

SECTION 93

TRAFFIC SIGNALS AND ROADWAY LIGHTING

93.1 DESCRIPTION

A. General: This work consists of furnishing and installing all material and equipment necessary for the operation of traffic signals and roadway lighting. Contractor shall coordinate with City Traffic Operations to determine which materials are salvaged to the City, and which material may be disposed of by the contractor. Salvaged material shall be delivered to a location as determined by City Traffic Operations.

B. Related Work:

Section 90	Roadway Signs and Delineators
Section 91	Pavement Marking
Section 92	Temporary Traffic Control
Section 203	Submittals

93.2 MATERIALS

Prior to fabrication or purchase, the Contractor shall submit shop drawings or catalog cuts for all signal equipment and luminaires to the City in accordance with Section 203 Submittals. The Contractor will not begin fabrication or construction of the work contained in the shop drawings or catalog cuts until the City has completed the review. Contractor shall not deviate from materials reviewed without additional review and approval.

A. Electrical Grounding and Bonding:

1. **Grounding Wire:** From electrical cabinets to the ground rod shall be bare, soft drawn copper, size per National Electrical Code (NEC). Grounding wire from pole to ground rod shall be bare, soft drawn copper, minimum size #6 AWG.
2. **Bonding Conductors:** Shall be of the same size and insulation grade as the associated circuit conductors. Equipment grounding conductors shall be sized in compliance with the NEC.
3. **Ground Rods:** Shall be copper-coated electrodes in accordance with Underwriters Laboratory (UL). The size and length shall conform to NEC requirements.

B. Conduit:

1. **Rigid Steel Conduit:** Conduit and fittings shall meet the requirements of UL 6 and 514 and shall be hot dip galvanized. Each section of conduit shall bear the UL label.

2. **Rigid Nonmetallic Conduit:** Conduit and fittings shall be polyvinyl chloride heavy wall meeting the requirements of UL 651 and 514. Use and installation of polyvinyl chloride (PVC) schedule 40 and 80 shall be in accordance with NEC and each section shall bear the UL label. The contractor shall use schedule 80 nonmetallic conduit under all roadways and other locations as shown in the plans.
3. **Innerduct Conduit:** Shall be SDR 13.5 HDPE. Innerduct conduit shall provide 1-inch nominal duct size, be orange in color, and be longitudinally ribbed on the inside wall.

C. Junction Boxes:

1. Shall be polymer concrete material and conform to NEC standards 314.29 and 314.30. The loading requirement for all electrical junction boxes and covers will be tier 22 of ANSI/SCTE 77 2007. The word "ELECTRIC(AL)" or "SIGNAL(S)" shall be cast into the top of the cover.
2. Surface mounted junction boxes shall comply with NEMA 4X stainless steel, shall be UL-listed, and, at a minimum, shall be sized according to the NEC. Stainless steel junction boxes shall have the cover held in place with a continuous hinge and kept closed with screws and clamps on the remaining three sides. The cover shall be removable by removing the pin with the continuous hinge. All seams shall be continuously welded. Gaskets shall be closed cell neoprene.

D. Concrete Footings: Shall meet the requirements for Class M6 concrete. Cement shall be Type II. Vertical reinforcement shall be deformed unless otherwise noted and shall conform to the requirements of ASTM A615/AASHTO M 31 Grade 60. Circular ties, stirrups, and spiral reinforcing may be fabricated from deformed bars conforming to the requirements of ASTM A615/AASHTO M 31 Grade 60. Spiral reinforcing may also be fabricated from cold drawn wire conforming to ASTM A1064 or hot rolled plain bars conforming to ASTM A615/AASHTO M 31 Grade 60.

E. Bolts: All bolts, anchor bolts, anchor rods, nuts, and washers shall conform to SDDOT Standard Specifications for Road and Bridges Section 972.

F. Electrical Power Wire: Shall be Type THW, THWN, XLPE, or XHHW rated for 600 volts AC and be clearly and durably marked with the UL label, type of insulation, number of conductors, and the AWG size.

Traffic signals with intersection lighting using the same service cabinet shall utilize stranded copper meeting the requirements of ASTM B3 and B8, Class C. Roadway lighting shall utilize stranded copper conductors for service, feeder, and branch circuits.

G. Pole and Bracket Cable: The cable from pole base to luminaire shall be two-conductor of the AWG size shown, meeting ICEA Standards.

Conductors shall be THWN/THNN meeting ASTM B3. Conductors shall be stranded bare soft copper meeting ASTM B3 and B8, Class C. Each conductor shall be insulated with high dielectric strength heat and moisture resistant PVC rated for use at 75°C, and shall meet the requirements of ICEA. One insulated conductor shall be colored white and the other black. The two insulated conductors shall be laid parallel and covered with a black polyethylene belt. The belt shall meet the requirements of ICEA.

H. Traffic Signal Control Cables:

1. **Multiple Conductor Cables:** Shall be THHN/THWN insulated conductors with fillers of nonabsorbent material, bound with polyester tape and with a PVC jacket. Two-conductor cables may either be of round or flat construction.
2. **Conductors:** Shall be Class C stranded copper meeting the requirements of ASTM B3 and B8.
3. **Insulation:** Shall have a minimum thickness of 19 mils of which 15 mils shall be PVC with the remaining thickness of nylon.
4. **Colors:** Conductor insulation shall be colored in accordance with ICEA S-73-532 Table E2.
5. **Jackets:** Shall be PVC meeting UL requirements for Class 12 jackets and ICEA standards.
6. **Markings:** The cable shall be marked with the name of the manufacturer, rated voltage, UL label, American Wire Gauge (AWG) size, and number of conductors.

I. Electrical Service Cabinet:

1. Shall be a NEMA Type 3R enclosure.
2. Size shall be as required to house required components.
3. Shall be rated for service entrance equipment.
4. Required components:
 - a) Main breaker.
 - b) A copper bus rated for the voltage, current, and phases required by the plans.
 - c) Branch circuit breakers meeting plan requirements for amps, voltage, and phases. Minimum A.I.C. shall be 10,000.
 - d) When plans require, a mechanically held contactor, NEMA rated for the load

served, shall be provided. The contactor shall be encased in a UL approved weatherproof housing with an integral test switch included. The contactor shall be complete with an interface relay for photocell control and photocell bypass switch. A photocell shall be provided.

- 5. Secondary Disconnect:** When the electrical service is not on the same corner as the traffic signal cabinet, a secondary disconnect shall be provided. The disconnect shall be a Nema Type 3R, 60 amp non-fused and shall break the power to the cabinet.

