ITEM 725 TRAFFIC SIGNAL UNDERGROUND / HIGHWAY LIGHTING MATERIALS

725.01 General. Provide luminaires, conduits, wire, switch gear and other electrical hardware listed with Underwriters Laboratories.

Provide each item of manufactured electrical apparatus as a unit with a durable nameplate identifying the manufacturer and manufacturer's product identification.

The Engineer will inspect all lighting materials at the project site.

Only provide samples when required by the Laboratory.

725.02 Wire and Cable. Use nonshielded wire or cable rated 0-2kV with single conductor, stranded copper with cross-linked thermosetting polyethylene insulation, nonjacketed, meeting the requirements of ICEA S-95-658/NEMA WC70 and conforming to UL Type RHH-RHW-USE. Also use conductors 10 AWG and smaller with insulation meeting the requirements of UL Type XHHW.

Provide each non-shielded wire or cable rated 5000 volts (2400 volts working under the 2005 NEC) as a single conductor, stranded copper with chemically cross-linked polyethylene insulation, nonjacketed, meeting the requirements of ICEA S-96-659/NEMA WC71 and of UL Type MV-90 dry.

Provide each cable with an identification device defining its use with either a tag tied onto the cable or a band applied around the cable. Provide cable tags of copper, brass or plastic (except use nonconducting tags within switch and device cabinets) with 1/32 inch (0.8 mm) minimum thickness permanently fastened to the cables by means of cable tying straps. Provide cable identifying bands of approximately 1/32-inch (0.8 mm) thickness and wrap completely around the cable and close securely. Mare each tag or band using 1/4 inch (6 mm) minimum height embossed or engraved letters.

Mark conductors as "CKT" followed by the circuit designation shown on the plans; mark grounding conductors as "GND"; mark neutral conductors as "NEU"; and mark hot conductors as "Line" followed by "1" or "2" for single phase power or "Phase" followed by "A" or "B" or "C" for three phase power.

Provide materials in accordance with the City's QPL.

725.04 Rigid Galvanized Steel Conduit and Fittings. Provide rigid galvanized steel conduit complying with the requirements of ANSI C 80.1 and UL 6 Type I and that each length of conduit bears the UL label. Provide fittings that comply with the requirements of ANSI/NEMA FB 1 and ANSI/UL 514B.

Provide materials in accordance with the City's QPL.

725.051 Polyvinyl Chloride Conduits and Fittings. Provide polyvinyl chloride conduit EPC-40-PVC conforming with NEMA Standard TC 2 for normal above ground or below ground, either concrete encased or direct burial. Use fittings conforming to NEMA Standard TC-2 references.

Provide materials in accordance with the City's QPL.

725.052 Polyethylene Conduits and Fittings. Provide polyethylene conduit EPEC-40-HDPE conforming to NEMA Standard TC 7 for below ground only, for concrete encased or direct burial. Use fittings conforming to ASTM D3350.

Provide materials in accordance with the City's QPL.

725.06 Polymer Concrete Pull Boxes. Provide polymer concrete pull box and cover of aggregate bound with a polymer resin. Provide the body of the box as of one piece construction. Provide smooth surfaces of the box and cover and the cover with a molded slip resistant surface. Label the cover in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Provide a cover closely fitting the opening and secured by stainless steel hex head bolts and hardware with the threaded holes into which the cover bolts fasten of open bottom design. Provide a minimum box depth of 15 inches. Provide the box and cover rated for installation in concrete area, rated as heavy duty, and meeting the structural requirements of Society of Cable Telecommunications Engineers Tier 15.

Provide materials in accordance with the City's QPL.

725.07 Plastic Pull Boxes. Provide plastic pull box and cover of high density ultraviolet stabilized molded polyethylene with a box wall thickness of at least 1/4 inch (6 mm). Obtain the box depth using extensions or stacking. Provide a slip-resistant cover having in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained in the box. Provide a closely fitting cover for the opening, secured by stainless steel bolts and hardware with threaded holes into which the cover bolts fasten of open bottom design. Provide a box meeting the structural requirements of Western Underground Committee Guide 3.6.

Provide materials in accordance with the City's QPL.

725.08 Portland Concrete Pull Boxes.

A. Pull Box. Provide Portland concrete pull boxes constructed of reinforced portland cement concrete. Provide a pull box assembly rated as medium to heavy duty and rated for installation in concrete walks with stainless steel hex head bolts fastening the cover to the frame. For pull precast boxes, provide pull boxes from City's QPL. Provide pull box covers constructed in accordance with 725.08.B and as shown on the plans.

B. Pull Box Covers. Provide metal pull box covers that conform to the following requirements:

1. Provide 1/2-inch (13 mm) thick steel plate for the steel cover conforming to 711.01 with 1/2-inch (13 mm) minimum flange around the edge and galvanized to conform to Section 711.02. Display on the steel cover or on an attached brass or stainless steel plate (tag) clearly legible block letters 1 inch to 2 inches (25 mm to 50 mm) in height with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained in the box. Provide the word designating the use in raised letters either integral to the steel cover or integral to a brass or stainless steel plate 1/16 inch (1.6 mm) in thickness securely mechanically attached to the steel cover by three (3) rivets, one on each end and one in the middle.

