dispose of the excavated material not needed and/or backfilled lawfully offsite.

Restore all sodded areas using excavated material with the top four inches (100 mm) of restoration being topsoil compacted to grade.

Furnish well-rooted Kentucky Bluegrass or Canadian Bluegrass containing a growth of not more than 30 percent of other grasses and clovers, unless plans specify otherwise.

Restoration is incidental to the payment of the various items requiring restoration.

Item 1335 Cable and Pole Identification

Identify all lighting cable by circuit with tags in accordance with Item 725. Identify using adhesive decals with reflective characters and background installed as details show.

The City furnishes pole decals, and the Contractor furnishes circuit cable tags.

Providing and installing these items is incidental to the payment of the cable and poles.

Item 1336 Method of Payment

City will make payment for accepted quantities of street lighting and traffic control items provided in these specifications at the prices the Contract specifies.

Method of Payment will be one of the following:

A. Unit price for each item.

B. Lump sum for the entire Contract (by location or circuit).

C. Lump sum for the entire Contract with unit prices for major items to cover possible changes of quantities, which may arise during the Contract period.

The enclosed specification items are based on unit price bidding, with the Contractor furnishing all materials and equipment except that which is specified as furnished by the City. Where the City specifies in a Contract that it will furnish equipment, make adjustments for bidding these items where the work is reduced to installation and materials required to complete the item of work.

Where the City specifies that the Contract (by location or circuits within a Contract area) will be bid on a lump sum basis, the basis of payment includes all accepted quantities of equipment and materials as plans specify, as required to provide a complete item, in place, tested and accepted. The basis of measurement includes the work requirements of all the various items required.

Item 1337 Turn On-Off Records

Notify the City Traffic Engineer and provide a written record thereof when turning on or off any electrical operated lighting and traffic control device, and when installing and removing all electrical and non-electrical devices.

This is to provide the City of Cincinnati with information for public record and for purposes of energy billing.

The record shall show the time of day and the date. This information shall also include dates for burn tests.

The City will make payment incidental to items so noted.