J. Traffic Signal Poles:

1. Design:

- a) The location, number, area, and weight of the signal heads, preemption, video detection, and signing as shown on the plan detail plates shall be used for determination of adequate pole and footing structural design. The actual quantity and locations of signal heads shall be as shown on the plan sheet.
- b) Design and fabrication shall be in accordance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, including all subsequent interims and plan details.
- c) Wind load shall be calculated using the 50 year mean recurrent interval basic wind speed.
- d) New poles shall be galvanized steel. Galvanizing shall be in accordance with AASHTO M 111 (ASTM A123). Steel pole material shall be in accordance with ASTM A36, A242, A570, A572, A607, A709, A1008, A1011, or A595 Grade A or B. A595 material shall be limited to a 3/8 inch maximum thickness. Steel pole material with a thickness of 1/2 inch to 2 inches, shall satisfy Charpy V-Notch toughness test requirements of 15 foot pounds at 40°F. The City's Traffic Engineer shall be contacted for Charpy impact requirements for steel pole material thickness greater than 2 inches.
- e) The steel pole-to-base-plate connection shall be a full-penetration groove-welded connection with a backing ring as described in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- f) The design yield strength shall be no higher than 55,000 psi. Strength of steel for fabricating poles may be higher than 55,000 psi, but not lower than 36,000 psi.
- g) Anchor bolt or rod circle, anchor bolt or rod size, and other structural properties of the pole and base are to be designed and determined by the pole manufacturer.

- h) Connections at the base of the pole shall be 3M™ Scotchlok™314 wire connectors, or approved equal.
- i) Pole designs must provide for drainage with no laps or edges to hold moisture.
- j) Mast arm pole shafts shall have a removable cover and an opening for cable entrance to the mast arm.
- k) A "J" hook for a cable strain relief grip or other strain relief device shall be provided at the top of the pole.
- l) Luminaire extensions shall meet specifications for roadway luminaire poles.
- m) Hand holes and other openings shall be smooth, neat, and covered.
- n) All pole shall be designed with rotating arms.
- o) All poles shall have a metal identifying badge with the following information:
 - 1) Manufacturer's name
 - 2) Year of manufacture
 - 3) Pole model number
 - 4) Project name or other identifying information to determine what project the pole originated from

2. **Certification:** A statement is required, signed by a Professional Engineer registered in the state of South Dakota, certifying the pole designs meet all plan and specification requirements.
3. **Shop Drawings:** Prior to fabrication, the Contractor shall submit shop drawings or catalog cuts for the traffic signal poles to the City in accordance with Section 203 Submittals. With the shop drawings, the Contractor shall submit comprehensive design calculations for the traffic signal poles, including anchor bolts, signed and sealed by a SD registered Professional Engineer. Contractor shall not deviate from materials reviewed without additional review and approval.

K. Pedestal signal poles:

Pedestal signal poles may be aluminum. Aluminum poles will conform to the following requirements:

Aluminum will conform to ASTM B221, Alloy 6061, and Temper T6.

Poles will be round with a minimum outside pole diameter of 4 inches, and the pole assembly will have a square, cast aluminum base with aluminum access door. The base will conform to the breakaway requirements of NCHRP 350 or MASH. A

grounding lug will be provided in the base.

The pole to base connection will be a threaded connection; threads will be 8 TPI, NPT. A collar (integral or non-integral) to prevent wind-induced loosening of pole will be provided. All bolt and connection threads will be coated with a commercially available anti-seize compound intended for use in aluminum-to-aluminum and steel-to-aluminum connections.

The pole finish will either be brushed satin or spun. The top of the pole will be sealed by the traffic signal head mounting hardware or by an aluminum cap.

L. Roadway Luminaire Poles:

1. Design:

- a)** Design and fabrication shall be in accordance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, including all subsequent interims and plan details. Design shall also include provisions for mounting a 36-inch x 36-inch sign located 10 feet above the base.
- b)** Wind load shall be calculated using the 50 year mean recurrent interval basic wind speed.
- c)** New poles shall be galvanized steel. Galvanizing shall be in accordance with AASHTO M 111 (ASTM A123). Steel pole material shall be in accordance with ASTM A36, A242, A570, A572, A607, A709, A1008, A1011, or A595 Grade A or B. A595 material shall be limited to a 3/8 inch maximum thickness. Steel pole material with a thickness of 1/2 inch to 2 inches, shall satisfy Charpy V-Notch toughness test requirements of 15 foot pounds at 40°F. The City's Traffic Engineer shall be contacted for Charpy impact requirements for steel pole material thickness greater than 2 inches.
- d)** The steel pole-to-base-plate connection shall be a full-penetration groove-welded connection with a backing ring as described in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- e)** The design yield strength for steel shall be no higher than 55,000 psi. Yield strength of the steel used in fabricating poles may be higher than 55,000 psi but shall not be lower than 36,000 psi.
- f)** All poles shall have breakaway transformer bases. Hand hole latch shall be located at the top of the access panel.
- g)** Anchor bolt or rod circle, anchor bolt or rod size, and other structural properties of the pole and base are to be designed and determined by the pole

manufacturer.

- h) Connections at the pole or junction boxes shall be made with water tight connectors approved for outdoor use. Connectors shall be TE Connectivity GTAP or approved equal.
 - i) Pole designs must provide for drainage with no laps or edges to hold moisture.
 - j) A "J" hook for a cable strain relief grip or other strain relief device shall be provided at the top of the pole.
 - k) A 1/2 inch nut shall be welded inside the hand hole for grounding purposes. The weld shall not show through to the outside.
2. **Certification:** A statement is required, signed by a Professional Engineer registered in the state of South Dakota, certifying the pole designs meet all plan and specification requirements, including breakaway and structural adequacy, of the AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The physical testing procedures outlined in the Aluminum Association's Specifications for Aluminum Structures may be used to establish service limits for structural adequacy certification of aluminum breakaway transformer bases and frangible couplings. If requested, test data of production samples to support the certification shall be provided.
 3. **Shop Drawings:** Prior to fabrication, the Contractor shall submit shop drawings or catalog cuts for the roadway luminaire poles to the City in accordance with Section 203 Submittals. With the shop drawings, the Contractor shall also submit comprehensive design calculations for the roadway luminaire poles, including anchor bolts or rods, signed and sealed by a SD registered Professional Engineer. The Contractor shall not begin fabrication prior to the City's review and final approval. Contractor shall not deviate from materials reviewed without additional review and approval.

M. Luminaires:

1. All fixtures shall be "cobra head" style with NEMA 7-pin photocontrol receptacle and 2-inch slip fitter mounting unless otherwise specified in plans.
2. All fixtures shall have multi-voltage driver covering the range from 120 volts– 277 volts AC.
3. Fixtures shall be LED with a color temperature of 4,000K, minimum color rendering index of 70, and minimum L₇₀ of 100,000 hours at 25° Celsius.
4. All fixtures shall have an upright rating as defined by IESNA TM-15-11 of zero (0).