Provide the frame for the pull box designed with cover bolt holes offset from the frame corner by a nominal 1-1/2", allowing the bolt hole to remain free of debris at all times. Secure the pull box cover with a heavy duty, threaded 3/8" x 16 u-nut securely inserted into the frame bolt hole opening. Make the 1/8" x 1 1/4" frame (20" sq. OD)

and cover (19 3/4" sq. OD) from A36 steel, galvanized after fabrication conforming to A123. Provide the cover with a 3/4" pick hole on the cover centerline and 4" from the edge. The City will not require countersunk cover bolt holes. Provide the pull boxes with knockouts (4 each) on a 12"x12" area starting at the pull box bottom and centered in the sidewall.

2. Provide gray iron or ductile iron with a minimum thickness of 3/8 inch (9 mm) conforming to C&MS 711.14. The Engineer will require certification. Provide the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" cast in the top surface of the cover forming letters 1 inch to 2 inches (25 mm to 50 mm) in height.

725.10 Junction Boxes. Provide junction boxes of iron castings hot-dip galvanized in accordance with 711.02. Ensure that the junction boxes meet the requirements of NEMA ICS-6-Type 3. When the City specifies a drilled and tapped conduit entry, provide the junction box with adequate wall thickness and a boss cast into the box, if necessary.

Provide materials in accordance with the City's QPL.

725.11 Luminaires.

A. Optical System. Provide a luminaire set to the photometric distribution stipulated in the plan indicating the distribution along with the settings required to produce it. Place on a durable label affixed to the interior of the housing in a position readily apparent and easily read by a worker lamping the luminaire.

Provide a luminaire with a borosilicate glass refractor free of striations and imperfections and embossed to clearly indicate the street side for refractors that the Contractor could install in more than one position. Firmly hold the refractor in the housing, but allow for easy removal without the use of special tools.

Provide a luminaire with an aluminum reflector with a specular polished reflective surface free from scratches. Firmly hold the reflector in the housing, but allow for easy removal without the use of special tools.

Provide a luminaire with a socket for mogul base lamps for applications allowing a choice of size.

Provide a lamp socket with a large center contact spring providing a firm contact with the lamp base and lamp grips to prevent the lamp from loosening. Shroud the shell in porcelain and identify the wiring terminals and contacts.

Provide the socket position adjustments with positive indexing such as holes, lugs, or notches. Do not provide lamp sockets with infinite settings.

Do not use socket adaptors.

B. Lamps. Provide a luminaire with a lamp of the type and wattage specified. Provide each lamp with a clear glass envelope, a date recording feature, and no ballasting or starting components.

Provide first line, high quality high pressure sodium lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens. Provide high pressure sodium lamps with approximate hours of life not less than the values shown in Table 725.11-1.

TABLE 725.11-1

ANSI	WATTS	Horizontal Lumens Initial	Economic Life Hours
S62	70	5,800	14,000
S54	100	9,500	14,000
S56	150	16,000	16,000
S66	200	22,000	16,000
S50	250	27,500	16,000
S67	310	37,000	16,000
S51	400	50,000	16,000
S52	1,000	130,000	16,000

Provide high pressure sodium lamps that produce a minimum of 80 percent of the initial lumen output at the end of economic life.

Provide first line, high quality metal halide lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens. Provide metal halide lamps with approximate hours of life not less than the values shown in Table 725.11-3.

TABLE 725. 11-3

ANSI	WATTS	Horizontal Lumens Initial	Economic Life Hours
M57	175	14,000	4,000
M58	250	18,000	4,000
M59	400	32,000	10,000
M47	1,000	95,000	7,500

Provide metal halide lamps that produce a minimum of 65 percent of the initial lumen output at the end of economic life.

Provide first line, high quality low pressure sodium lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens. Provide low pressure sodium lamps with approximate hours of life not less than the values shown in Table 725.11-4.

TABLE 725.11-4

WATTS	Lumens Initial	Economic Life Hours
35	4,000	16,000
55	8,000	16,000
90	13,500	16,000
135	22,500	16,000
180	33,000	16,000

Provide lamp materials in accordance with the City's QPL.

C. Ballast. Provide a ballast of an integral design contained within the luminaire housing.

For ballast wired line to line or phase to phase, ensure that the ballast has an isolated primary winding. For ballast wired line to grounded neutral or phase to grounded

neutral, provide a ballast using the isolated primary winding design or the auto transformer design.

Provide a ballast (in conjunction with the starter in the case of high pressure sodium lamps) capable of starting and operating the lamp at ambient temperatures as low as -20°F (-30°C).

At circuit voltage of nominal plus or minus 10 percent or the ballast manufacture's stated range if greater, ensure that the ballast can start (in conjunction with the starter in the case of high pressure sodium lamps) and operate the lamp within the lamp's ANSI operating parameters for the full design life of the lamp.

If required by the Engineer, furnish original copies of the luminaire manufacturer's 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.

Provide a ballast capable of operation with the lamp in an open or short circuit condition for six months without significant loss of ballast life.

Provide a starter of encapsulated solid state design capable of withstanding the temperatures encountered in the ballast compartment of the luminaire.

Provide the starter with a timed pulsing with sufficient follow through current to completely ionize and start all lamps meeting published ANSI standards.

Provide a starter ceasing operation after the lamp starts and protecting itself, the ballast, the capacitor, and the lamp socket against cycling, burned out, broken, or missing lamps by ceasing the starting operation after applying the power to the luminaire for a period of not less than 3 minutes and no more than ten minutes. Provide a starter that does not begin the starting operation again until shutting off and reapplying power and to the luminaire.