N. Photoelectric Control Requirements: Shall be one of the photoelectric controls

listed on the SDDOT's Approved Products List.

O. Controller Cabinet: Shall be NEMA compliant.

1. Cabinet Design:

- a) The cabinet shall be made of welded sheet aluminum.
 - b) The type and size of cabinets shall be determined by the signal controller supplier. The cabinet shall be of sufficient size to accommodate the controller and associated equipment.
 - c) The cabinet shall be furnished with a hinged door that provides complete access to the cabinet interior. The controller cabinet door shall be hinged on the right side. The door shall have a gasket making a weatherproof and dust tight seal. The door shall be provided with a lock and two standard keys. Base mounted cabinets shall be furnished with doorstops to hold the door open during servicing.
 - d) The cabinet door shall contain a police panel with a lock and key. The police panel shall contain two switches. One switch shall be designated "flash/normal" and the other switch designated "signal off/on". At any switch position, power shall be maintained for all control equipment, including detector amplifier units, within the cabinet. The switch shall be labeled and rated for the current load. Switch terminals on the rear of the police panel shall be insulated so live parts are not exposed.
 - e) The controller cabinet shall be a NEMA Type 3R Enclosure.
 - f) Underside mounted LED light strips shall be installed on each shelf in the controller cabinet. An on/off switch that is turned on when the cabinet door is opened and turned off when the cabinet door is closed shall activate the lights. The switch shall be wired to place an input to the signal controller event or alarm log when the cabinet door is opened. The power supply for the LED light strips shall be separate from the standard double plug receptacle.
 - g) The controller cabinets shall be capable of placing vehicle and pedestrian calls into the controller. Placed calls shall provide for eight vehicle phases and four pedestrian phases. The placed calls for vehicle phases shall be capable of extending the associated vehicle phase by continuous or intermittent contact.
- 2. Fan Assembly:** Cabinets shall be provided with thermostatically controlled fan vent assemblies. The thermostat shall be adjustable within a range from 75°F to 150°F and shall be separately fused. A screened and filtered air intake area of at least 12 square inches shall be provided. The filters shall be removable, cleanable, reusable, and replaceable.

3. Electrical:

- a) A three wire 15 ampere NEMA standard double plug receptacle with ground contact shall be wired as a separate circuit ahead of the main breaker.
- b) A main circuit breaker shall be furnished and installed in the controller cabinet. An auxiliary circuit breaker shall be provided and connected to the load side of the main breaker. The main breaker shall be wired to protect the signal load and controller circuits. The auxiliary circuit breaker shall be properly rated and fused to protect circuits utilizing unfiltered AC power. Terminal facilities in the cabinet for incoming AC power will be protected to prevent short-circuiting when working with tools in the cabinet. The circuit breakers shall be capable of manual operation with markings to indicate ratings and whether it is in the open or closed position.
- c) A power line filter certified in accordance with UL Standard 1283 and meeting the following specifications shall be installed at the main breaker:
 - 1) 50 db minimum attenuation over a frequency range of 200 kilohertz to 75 kilohertz.
 - 2) Minimum feed through current of 30 amperes at 120 volts, 60 hertz.
- d) The cabinet shall be equipped with a surge protection device certified in accordance with UL Standard 1449 and meeting the following specifications:
 - 1) Nominal discharge current rating of 3kA.
 - 2) Voltage protection rating 330V.
- e) Bus bar terminals such as AC common (neutral), AC power, safety (chassis) ground and AC signal power shall be furnished and properly installed.
- f) Terminals and panel wiring for detector leads, interconnect, time switches, relays, load switch sockets, flash transfer relay sockets, and any other components required to provide the controller operation shall be installed.
- g) Terminals and components that make up the basic terminal facilities shall be permanently identified in accordance with the cabinet wiring diagram. Identification shall be permanently attached as close as possible to the terminal or component and shall not be affixed to any part which is easily removed.
- h) Each input or output terminated on a terminal block shall be identified on the front of the panel by a position number and functional terminology (e.g. 0/1 Red, 0/2 Hold, Channel 3 Red, etc.). The same identification shall be used consistently on the cabinet wiring diagram.
- i) Each component shall be identified on the front of the panel by a symbol and

function terminology consistent with the cabinet wiring diagram. Provisions shall be made that each load switch socket can be identified by the phase or overlap number by writing on the panel in an area established for this feature.

- j) Panel wiring shall be neat and firm with panel mounted terminals for signal lamp circuit conductors, one for each signal circuit, and one or more terminals for the common conductor. The terminals shall be located a minimum of 3 inches from the bottom of the cabinet and arranged for adequate clearance between the terminals. The controller equipment and terminals shall be arranged within the cabinet so they will not upset the entrance, training, and connection of incoming conductors.
 - k) A flasher socket and a solid state flasher meeting current NEMA standards shall be provided in the controller cabinet.
- P. Controller:** Shall be a solid state, digital, NEMA TS2 Type 1 from the SDDOT Approved Products List and as approved by the City's Traffic Engineer. The controller shall have front panel access to display cycle length, offset, and internal timing values. Access to these timing functions shall be by keyboard entry as an integral part of the controller. The controller shall meet NEMA environmental and electrical performance standards. The controller shall also have a USB port and an Ethernet port.

The controller shall be two through twelve phase controllers.

Digital timing shall be provided with a battery backup.

The controller shall be capable of programming by manual entry via the front panel keyboard, data downloading from a portable PC computer via null-modem cable, data downloading from one controller to another using a serial port on each controller, and restoring data using a data transfer module (data key). In a closed-loop system, the controller shall be capable of data downloading via telemetry. In an enterprise system, the controller shall be capable of data downloading from a central server.

The controllers shall be capable of operating coordinated by time-based, hardware, and telemetry.

The controllers shall have a copy function to copy all timing data from one phase to another. The controllers shall also permit copying all coordination pattern data from one pattern to another.

Hardware for future pedestrian signals shall be provided when shown.

The controller shall be equipped with solid state signal load switching devices meeting current NEMA requirements. Load switches shall be furnished with input and output indicator lights on the front panel.

The interface panels shall be capable of inserting up to sixteen load switches.

Each controller shall be furnished with a malfunction management unit (MMU) conforming to the requirements of NEMA Standard TS-2 Section 4. The provided MMU shall have visual displays for programming and operational purposes.

A sufficient quantity of BUS Interface Units shall be installed in the cabinet to provide communication between detectors, load switches, controller unit, etc. Each BUS Interface Unit shall conform to NEMA Standard TS-2, Section 8.

The controller shall be furnished with extra feature wiring to provide for remote flashing and each wire shall have its own terminal connection. The flash control circuit shall ensure that remote transfer to flashing from normal stop and go operations occurs during the end of the mainline green interval in the cycle. When the controller is in a flashing condition, the signal switching mechanism shall be inoperative.

The controller time of day flash shall alternate the red and yellow indication with yellow on the major route and red on the minor route. The controller malfunction flash shall be red-red.

Load switches for pedestrian indications shall be required when pedestrian indications are shown. The cabinet wiring, load switch sockets, and connection facilities shall be included for pedestrian movements permissible with phasing shown.

The controller furnished shall meet current NTCIP requirements.

Q. Detector Unit: Components and workmanship shall conform to the standards of NEMA. Detector units shall include a visual display screen in the controller cabinet.

R. Detector Loops:

1. Detector Loop Wires and Cables:

a) Lead-in (Home Run) Cables: Feeder cables from loop junction box to detector units shall be twisted shielded pairs, conforming to International Municipal Signal Association (IMSA) 50-2, #16 AWG minimum size. Splices are to be avoided in feeder wires.

b) All wire connections shall be sealed and insulated with 3M[™] Scotchcast[™] 3570G Connector Sealing Pack, or approved equal.

2. Sawed-in Loops:

a) Conductors shall conform to the following requirements:

Material	Stranded Copper
Size	#16 AWG (Minimum)
Insulation	XHHW, THHN, RHH, or RHW
Encasement	1/4 inch Polyethylene tubing

- b) Backer rod material shall be resilient, nonabsorbent material approximately 25% larger in diameter than the width of the sawed slot to be sealed.
- c) Loop Sealants: Shall be one of the products as listed on the SDDOT Approved Products List.
- d) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box.
- e) Loop wire shall be continuous throughout the loop and lead-ins to the junction box.

3. Preformed Loops:

- a) Conductors shall conform to the following requirements:

Material	Stranded Copper
Size	#16 AWG (minimum)
Insulation	600 Volt, XLP, bearing the U.L. designation for either Type RHH and RHW or Type XHHW

- b) Loop wire shall be continuous throughout the loop and lead-ins to the junction box.
- c) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box.
- d) If loop will be in direct contact with hot asphalt, it shall be rated to withstand the hot asphalt temperature.

S. Signal Heads:

1. All vehicle and pedestrian signal indications shall be light emitting diode (LED) signal modules.
2. Vehicular signal indications shall meet the requirements of the Institute of Transportation Engineers (ITE) Standard, Vehicle Traffic Control Signal Heads.
3. Pedestrian signal indications shall meet the requirements of the ITE Standard, Pedestrian Traffic Control Signal Indicators.
4. The LED signal modules shall be warranted against defects in materials and workmanship for a period of 5 years after the installation of the modules. The manufacturer shall provide this warranty in writing to the Engineer prior to installation of the LED signal modules.

5. Size: Shall be a minimum of 12 inches diameter.
 6. Color: Doors, visors, and backplates shall be dull black and housing highway yellow.
 7. Material may be polycarbonate resin.
 8. Each circular signal section shall be furnished with a tunnel type visor and shall be attached to the door front using four (4) stainless steel screws, which shall thread into a brass thread insert.
 9. Backplates for Signal Heads: All new vehicle signal heads will have backplates with retroreflective border. The vehicle signal head backplates will have a factory applied 3-inch wide yellow retroreflective border. Sheeting for the border will be Type XI or Type IX in conformance with ASTM D4956. Backplates will be polycarbonate, aluminum, or aluminum-composite. Minimum material thicknesses are:
 - Polycarbonate, 0.10-inch
 - Aluminum, 0.06-inch
 - Aluminum-Composite, 0.08-inch

Signal backplates will extend not less than 5 inches from the edge of the signal head at the top, bottom, and sides. The bottom of the backplate on vehicle signal faces mounted directly above pedestrian signal indications will be sized to permit the separate adjustment of the vehicle and pedestrian signal indication and may be less than 4 inches.
 10. Green LED displays shall have clear lenses.
- T. Pedestrian Push Button:** Shall be compliant with the Americans with Disabilities Act (ADA). Accessible pedestrian push buttons shall be one of the accessible pedestrian signals on the SDDOT's Approved Products List. Pedestrian push button pole and material shall be as specified in plans.

1. General:

- a) Shall be pressure activated with essentially no moving parts.
- b) Shall be vandal resistant.
- c) Shall activate with 3 pounds force or less.
- d) Shall have an LED that illuminates when the button is being pushed and remains illuminated until the pedestrian call is served.
- e) Shall give a toned beep verification of button being pushed.
- f) Shall have an operating life of 1 million actuations.

- g) Shall be compatible with NEMA TS2 controllers.
- h) Shall be capable of being programmed via Bluetooth®.

2. Housing:

- a) Button housing shall be unfinished, high impact cast or machined aluminum.
- b) All switch electronics shall be sealed within the high impact cast or machined aluminum housing.
- c) Shall have a gasket between the button housing and the mounting cup.

3. Electrical:

- a) Operating Voltage: 15 to 24V DC or 12 to 24V AC.
- b) On Resistance 10 Ohms (when the button is activated and placing a call).
- c) Standby Current 10 micro amps typical.
- d) Shall have built in surge protection.
- e) Shall have a solid state electronic piezo switch rated for 1 million cycles with no moving plunger or moving electrical contacts.
- f) Shall hold the call for a minimum of 5 seconds.
- g) Requires only two conductors be run from the traffic signal cabinet to the push button to operate.
- h) Six units wired in parallel on a single pedestrian isolator input shall not pull the input voltage of the pedestrian isolator down such that a false pedestrian call is placed in the controller.

U. Emergency Vehicle Preemption System: The emergency vehicle siren registers its presence by activation of the siren's "yelp" mode. The emergency vehicle preemption system provides a method that allows an emergency vehicle to have priority at the traffic signal. This specification describes the minimum operating requirements of a siren activated emergency vehicle preemption system.

1. System Equipment:

- a) **Detectors:** Directional microphones at each approach to the signal detect the arrival of an emergency vehicle.

- b) **Phase Selector:** Located in the signal controller cabinet. The phase selector shall process the input detector information and produce an appropriate output signal to the controller.
- c) **Emitters:** The existing electronic siren on each vehicle. Any electronic siren that meets current federal standards shall be compatible with the system. Sirens are not to be furnished as part of the project.

2. Equipment Requirements:

- a) **General:** The emergency vehicle preemption system shall be expandable to include sirens that generate an embedded vehicle identification code.

The signal controller shall be programmed for the special preemption sequence.

- b) **Detector Devices:** Shall be specially designed microphones that are positioned on the traffic signal poles in such a manner that each approach to the signal is adequately detected. The detectors shall be weatherproof and designed to withstand electrical transients normally encountered in the ambient outdoor environment. The detectors shall not be affected by fog, rain, ice, snow or any other adverse weather conditions. The close proximity of high profile vehicle to the emergency vehicle shall not present a shield or barrier to the acoustical energy emitted from the siren. The detectors shall be directional with an 18° cone of sensitivity and polar curve of 9:1 (from the front side).