Provide a starter with push-on type electrical terminations, field replaceable with no adjustment necessary for proper operation.

Provide a barrier type terminal block for connection of the incoming electrical circuit.

D. Housing. Provide a housing of cast aluminum.

Provide the housing with a flat area on the top side to place a level may be placed readable by a worker leveling a mounted luminaire on an erected support.

Provide the door(s) providing access to the optical and electrical components with hinges and latches of corrosion resistant materials that remain securely closed during operation.

Provide silicone rubber, ethylene propylene terpolymer, dacron felt or other durable gaskets and seals supplied by the manufacturer either as part of the basic luminaire or as options in good condition and properly installed at the socket entry, between the refractor and reflector, and any other location where such gaskets or shields make up a part of the luminaire and options.

Provide the exterior finish of the luminaire with a light gray color unless otherwise specified.

Provide a glare shield of aluminum or opaque plastic material when specified. Provide a shield supplied by the manufacturer of the luminaire.

E. Conventional Luminaries. Provide luminaire housing doors capable of opening, closing, removal, or installation without the use of tools.

Provide the clamp for the slip-fit mounting accommodating both 1 1/4" (32 mm) and 2" (50 mm) nominal pipe mounting brackets. Provide a stop as part of the housing to prevent over insertion of the bracket into the housing. Design the clamp to engage at least 4 1/2"(115 mm) longitudinally along the arm of the bracket arm between the extremes of a minimum of two clamping points. Design the mounting clamp to provide for leveling of the luminaire to the specified transverse and longitudinal positions with respect to the roadway.

Equip the luminaire with a device indicating the direction and amount of tilt over a range of zero to five degrees in any direction with indications at level, three degree tilt and five degree tilt all accurate to one half degree. Provide an indicating device clearly readable in daylight from a distance of 50 feet (15 m) and does not alter or reduce the amount of light from the luminaire. Construct the indicating device of a transparent container having one horizontal surface curvilinear in any vertical cross section for supporting an indicator and a damping fluid. Provide a damping fluid of a liquid suitable for operation at -40° F (-40° C) and fabricate the transparent container from clear ultraviolet-inhibited acrylic or similar material.

Provide a glare shield cutting off the upward component of light to not reduce the total output of the luminaire more than 3 percent.

Provide the luminaire with a label or decal indicating the type of source and wattage rating. Provide the luminaire installed in its normal operating position with a label or decal clearly legible in daylight at a distance of 50 feet (15 m). Provide the labeling in accordance with the provisions of NEMA Publication OD-150 or EEI Publication TDJ-150.

Provide the complete conventional luminaire assembly including the lamp and all options including, if required, with the glare shield weighing not more than 75 pounds (34 kg).

Provide conventional luminaire materials in accordance with the City's QPL.

F. Wall Mounted Underpass Luminaires. Provide a weatherproof assembly sealed against dust.

Provide a wire entry for the incoming power on both of the vertical side surfaces of the housing, drilled and tapped for 3/4 inch (19 mm) conduit, with the unused entry properly closed with the screw type plug supplied by the manufacturer.

Provide luminaire housing doors capable of be opening, closing, removal, or installation without the use of special tools.

Provide a housing mountable on a vertical flat surface by means of cap screws or bolts through the wall side of the housing.

Provide a luminaire with the option for protecting the glass refractor with a guard or shield integral to the luminaire and not requiring removal for access to the lamp or ballast.

Provide wall mounted underpass luminaire materials in accordance with the City's QPL.

G. High Mast / Low Mast Luminaires. Provide luminaires with a symmetric distribution having an initial intensity of no more than 100 candela per 1000 lamp lumens at nadir and no more than 325 candela per 1000 lamp lumens at angles between 55 and 65 degrees above nadir.

Provide luminaires with an asymmetric distribution or a long and narrow distribution having an initial intensity of no more than 175 candela per 1000 lamp lumens at nadir and no more than 425 candela per 1000 lamp lumens at angles from 66 through 73 degrees above nadir.

Provide a luminaire with an output efficiency of not less than 65 percent of the bare lamp lumens. Provide a luminaire that emits at least 25 percent, but not more than 35 percent, of the bare lamp lumens at vertical angles between at least 60 degrees above nadir and not more than 90 degrees above nadir.

Provide a luminaire with no portion of the arc tube of the lamp viewable at angles of 70 degrees or more above nadir.

Provide for the photometric distribution produced by an optical assembly consisting of a reflector alone or in combination with a refractor and redirected to the output of a lamp mounted in a socket. Provide a one piece design for the reflector and refractor (if used).

Provide a field rotatable optical assembly to align the light distribution horizontally independent of the orientation of the arm supporting the luminaire.

Provide a luminaire for use with a 1000 watt lamp having an auxiliary lamp support engaging the outer end of the lamp envelope.

Provide a luminaire of substantial design adequate to operate at mounting heights up to and including 150-feet (45 m) and wind velocities up to and including 90 mph (145 km/h).

Provide a luminaire that mounts by means of a slip fit onto a horizontal 2 inch (50 mm) pipe. Provide for the luminaire's integral mounting by providing adjustment for leveling while remaining secure and not twist about the mounting pipe of the bracket when subjected to the vibration and wind loads of the installation.

Provide a complete luminaire with a maximum weight not exceeding 75 pounds (34 kg) and a maximum projected area not exceed 3.5 square feet (0.3 m^2).

Provide high mast/low mast luminaire materials in accordance with the City's QPL.

725.12 Polyethylene, Fiberglass Reinforced, Pull Box with Polymer Concrete Cover and Support Ring. Provide a pull box body made of fiberglass reinforced high density ultraviolet stabilized molded polyethylene with a polymer concrete cover support ring and polymer concrete cover. Provide a body consisting of one piece construction with a wall thickness of at least 1/4 inch (6 mm). Use a cover support ring permanently integrated into the box and a slip resistant cover having in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Provide a cover closely fitting the opening and secured by stainless

steel bolts and hardware with threaded holes of open bottom design for the cover bolts to fasten to. Ensure that the box and cover meet the structural requirements of Society of Cable Telecommunications Engineers Tier 5.

Provide materials in accordance with the City's QPL.

725.15 Circuit Cable Connections and Terminations. Ensure that each connector or terminator is of the same voltage rating as the wire being connected or terminated except that 600 volt connectors may be used with 5000 volt (secondary service) cable used in 600 volt service for the highway lighting circuits.

Use compression style connectors or terminators that fully enclose the conductor(s) made of high strength copper alloy and not a plated metal other than copper. Use sleeve type connectors for "butt" splices with a "stop" in the center.

A. Termination of Oversize Wire. Use a cable terminal for each device capable of properly accommodating the size of the terminated wire. If the Contractor cannot provide a terminal of adequate size, use a short length of smaller wire connected to the oversize conductor with a proper butt style crimp connector or a terminal block. Do not cut back strands in the oversize conductor to make the connection and use a smaller wire rated to carry the full ampacity of the circuit protection device.

B. Fused Pull-Apart Connection. Provide each fused pull-apart cable connector kit in a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a socket type fuse holder allowing the fuse to act as the pin for the load connection designed to break the circuit upon separation of the two halves of the connector body. Use an assembled kit rated for direct burial and exposure to sunlight. Use copper metal connector parts with a conductivity of 90 percent, having individual compression connections for each wire on the line side, having a crimp connection for the wire on the load side, and having annular spring on the socket for each end of the fuse. Use a fuse holder for a standard midget [13/32" x 1-1/2" (10 mm x 38 mm)] fuse rated 600 VAC, 100,000 AIC, and not having a glass body. Use a cable port sized for the wire or cable entering the port and a closure for the second line port if not used.

C. Unfused Pull-Apart Connection. Provide each unfused pull-apart cable connector kit in a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a line side socket and load side pin making a connection designed to break the circuit upon separation of the two halves of the connector body. Use an assembled kit rated for direct burial and exposure to sunlight. Use copper metal connector parts with a conductivity of 90 percent, having an individual compression connection for each wire on the line side, having a crimp connection for the wire on the load side, and having an annular spring on the socket for the pin. Use a cable port sized for the wire or cable entering the port and a closure for the second line port if not used.

D. Unfused Bolted Connection. Provide each unfused re-enterable cable connector kit in a rigid molded plastic sleeve closed on each end by a molded synthetic rubber female end housing having one or two ports as needed containing space to make the connection by crimping a lug onto each wire and then bolting all of the lugs together. Use an assembled kit rated for direct burial and exposure to sunlight. Use copper metal connector parts with a conductivity of 90 percent and connecting bolts having self

locking nuts. Provide ports sized for the wire entering each port and a closure for a port if not used.

E. Unfused Permanent Connection. Provide each cable splicing kit in a rigid transparent molded body having as many as two ports on each that allows a completely encapsulated completed splice by filling the mold with a resin compound. Provide the actual conductor connections made using one time use compression connectors with each wire or cable entering the mold through its own port.

Provide materials in accordance with the City's QPL.

725.16 Ground Rods. Provide ground rods 1 inch (25 mm) in diameter and 10 feet (3 m) in length with a driving point on the lower end. For other cross sections, provide rods with a periphery at least 3.2 inches (80 mm). Use rods of solid construction and made of stainless steel jacketed steel, copper clad steel, or hot dipped galvanized steel in accordance with ASTM A 153, Class B-1.

For traffic signal installations, use cross-linked polyethylene ground wire cable with a minimum #6 awg copper, stranded, RHW insulated, 600 volt rated and exothermically welded to the ground rod with insulating varnish applied to the weld. Use copper in the ground wire hard enough to withstand the exothermal welding process but soft enough to melt and form a solid bond to the rod.

Provide UL listed rods with labels showing same.

Provide materials in accordance with the City's QPL.

725.19 Power Service Components. Furnish the materials and equipment comprising a service pole, including service equipment, that meets the following requirements.

A. Service Entrance Conduit. Ensure that the service entrance or riser conduit is rigid galvanized steel with a rain tight galvanized steel service entrance head (weatherhead) threaded to fit the conduit containing a composition insert for 3 conductors.

B. Service Disconnect. Ensure that the service disconnect is a properly rated fused switch of the ampacity specified and solid neutral. Ensure that the service fuses are cartridge fuses on the load side of the switch.

C. Lighting Contactor. Ensure that the lighting contactor is of the open type electromagnetically held.

Ensure that control of the contactor is through a photocell connected through a "HAND-OFF-AUTOMATIC" selector switch accessible only with the contactor enclosure open. Ensure that the control circuit is a separate circuit with its own protection.