Detectors shall be located as shown in the plans and shall be installed in accordance with the manufacturer's recommendations.

- c) **Phase Selector:** Shall be located in the controller cabinet. The phase selector is used to decode the information from each detector and produce suitable outputs to the controller. The phase selector shall meet the environmental and electrical standard specified by NEMA Standard TS1 or TS2. The phase selector shall be designed using microprocessor circuitry and shall be fully compatible with NEMA TS1, NEMA TS2, and Type 170 controller cabinet assemblies.

The phase selector shall have resident software that allows a range of sensitivity adjustments to be made using a portable computer. The phase selector shall have adequate memory to record all system activity. Each access to the system shall be recorded with the date, time, duration of access and quality of the emitter/detector input signal.

The portable computer shall not be furnished as part of this project.

- 3. **Electrical Cable:** From the detector to the controller cabinet shall be 18 AWG (minimum) 2-conductor twisted shielded pair Belden 8762 or equal. Electrical cable

from the confirmation light to the controller cabinet shall be a 16AWG (minimum) 2-conductor cable that meets 93.2.H.

4. **Confirmation Light:** Shall be installed facing the intersection that informs the driver whether the signal is under preemption or normal operation. The confirmation light should be mounted as close to the last head on the mast arm as possible.

93.3 CONSTRUCTION

- A. **General:** Installations shall comply with applicable sections of the National Electrical Code (NEC), State regulations, and local ordinances. Licenses or permits required shall be obtained by and at the expense of the Contractor.

The Contractor shall arrange for necessary electrical services at locations specified, as agreed to by the City and the utility company.

Any changes during construction shall be clearly shown on the asbuilt drawings.

After the traffic signals and the lighting system have been turned on and found to be operating satisfactorily and all installation of the system is complete, the Engineer shall notify the Contractor of acceptance. Upon acceptance, the Contractor shall be relieved of routine maintenance responsibility. The Contractor shall remain responsible for failures due to character of work, materials, or equipment that occur during a two (2) year period following the date of acceptance. The Contractor shall warrant and guarantee materials, electrical, and mechanical equipment furnished and installed to be free from defects in materials and character of work in accordance with the following:

Warranties and guarantees offered by electrical and mechanical equipment manufacturers shall be turned over to the maintaining authority at the time of acceptance of the project. The maintaining authority shall be named as the obligee on all manufacturer warranties and guarantees.

The Contractor shall warrant and guarantee satisfactory in-service operations of electrical and mechanical equipment, and related components, and shall replace or correct parts found to be defective within a two (2) year period. Compensation will not be made for replacements or corrections. The warranty and guarantee requirements shall not apply to parts of electrical and mechanical equipment which have been subjected to misuse, negligence, or accident by other parties.

- B. **Junction Boxes:**

1. Eighteen (18) inches of Type 2 Select Granular Backfill material shall be placed below the bottom of the junction box as foundation.
2. The top of the junction box shall be flush with hard-surfaced areas and approximately one inch above earth or grass areas.

3. Junction box cover labels “ELICTRIC(AL)” or “SIGNAL” shall be as specified in plans.

C. Conduit: Use and installation shall conform to NEC and the following requirements:

1. The size of the conduits installed shall not be less than the electrical trade size specified.
2. The location and direction of conduit runs is diagrammatic and may be shifted to meet field conditions.
3. Underground conduit shall be placed by trenching, jacking, or drilling methods. The use of the trenching method for placement under existing roadway pavements will be permitted only after jacking or drilling attempts have failed. The Contractor shall not use equipment requiring flowing water for installation of conduit under streets or roadways unless approved by the Engineer.

When the trenching installation method is used, electrical underground warnings tape shall be included in the construction and is incidental to the install.

Trenches shall be backfilled and compacted to the same density as the adjoining ground. Roadway surfaces, sidewalks, curb and gutters, sod, etc., which are removed by trenching operations shall be replaced. The cost of removing and replacing these materials shall be incidental to the bid price for the conduit.

4. Where trenching operations require the removal of concrete pavement or sidewalk, the concrete shall be sawed full depth along the removal lines or the concrete shall be removed to existing joints.
5. Conduit entering through junction or pull box walls shall terminate approximately 2 inches in from the inside wall and not less than 2 inches above the bottom. The diameter of the holes in the junction or pull box walls shall be no more than 1/4 inch larger than the diameter of the conduit. The area around the conduit shall be sealed with a waterproof silicone sealant.
6. Conduit entering the traffic signal cabinet shall be sealed with paraffin or other approved sealing compounds to prevent the entrance of gases. The height of the conduit shall not exceed 2 inches above the cabinet base.
7. Metal conduit open ends in junction boxes or above concrete foundations shall be provided with an approved threaded conduit grounding bushing.

Nonmetallic conduit open ends shall have an approved bell end or bushing installed to prevent damage to cable or conductors.

8. Metal conduit ends shall be reamed to remove sharp edges and burrs. Threads on threaded conduit shall be painted with a good quality lead or rust preventive paint

as the couplings are made up. Couplings shall be tightened until the ends of the conduit are brought together.

- D. Concrete Footings:** The bottom of concrete footings shall rest on firm ground. The sides of the footings shall be formed by using an auger and then placing the concrete against the natural soil. A suitable form shall be used above existing ground line and all exposed portions shall be formed to present a neat appearance. The above ground portion of the footing shall be formed of sufficient size and shape so no part of the pole base, including transformer type bases, shall overhang or protrude beyond the footing. An acceptable form shall be used if the excavation is larger than the standard footing dimensions. Backfill must be replaced to a density equal to or greater than the adjacent undisturbed natural soil. The top of the concrete footing shall be above grade with a maximum height that meets clear zone requirements. The top of the concrete footing shall be finished smooth and shall be level after anchor bolt/rod installation.

A 1/2 inch conduit for grounding wire raceway shall be installed through the footing. Ground rods shall be a minimum of 2 feet from the footing.