D. Lighting Circuit Protection. Ensure that separate protection is provided on the load side of the lighting contactor for each lighting circuit and that such protection will open all line or phase conductors of the respective circuit should a fault occur on any one line or phase conductors.

E. Photoelectric Cell. Ensure that the photoelectric control is a twist-lock plug-in, utility grade, solid state, cadmium sulfide type of the proper voltage, rated for 1000

watts maximum load, with integral surge protection, a fail-safe mode in which the lighting circuits will remain energized, and a hermetically sealed case. Ensure that the nominal "turn on" level is 1 footcandle (10 lux) vertical and that the nominal "turn-off" level is 6 footcandles (65 lux) vertical with tolerances of 20 percent for the specified values. Ensure that the photocell has a time delayed response that will not respond to flashes of light from lightning, headlights of passing vehicles or emergency vehicle strobes and beacons. Ensure that the photoelectric control mounting bracket has a EEI-NEMA locking-type receptacle.

F. Switchgear Enclosure. Ensure that components are mounted on a removable back panel of 14 gage or heavier enameled steel rather than directly on the back wall of the enclosure and that the back panel mountings do not penetrate the walls of the enclosure.

Ensure that a neutral terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where neutral conductors are to be terminated. Ensure that an equipment grounding conductor terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where grounding conductors are to be terminated. When there is no code or utility company prohibition, a combination neutral and equipment grounding conductor bar may be furnished.

Ensure that an enclosure containing a disconnect switch with an external operating handle allows that handle to be padlocked in either the “OFF” or the “ON” position.

Ensure that the enclosure containing the service disconnect switch has an interlock to prevent the door from being opened when the switch is in the "ON" position

Ensure that the enclosure provides for padlocking the door.

Ensure that each switchgear enclosure is a NEMA ICS-1-110.15 Type 4 fabricated from No. 16 gage or heavier AISI Type 302 or 303 annealed stainless steel with fully welded seams and a brushed finish.

All fasteners used in assembly of the enclosures shall conform to ASTM A 320/A 320M (AISI-300 series).

G. Wiring Schematic, Wiring Diagram, Placards. Furnish both a schematic diagram and a wiring diagram of the entire power service from the power company service transformer secondary connection through the lighting branch circuit connections in triplicate with two copies delivered to the project and the third copy placed in the service disconnect enclosure. The Engineer will ensure that one of the two copies delivered to the project is filed with the project records and the other is delivered to the maintaining agency contact person.

Ensure that each placard to be attached to an apparatus enclosure is of multiple layers of plastic thermally bonded together to provide a plate of at least 1/8" (3 mm) in thickness with engraved plain block letters at least 1/2" (12 mm) in height. Ensure that placards designating the function of the apparatus contained in an enclosure or other such information are of white letters on a black placard. Ensure that placards warning of high voltage possibly present in an enclosure or other such warning are of white letters on a red placard.

H. Customer Service Pole. Furnish a wood pole that complies with ODOT Supplement 1072. Ensure that the pole and any cross arms or pole key is Southern Pine

or Western Red Cedar, full length, pressure treated in compliance with specifications of the American Wood Preservers Association using either creosote or pentachlorophenol. Ensure that the retention of preservative in Southern Pine is 7.5 pounds (120 kg) of creosote by assay or 0.38 pounds (6 kg) of pentachlorophenol by lime-ignition assay per cubic foot (cubic meter) of wood. Ensure that the retention of preservative in Western Red Cedar is 16 pounds (256 kg) of creosote by assay or 0.8 pounds (13 kg) of pentachlorophenol by lime-ignition assay per cubic foot (cubic meter) of wood. Ensure that the pole is 35 feet (10.5 m) minimum in length and Class 4 or heavier and conforming to ANSI 05.1 Specifications and Dimensions for wood poles. Ensure that the pole is reasonably straight without pronounced sweep or short crooks.

Ensure that all pole hardware, including racks, braces, straps, guy anchors, guy wire, clamps, bolts, nuts, washers, screws, nails, etc. is hot dip galvanized in accordance with 711.02.

Ensure that the grounding conductor is fastened to the pole with copper clad, rolled point staples of adequate size.

Ensure that the grounding conductor molding is either wood or plastic, in sections not less than 8 feet (2.4 m) long, of sufficient width and groove depth to completely enclose the grounding conductor.

Ensure that each pole anchor is of malleable iron or galvanized steel, 6 inch (150 mm) minimum diameter, two-way or four-way expanding type. Ensure that each anchor rod is 5/8 inch (16 mm) minimum diameter, 8 feet (2.4 m) minimum length galvanized steel with thimble eye. Ensure that each guy wire is 3/8 inch (10 mm) minimum diameter, conforming to ASTM A 475, galvanized steel.

725.20 Multiple Cell Polyvinyl Chloride Conduit and Fittings. Provide multiple cell conduit consisting of inner ducts conforming to NEMA TC-8 type DB in an outer conduit conforming to NEMA TC-2 (type EPC-40 or EPC-80 as specified, except measure size by the true inside diameter) in a factory preassembled unit. Provide factory made coupling fittings that couple inner ducts and the outer conduit simultaneously, maintain the continuity and indexing of the inner ducts and consist of a push fit design mechanically locked in place.

Provide materials in accordance with the City's QPL.