- E. Anchor Bolts/Rods:** Shall be installed in accordance with the following requirements:
1. **General:** Shall be provided with all hardware required for attaching and leveling in accordance with the manufacturer's recommendations.
 2. **Anchor Bolt/Rod Installation:** A steel template shall be used to accurately locate and hold the anchor bolts/rods plumb and in proper alignment. This template shall be in place during placement of the concrete base and shall remain in place a minimum of 24 hours after the concrete placement has been completed. Out of position anchor bolts/rods and anchor bolts/rods greater than 1:40 out-of-plumb are cause for rejection of the base. Bending, cutting, or welding of the anchor bolts/rods to straighten or move into position, or alterations of the pole base plate will not be permitted.
 3. **Anchor Bolt/Rod Tightening:** Breakaway transformer bases shall be tightened in accordance with the manufacturer's recommendations. All others shall be tightened in accordance with the following:
 - a) All leveling nuts (bottom nuts) shall be brought to full bearing on the bottom of the base plate. The bottom of the leveling nuts must be kept as close to the concrete base as practical, and shall not be more than one anchor bolt/rod diameter above the top of the concrete base. Leveling nuts must be threaded onto the anchor bolt to provide at least 1/4 inch projection of the anchor bolt/rod above the top nut or jam nut if required when in its tightened position.
 - b) A softened beeswax or equivalent shall be applied to the top nut bearing face and top nut internal threads prior to placement on the anchor bolt/rod. All top nuts shall be tightened to a snug tight condition. Snug tight is defined as the tightness attained by the full effort of a person using a wrench with a length

equal to 14 times the diameter of the anchor bolt/rod, except the minimum length shall be 18 inches. The use of adjustable wrenches will not be allowed. The full effort required to achieve a snug tight condition shall be applied as close to the end of the wrench as possible. Pull firmly by leaning back and using full body weight (brace feet to prevent slipping) on the end of the wrench until the nut stops rotating. This snug tightening shall be accomplished in a minimum of two separate passes of tightening. The sequence of tightening in each pass shall be such that the opposite side nut, to the extent possible, shall be subsequently tightened until all the nuts in that pass have been snugged.

Snug tightness of both the top and leveling nuts shall be checked in the presence of City personnel after the Contractor has completed nut snugging as described above, but prior to final tightening. Snug tightness of the nuts (top and leveling) shall be checked by applying a torque in a range from 20% to 30% of the verification torque. See Table 1 for verification and snug tight torque values.

(Remainder of page intentionally left blank for table on next page)

Table 1
Anchor Bolt/Rod Tightening

Anchor Bolt/Rod Diameter (in)	Anchor Bolt/Rod Stress Area (sq in)	Yield Strength (ksi)	Minimum Tensile Strength (ksi)	Verification Torque (ft-lbs)	30% Snug Tight Torque (ft-lbs)	20% Snug Tight Torque (ft-lbs)
1.00	0.61	36.0	58.0	177	53	35
1.25	0.97	36.0	58.0	351	105	70
1.50	1.41	36.0	58.0	613	184	123
1.75	1.90	36.0	58.0	964	289	193
2.00	2.50	36.0	58.0	1449	435	290
2.25	3.25	36.0	58.0	2120	636	424
2.50	4.00	36.0	58.0	2899	870	580
2.75	4.93	36.0	58.0	3930	1179	786
3.00	5.97	36.0	58.0	5192	1558	1038
1.00	0.61	55.0	75.0	274	82	55
1.25	0.97	55.0	75.0	545	163	109
1.50	1.41	55.0	75.0	951	285	190
1.75	1.90	55.0	75.0	1496	449	299
2.00	2.50	55.0	75.0	2249	675	450
2.25	3.25	55.0	75.0	3289	987	658
2.50	4.00	55.0	75.0	4498	1349	900
2.75	4.93	55.0	75.0	6098	1830	1220
3.00	5.97	55.0	75.0	8056	2417	1611
1.00	0.61	75.0	100.0	366	110	73
1.25	0.97	75.0	100.0	726	218	145
1.50	1.41	75.0	100.0	1268	381	254
1.75	1.90	75.0	100.0	1994	598	399
2.00	2.50	75.0	100.0	2999	900	600
2.25	3.25	75.0	100.0	4386	1316	877
2.50	4.00	75.0	100.0	5998	1799	1200
2.75	4.93	75.0	100.0	8131	2439	1626
3.00	5.97	75.0	100.0	10742	3223	2148
1.00	0.61	105.0	125.0	457	137	91
1.25	0.97	105.0	125.0	908	272	182
1.50	1.41	105.0	125.0	1586	476	317
1.75	1.90	105.0	125.0	2493	748	499
2.00	2.50	105.0	125.0	3749	1125	750
2.25	3.25	105.0	125.0	5482	1645	1096
2.50	4.00	105.0	125.0	7497	2249	1499
2.75	4.93	105.0	125.0	10164	3049	2033
3.00	5.97	105.0	125.0	13427	4028	2685

- c) At this point, the top nut and leveling nut must be in full bearing on the base plate. If any gap exists between either nut (top or leveling) and the base plate, a beveled washer shall be added between the nut washer and the base plate to eliminate the gap. The beveled washer shall be stainless steel Type 304 or Type 316, the same diameter as the hardened washer, and beveled as required to eliminate the gap between the nut and the base plate. All nuts shall be retightened according to steps (a) and (b) above if beveled washers are added. All costs required to remove and re-erect the structure to install beveled stainless steel washers shall be at the Contractor's expense.
- d) Using a hydraulic wrench, rotate all top nuts as indicated in Table 2. The additional turn of the nuts shall be accomplished by tightening all the nuts in two separate passes of equal incremental turns (i.e., for 1/3 turn use 1/6 turn each pass). The sequence of nut tightening in each pass shall be such that the opposite side nut, to the extent possible, shall be subsequently tightened until all the nuts in that pass have been turned. There shall be no rotation of the leveling nut during top nut tightening.

In lieu of a hydraulic wrench, torque wrenches and multipliers may be used to achieve the desired nut rotations and tightness.

- e) Tightness of the nuts shall be checked in the presence of City personnel. Tightness of the nuts shall be checked within a minimum of 48 hours and a maximum of 96 hours after the nuts have been rotated as indicated in this section. Tightness of the top nuts shall be checked by applying the verification torque to the nut. See Table 1 for verification torque.

Table 2
Nut Rotation for Turn-Of-Nut Pretensioning

Anchor Bolt/Rod Diameter (inches)	Nut Rotation from Snug-Tight Condition * ^{1,2}	
	F1554 Grade 36	F1554 Grade 55 and 105
< 1½	1/6 Turn	1/3 Turn
≥ 1½	1/12 Turn	1/6 Turn

¹ Nut rotation is relative to anchor bolt/rod. The tolerance is plus 20 degrees.

² Applicable only to double-nut-movement joints.

Bottom leveling nuts shall be in contact with the base prior to applying the torque. An inability to achieve the verification torque indicates that the threads have stripped and the anchor bolt must be replaced. All costs for replacing anchor bolts/rods shall be at the Contractor's expense.

- f) Install jam nut after verification torque has been applied to top nut. Lubricate threads of jam nut with beeswax or equivalent and tighten to a torque of 100 foot pound (approximated without the use of a torque wrench).

- F. Electrical Power Cables:** Shall be installed using methods that will not damage or deform the jacket, insulation, or conductors. All cables within a single conduit shall be installed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer's recommendations and the use shall not damage or deform the cable.

Street light cables within each circuit shall have individually colored conductor wires.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

The Contractor may provide cables with conductor AWG size larger than specified where conduit fill requirements are not exceeded, subject to approval by the Engineer. When larger cables are substituted, the cables must extend from terminal to terminal for circuits used. Splicing to a conductor of a different size is not permitted. Splice connectors shall be per the materials section of this specification.

For Pole and Bracket Cable, a strain relief shall be utilized to support the weight of the cable on the "J" Hook or other strain relief device in the pole.

- G. Traffic Signal Control Cables:** Traffic signal conductors shall be continuous from the controller cabinets to the pole bases. Splicing of conductors will not be allowed in the junction boxes. Contractor shall leave no more than five (5) feet of excess cable in the cabinet, and no less than 10-feet in the junction box adjacent to the signal pole, and no less than six (6) feet in all other junction boxes.

Traffic signal control cables shall be identified in hand holes, junction boxes, pedestal bases, electrical service cabinets, and controller cabinets as indicated on the wiring diagram. Cable terminations in pole bases shall use 3M™ Scotchlok™314 wire connectors. Labels shall be wrapped around the traffic signal cable to indicate the signal pole and signal head the cable is connected to. Wires from signal heads shall be labeled with cloth type labels. Traffic signal control cables from the controller to the poles shall be marked with a legend and shall be color coded as follows: northwest (blue), northeast (red), southeast (green), and southwest (orange). All wires entering the controller cabinet shall be color coded to each corner and bundled neatly.

Cables shall be installed using methods that will not damage or deform the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer's recommendations and the use shall not damage or deform the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

- H. Electrical Service Cabinet:** Shall be installed in accordance with the plans and the manufacturer's recommendations. The City shall provide the lock. Breakers within the electrical service cabinet shall be sized according to the plans.
- I. Traffic Signal Poles:** The following shall apply to traffic signal poles:
1. Poles shall be plumb after the bracket arms, signal heads, fittings, and fixtures have been installed and connections have been made. Nuts shall be firmly tightened as per manufacturer's recommendations.
 2. Field repair of damaged galvanizing shall be done in accordance with ASTM A780.
 3. Mast arms shall be installed perpendicular to the roadway unless otherwise shown in plans, and vertical clearance shall be checked after all hardware and signing is installed.
- J. Roadway Luminaire Poles:** The following shall apply to roadway luminaire poles:
1. Poles shall be plumb when the installation is complete. Nuts shall be firmly tightened as per manufacturer's recommendations.
 2. The luminaire arm shall be set perpendicular to the project centerline, unless otherwise shown in plans.
 3. Field repair of damaged galvanizing shall be done in accordance with ASTM A780.
- K. Luminaires:** Shall be adjusted on the support so the luminaire sits level as indicated by a small bubble level. Bolts shall be firmly tightened.
- L. Photoelectric Control Units:** The photoelectric cell shall normally be positioned so the light sensor is to the north. If light sources other than sunlight interfere with normal operation of the control, the photoelectric cell shall be adjusted in an attempt to obtain proper operation
- M. Controller Cabinet:**
1. The controller cabinet shall be installed according to the directions supplied by the manufacturer.
 2. Wiring and connections in the controller cabinet shall be neat, firm, and in accordance with industry standards.
 3. Three sets of wiring diagrams and three maintenance and operation manuals shall be supplied for each controller that is required. The Contractor shall place one set in a weather resistant container in the controller cabinet, give one set to the maintaining authority, and give one set to the Engineer.
 4. A weather resistant diagram showing phase movements, detector locations, and

labels shall be affixed to the inside of the signal cabinet door. If color coding is used to identify control cables, a legend key shall be included with the above schematic.

5. Controller cabinets equipped with a thermostat shall be set to 110°F.
6. The controller cabinets shall be footing mounted. The cabinet footing shall be oriented so that the door opening faces east or south. The cabinet shall be no less than 24-inches and no more than 26-inches above finished grade. A concrete pad shall be provided in front of the cabinet doors for a minimum 36-inches depth, the full cabinet width. Cabinet doors shall be allowed to fully open without obstruction.

N. Detector Loops:

1. **Clearance between Loops and Metallic Objects:** The Contractor shall provide sufficient clearance between detector loops and metallic objects such as manhole covers, drop inlets, etc., to avoid interference with the operation of the loop.
2. **Sawed-in Loops:**
 - a) Lead-in saw cuts shall clear each other by 1 foot.
 - b) Backer rod material shall be cut into 1 inch by 2 inch lengths and spaced not farther apart than 2 feet.
 - c) Saw slots in the pavement shall be blown out with compressed air and shall be clean and free of loose grit and moisture when wires are placed and sealer is applied.
 - d) The loop wires shall be pushed into the sawed slots with a blunt wood stick (not with a screwdriver). The wires shall be laid in the slots so there are no kinks or curls and without straining or stretching the insulation.
 - e) The flexible embedding sealer shall completely surround the 1/4 inch tube, displace all the air within the sawed slot, and fill the area of the sawed slot except for that area which is taken up by the backer rod and the wires.
 - f) Loop wires or lead-ins shall be given extra protection at pavement joint locations. The extra protection shall consist of a 12-inch long piece of 3/4-inch flexible tubing that fits snugly around the wires. Allow slack in the wires to install the tubing. A longitudinal cut may be made along the bottom of the tubing for ease of placement over the wires.
 - g) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box. Splices shall not be allowed.
3. **Preformed Loops:** Each set of loop wires shall be tagged to identify loop as

specified on plans. If installation of the loop is for future use, the loop wires in the same lane shall be taped together with the ends sealed from moisture. If installation is on a signal project, tagging shall be done and wires connected in series.

In new roadways, the preformed loops and lead-in conduits shall be placed in the base course or gravel cushion, with the top of the conduit flush with the top of the base, and then covered with hot mix asphalt or Portland cement concrete pavement. Preformed loops and lead-in conduits shall be protected from damage prior to and during pavement placement.

In new reinforced concrete structure decks, the preformed loops shall be secured to the top of the uppermost layer of reinforcing steel using nylon wire ties. The loop shall be held parallel to the structure deck by using PVC or polypropylene spacers where necessary. Conduit for lead-in conductors shall be placed below the upper mat of reinforcing steel.

In existing pavement, the preformed loops shall be placed in a saw slot, 1¼ inches minimum width, cut into the existing pavement. The top of the conduit shall be 2 inches, minimum, below the top of existing surface. Sawed slots shall be filled with an approved loop sealant.