725.21 Luminaire Supports. Provide a complete luminaire support from the luminaire(s) down through the connection to the foundation or other structure conforms to the requirements of AASHTO's "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". Ensure a combined stress ratio above the first field joint greater than the combined stress ratio at the base of the pole.

Use a design wind speed for all areas of the State of 90 mph (145 km/h).

The Engineer may require various tests including destructive tests at either the factory or on site prior to acceptance of a support, supervised bythe City's representative and performed by the Contractor and/or manufacturer as appropriate on supports selected at random by the City of Columbus from the lot produced for the project. Replace any support damaged by the testing at no additional cost to the City.

Provide adhesive support identification labels with silver white reflective characters on a reflective green background meeting the requirements of 730.18.

Provide certified luminaire supports in accordance with ODOT Supplement 1091.

A. Light Poles. Provide poles with a maximum deflection of the pole from vertical when placed under the load of the bracket arm, and a weight of 75 pounds (35 kg) in place of each luminaire of 1 degree 10 minutes when tested in accordance with ODOT Supplement 1025. Submit certified copies of the results from the deflection tests to the Laboratory.

The Contractor may provide a pole and arm constructed from either aluminum or steel. Do not provide a combination of aluminum and steel.

Provide bracket arms made from straight or tapered stock round or ovaliptic in cross section not less in size than 2 inch (50 mm) nominal pipe.

Provide the luminaire end of each bracket arm having an outside diameter equal to 2 inch (50 mm) pipe, straight for a distance of eight inches (203 mm), with the longitudinal axis canted not less than 1 degree nor more than 4 degrees above horizontal.

Provide a bracket having an internal raceway with a minimum internal diameter of 1-3/32 inches (28 mm) free of projections and obstructions, permitting, after assembly, installation of luminaire supply conductors without insulation damage and not requiring bending the conductors to a radius less than 3 inches (75 mm).

Provide a pole with no more than two sections, with the shorter section of a sectional at the top and the shorter section of a sectional pole not less than 10 feet (3 m) in length. Join the pole sections by telescoping the bottom of the upper section over the top of the lower section for a minimum length of 1 1/2 times the external diameter of the bottom of the upper section, driving the joint tight, and securing by through bolting with a stainless steel hex head bolt of a minimum diameter of 5/8 inch (16 mm).

Provide poles with a pole section having no more than one longitudinal, automatically electrically welded seam and no transverse seams looking neat and uniform in appearance, with the weld not less than the thickness of the base material and the bead height not exceeding 1/16 inch (2 mm). Provide a uniform wall thickness throughout, except at the weld bead. Provide a circular pole cross section, or multi-sided pole cross section with no less than eight sides with the difference between the major and minor diameters of poles of circular cross section or the difference between the maximum and minimum distances across corners for poles of multi-sided cross section, measured at any point along the longitudinal axis, not exceeding 3/16 inch (5 mm).

Use steel poles consisting of tapered tubes with a true continuous taper not less than 0.06 inches per foot(1.5 mm per 300 mm)nor more than 0.16 inches per foot(4.0 mm per 300 mm).

Use aluminum poles, either spun or cold rolled, with a true continuous taper except for straight top and bottom sections. Provide poles with no more than 40 percent of the total shaft length straight, and with the average rate of shaft taper including straight portions of the shaft not less than 0.06 inches per foot(1.5 mm per 300 mm) nor more than 0.16 inches per foot(4.0 mm per 300 mm).

Provide poles capable of transmitting the full design strength of the pole shaft section in bending through the base plate into the transformer base or the anchor bolts without permanent bending of the base plate or failure of the pole shaft to base plate connection.

Provide a "J" hook inside the pole just below the top to hang the pole and bracket cable support assembly.

Provide nonstructural castings for aluminum poles, including the pole cap conforming to ASTM B 26/B 26M or B 108, Alloy S 5 A, Condition F.

Provide steel poles and bracket arms hot dipped galvanized after fabrication in accordance with the requirements of 711.02.

Provide aluminum poles and bracket arms in natural aluminum with a satin brushed surface.

Identify each light pole by a raised or engraved marking applied to the edge of the base plate that identifies the manufacturer and the year of manufacture, capable of remaining legible after galvanizing the pole.

Use bolts, nuts, washers, and other fasteners to assemble the light pole of galvanized steel conforming to 711.02, stainless steel conforming to ASTM A 320/A 320M (AISI-300 series), or silicon bronze conforming to ASTM B 98M (B 98).

Provide non-frangible steel transformer bases capable of transmitting the design dead, live, ice and wind loads of the light poles mounted on the bases to the foundations without failure or permanent deformation. Provide bases with a flush door permanently attached by means of a top-mounted continuous stainless steel hinge, and made from steel conforming to ASTM A36/A 36M hot dip galvanized after fabrication.

Provide frangible aluminum transformer bases capable of transmitting the design dead, live, ice and wind loads of the light poles mounted on the bases to the foundation without failure or permanent deformation. Provide bases with a flush aluminum door permanently attached by means of a top-mounted continuous stainless steel hinge, bearing easily found, and read-durable labeling meeting AASHTO frangibility criteria. Provide bases tested and accepted by the FHWA as complying with the 1985 AASHTO frangibility requirements

Use heavy hex bolts and nuts to fasten the base plate of the pole to the transformer base conforming to ASTM A 307 and galvanized in accordance with 711.02. For the tops or the bottoms of aluminum transformer bases fastened against non-galvanized steel, provide the steel and the aluminum mating surfaces with a coating of heavy film of zinc rich paint.