On asphalt or concrete resurfacing projects, the preformed loops shall be placed in a saw slot, 1¼ inches minimum width, cut into the existing pavement. The top of the conduit shall be 2 inches, minimum, below the top of existing surface after any required surface removal is completed and prior to the placing of the new surface. Sawed slots shall be filled with loop sealant as specified in the materials section of this specification.

4. **Lead-ins:** Loop lead-ins shall be twisted at least three (3) turns per foot. Splices shall not be made in the loop or lead-in conductors except in the junction box. All wire connections shall be sealed and insulated with 3M™ Scotchcast™ 3570G Connector Sealing Pack, or equal.
5. **Connections in the Controller:** Terminal board screws shall be turned down tightly on the lug. The shield wire shall be cut off and taped.
6. **Loop Testing:** After installation, each loop shall be tested by the Contractor. Necessary equipment shall be furnished by the Contractor and test results recorded and furnished to the Engineer. Each detector loop shall conform to the following:

DC Continuity:	5 ohms maximum
600V (min.) Resistance, loop to ground:	10 megohms minimum
Inductance:	100-500 microhenries

7. Unless otherwise noted on the plans, the standard loop size is to be 6-feet by 6-feet.

O. Signal Heads:

1. Signal heads are to be rigidly attached to signal poles and shall appear vertical from the street approach they control. A jam nut shall be used to tighten the fitting to the pole hub.
2. Signals mounted on side of pole or top of pedestal pole shall use industry standard locking brackets made from 1 ½ inch aluminum pipe and appropriate locking fittings. Attachment to signal heads shall be with tri-stud type hardware. Exposed pipe and hardware shall not be painted.
3. Signals heads which are mounted in place, but are not in operation shall be hooded or positioned so the lenses are not visible to any approach.
4. Signals shall be aimed and trees shall be trimmed such that all the signals for each approach shall be continuously visible for the minimum distance listed in the MUTCD.
5. Signals mounted on mast arms shall utilize a universally adjustable mast arm Astrobrac® mounting assembly, or approved equal. It shall be unpainted aluminum or galvanized finish. Banding? vs cable comment?
6. Fasteners containing dissimilar metals shall have anti-seize compound applied the threads.

P. Pedestrian Push Button: Placement and mounting height shall be per plans and in conformance with the MUTCD. Fasteners containing dissimilar metals shall have anti-seize compound applied the threads. Speech messages for buttons within 10-feet of each other shall be provided to the Engineer for review and approval prior to installation. A digital file of the speech message shall be provided to the City prior to acceptance.

Q. Flashing Beacons: Shall be mounted in conformance with the MUTCD, and installed in accordance with the directions supplied by the manufacturer.

93.4 METHOD OF MEASUREMENT

- A. Electrical Grounding and Bonding:** No field measurement will be made.
- B. Conduit:** The plan shown quantity, of each type and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- C. Junction Boxes:** Measurement will be by actual count of the various types and sizes of junction boxes furnished and installed.
- D. Concrete Footings:** Concrete footings of the various diameters will be measured to the nearest 0.1 foot.

- E. Anchor Bolts/Rods:** No field measurement will be made.
- F. Electrical Power Cable:** The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- G. Traffic Signal Control Cable:** The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- H. Electrical Service Cabinets:** Measurement will be by actual count of cabinets furnished and installed.
- I. Traffic Signal Poles:** Measurement will be by actual count of the various types and sizes furnished and installed.
- J. Roadway Luminaire Poles:** Measurement will be by actual count of the various types and sizes furnished and installed.
- K. Luminaires:** Measurement will be by actual count of the various types and sizes of luminaires furnished and installed.
- L. Photoelectric Control Units:** No field measurement will be made.
- M. Controller Cabinet:** No field measurement will be made.
- N. Traffic Signal Controller:** Measurement will be by actual count of controllers furnished and installed.
- O. Detector Units:** Will not be measured.
- P. Detector Loops:** Measurement will be actual count of the various types of detector loops installed.
- Q. Signal Heads:** Measurement will be by actual count of the various types and sizes of signal heads furnished and installed.
- R. Pedestrian Push Button:** Measurement will be by the actual count of pedestrian push buttons furnished and installed.
- S. Flashing Beacons:** Measurement will be by the actual count of the various types of flashing beacons furnished and installed.
- T. Emergency Vehicle Preemption System:** Will be measured by actual count of Emergency Vehicle Preemption Systems furnished and installed.

93.5 BASIS OF PAYMENT

- A. Electrical Grounding and Bonding:** The cost of furnishing and installing conduits for grounding will be incidental to the cost of footing, electrical service cabinet, or controller cabinet to be grounded.
- B. Conduit:** Conduit of each type and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- C. Junction Boxes:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- D. Concrete Footings:** Payment for concrete footings of the various diameters will be at their respective contract unit prices per foot. Payment will be full compensation for materials and labor necessary to satisfactorily install the footings.
- E. Anchor Bolts/Rods:** Cost for anchor bolts/rods shall be included in the contract unit price for the concrete for which they are incorporated with.
- F. Electrical Power Cable:** Electrical power cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- G. Traffic Signal Control Cable:** Traffic signal control cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- H. Electrical Service Cabinet:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing electrical service cabinets, including circuit breakers, fuses, contactor, photoelectric control, manual on/off switch, mounting pole, pad, and other materials and fixtures required. Payment shall also include any fees associated with hookup.
- I. Traffic Signal Poles:** Payment for traffic signal poles of the various types will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- J. Roadway Luminaire Poles:** Payment for roadway luminaire poles will be at the contract unit price per each. Payment will be full compensation for furnishing and installing roadway luminaire poles.
- K. Luminaires:** Payment for luminaires of the various types and sizes will be at their respective contract unit prices per each. Payment will be full compensation for furnishing and installing luminaires.
- L. Photoelectric Control Units:** Cost of photoelectric controls shall be included in the

contract unit price for other related contract items.

- M. Controller Cabinet:** The cost of controller cabinets is to be included in the contract unit price for traffic signal controllers.
- N. Traffic Signal Controller:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing the controller cabinet and all required items included in the cabinet.
- O. Detector Unit:** The cost of detector units shall be included in the contract unit price for traffic signal controllers.
- P. Detector Loop:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing detector loops.
- Q. Signal Heads:** Payment for this item for the various types and sizes will be at the contract unit price per each. Payment will be full compensation for furnishing and installing signal heads, including mounting hardware, required bracketing, and backplates.
- R. Pedestrian Push Buttons:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing the pedestrian push buttons.
- S. Flashing Beacons:** Payment for this item will be at the contract unit price per each for the various types of flashing beacons. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- T. Emergency Vehicle Preemption System:** The Contractor will be paid the contract unit price bid for Emergency Vehicle Preemption System. This payment shall be full compensation for the detectors, phase selector, confirmation light, electrical cable for the detectors and confirmation light.

END OF SECTION