Use steel anchor bolts with 55,000 psi (380 Mpa) minimum yield strength, having threaded ends of the bolts and nuts galvanized in accordance with 711.02 for at least 2 inches (50 mm) beyond the threads and having nuts capable of developing the full strength of the anchor bolt and galvanized in accordance with 711.02.

B. Light Towers. Provide light towers with a structural design based the greater of either a load of six luminaires or the actual number of luminaires installed. Provide light towers with a structural design based on the greater of either each luminaire weighing 75 pounds (34 kg) and having an effective projected area of 3.5 square feet (0.3 m^2) or the actual weight and effective projected area of each luminaire. Provide light towers with a structural design based on the greater of either the head frame assembly with lowering device weighing 340 pounds (154 kg) and having a projected area of 5.3 square feet (0.5 m^2) or the actual weight and effective projected area of the head frame and lowering device.

Provide a luminaire lowering device (consisting of the luminaire ring, the head frame, the winch, the power cables and all miscellaneous mechanical and electrical equipment mounted in or on the pole) compatible with the pole.

1. Luminaire Ring. Provide a luminaire ring assembly fabricated from steel that conforms to ASTM A 36/A 36M and with a ring fitted with a separate 2 inch (50 mm) nominal steel pipe mounting arm directly attached to the ring for each luminaire.

Provide the luminaire ring with support by three wire ropes equally spaced around the ring. Provide wire ropes of the same material and construction having a 3/16 inch (5 mm) minimum diameter of either galvanized steel hoisting cable or aircraft grade stainless steel control cable made with 7 strands of 19 wires each. Connect each wire rope support cable to the ring by a corrosion resistant device allowing the connection to develop the full breaking strength of the wire rope while permitting ready adjustment of the length of the wire rope to level the ring. Equip the ring with a minimum of three spring loaded roller tipped centering arms equally spaced around the ring in continuous contact with the pole shaft, having guide arm rollers with nonabrasive, water resistant material.

Equip the luminaire ring with three positive latching devices equally spaced around the ring that latch to the head frame supporting the ring in the raised position allowing removal of tension to be removed from the lifting cables. Make all moving parts of each latching device part of the ring portion of the latch assembly with each latch assembly incorporating a reflectorized flag clearly discernible from the ground with the ring latched to the head frame. Do not allow the latching sequence to exert a horizontal force in excess of 4 g's acceleration upon the luminaires.

Equip the luminaire ring with a NEMA 4 corrosion resistant junction box for the connections between the main power cord bringing power to the ring and the separate power cords for each luminaire. Use copper conductors of adequate size and insulation for each power cord, suitable construction for each power cord, and power cords entering the junction box through a weather tight cord connector. Use a cord support capable of withstanding a load of 1-1/2 times the weight of the main power cord without damage to the cord transmitting the weight of the main power cord directly to the ring. Provide a weather tight power inlet on the luminaire ring allowing the main power cord in the base of the tower to connect to the ring when in the lowered position. Equip the junction box with a 600 volt class terminal block for the connections between the main power cord, the luminaire power cords, and the power inlet cord. Identify each luminaire ring by a raised or engraved marking applied in a prominent location identifying the manufacturer and the year of manufacture, legible after the ring galvanizing

2. Head Frame Assembly. Fabricate the head frame from steel conforming to the requirements of ASTM A 36/A 36M. Equip the head frame assembly with pulleys for the wire ropes hoisting cables and rollers for the main power cord to the luminaire ring. Provide hoisting cable sheaves with a tread diameter of at least 20 times the cable diameter for galvanized cable and 25 times the cable diameter for stainless steel cable, with the groove for the hoisting cable having a semi-circular cross section with a radius of one-half the cable diameter plus 1/64 inch (0.4 mm), with the sheave having an oil-impregnated bronze bushing, and with the shaft supporting the sheave made of stainless steel. Provide rollers for power cord run on AISI 304 stainless steel shafts

between cold-rolled steel plates. Provide a power cord with a bending radius not less than 7 inches (180 mm). Install keeper bars over the power cord and ring support cables to keep them in their respective tracks. Provide a guide to separate the individual cables as they pass between the head frame and the top of the pole. Protect the head frame mechanism from the weather by a domed cover of either copper, free spun aluminum, or fiberglass. Identify each head frame by a raised or engraved marking applied in a prominent location showing the manufacturer and the year of manufacture, legible after galvanizing the head frame.

3. Transition Plate. Provide a transition plate between the ring support cables and the main hoisting cable. Secure the luminaire ring support cables to the transition plate by shop applied, swage-type fittings designed to develop a connection strength equal to the breaking strength of the cable and prevent abrasion of the cable by the transition plate. Provide a cord support capable of withstanding a load of the weight of the main power cord plus a wind load on the cord equal to a 30 mph (48 km/h) wind perpendicular to the full length of the cord without damage to the cord connecting the main power cord to the transition plate.

4. Hoisting Winch. Provide a winch of cast iron and steel construction with an integral enclosed lubricant bathed worm and gear drive having a reduction great enough for self-locking. Provide the winch with a pulling capacity at least five times greater than required to lift the load. Provide the winch drum with a diameter not less than 4 inches (100 mm), and the drum flange with a diameter at least 3 inches (75 mm) greater than the diameter of the drum. Prevent cable buildup at the ends of the winch drum with a cable guide or follower.. Provide the support plate for the winch with a durable tag identifying the manufacturer, manufacturer's model, and year of manufacture for the lowering device.

5. Winch Drive Unit (Portable Power Unit). Power the winch drive unit by a heavy duty reversing drill motor with a minimum 560 W (3/4 horsepower) rating, 120 volt. Provide a mechanical slip clutch torque limiter incorporated into the output shaft with a placard on the portable winch drive unit giving the settings and instructions for care of the torque limiter. Include a separately packaged dry type isolated winding transformer to permit operation of the drill motor from the lighting circuit by plugging into the luminaire power cord outlet in the base of the tower. Provide a cord outlet and plug for connecting the motor to the transformer complying with NEMA L5-15. Ensure a hoisting rate of between 15 and 25 feet per minute (4 and 8 m/min). Provide a hand control switch incorporating 20 feet (6 m) of cable to allow operation of the lowering device from a position away from the pole and not beneath the ring and luminaires. Provide each winch drive unit frame with a raised or engraved marking applied in a prominent location identifying the manufacturer and the year of manufacture, legible after application of final finish to the frame.

6. Connection of Tower to Lighting Circuit. Provide a separate terminal block for each conductor of the supply circuit in the base of the tower, and enough spaces on the blocks to allow the incoming circuit to split into three outgoing directions in addition to the feed to the tower itself. Provide the terminal block with set screw style terminations, sized for 4 AWG - 1/0 AWG for the incoming and outgoing lighting circuit, and 12 AWG - 10 AWG for the tower wiring. Provide a circuit breaker in a NEMA 4 enclosure located electrically after the terminal blocks for the lighting circuit and before the power

cord leading up the tower to the luminaires. Internally mount the breaker enclosure and make the breaker readily accessible through the tower hand hole. Provide a bolt-on design for the circuit breaker, sized at 15 amperes with a minimum interrupting capacity of 14,000 amperes for 480 volt circuits or sized at 20 amperes with a minimum interrupting capacity of 10,000 amperes for 240 volt circuits and having a single handle rather than a tied handle design with one pole for each line or phase conductor. Provide a cord connector, plug, and inlet on the ring for electrical power to the luminaires conforming to NEMA L8-20 for 480 volt systems or to NEMA L6-30 for 240 volt systems.

7. Operating Manual. Provide a complete manual including instructions on installation, operation and maintenance for each lowering device, winch assembly, and portable power winch drive unit.

8. Shaft. Provide a tower shaft with not more than four round or multi-sided tapered steel sections for towers up to and including 100 feet (30 m), five sections for towers over 100 feet (30 m) up to and including 120 feet (37 m), and six sections for towers over 120 feet (37 m). Use steel for the shaft having a minimum yield strength of 55,000 psi (379 MPa). Join the shaft sections by telescoping the bottom of the upper section over the top of the lower section for the greater of either a minimum length of 1 1/2 times the external diameter of the bottom of the upper section or two feet (0.6 m) and driving the joint tight. Pre-fit the sections and match-mark at the factory. Provide a smooth inside surface of the shaft with no more than two longitudinal welds made by automatic electric arc welding. Make the longitudinal seam welds with complete penetration, having uniform density, no thinner than the shaft material or no more than 20 percent thicker than the shaft material. Fabricate the base plate from steel conforming to the requirements of ASTM A 36/A 36M and join the shaft to the base plate using the American Welding Society prequalified joint TC-U4a-S or TC-U4c-GF. Reinforce the hand hole in the shaft to avoid stress risers and weld the reinforcements to the shaft using a joint and techniques designed to ensure total penetration plus an outside fillet equal to the thickness of the shaft material. Provide welds in the shaft conforming to AWS D 1.1 Structural Welding Code Article 9.25.3 for tensile stress when tested either by the ultrasonic method or by an approved alternate method. Submit certified results to the Laboratory. Fabricate the door from the same type steel as the shaft, attach with a continuous stainless steel hinge having non-removable stainless steel hinge pins, fit closely to the door opening, and secure in the shut position. Provide for padlocking the handhole door closed and provide each tower with a vandal resistant padlock having a bronze or brass lock body and a corrosion-protected steel shackle keyed to the key number specified by the maintaining agency. Provide two holes, tapped 1/2-13, 180 degrees apart, at the base of the tower for the grounding conductors. Hot dip galvanize the shaft after fabrication in accordance with the requirements of Section 711.02. Provide identification on each shaft by a raised or engraved marking applied to the edge of the base plate showing the manufacturer and the year of manufacture, legible after galvanizing the pole.

9. Anchor Bolts and Nuts. Provide steel anchor bolts conforming to ASTM F1554, Grade 55, and galvanize in accordance with Section 711.02 at least 2 inches (50 mm) beyond the threads. In lieu of a bent end, the Contractor may provide an anchor bolt with the lower end threaded and inserted into a steel plate of approved size and

thickness, drilled and tapped to receive the anchor bolt. Use nuts with each anchor bolt capable of developing the full strength of the anchor bolt.

725.22 Plastic Caution Tape. Provide tape from an inert material, approximately 6 inches (150 mm) wide composed of polyethylene plastic, highly resistant to alkalis, acids or other chemical components that the Contractor likely will encounter in soils. Provide bright red tape with identifying printing “ELECTRIC” in black letters on one side only. Provide tape in continuous rolls with the identifying lettering repeated continuously the full length of the tape.