

## TECHNICAL SPECIFICATIONS

### DIVISION 2900 TRAFFIC SIGNALS

**2901 GENERAL:** This work shall include the furnishing of all labor, materials and equipment for the installation of a complete operational traffic signal installation in accordance with the plans and these Specifications. A complete list of pre-approved traffic signal materials is available at the office of the Traffic Engineer or can be found on the City of Shawnee's Internet website at [www.cityofshawnee.org](http://www.cityofshawnee.org)

**.1 Codes and Standards:** In addition to the requirements of these Specifications, the Plans and the Special Provisions, all material and work shall conform to the latest requirements of the National Electrical Code (ANSI C1), the National Electrical Safety Code (ANSI C2), and the standards of the American Society for Testing Materials (ASTM) the American Standards Associations (ASA), and the Manual on Uniform Traffic Control Devices (MUTCD), and local ordinances. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA).

**.2 Revision of Standard Specifications:** When reference is made to a standard specification (NEMA, ASTM, ASA, MUTCD, ANSI, IES, IPCEA, UL, AASHTO, FSS, etc.), the standard specification referred to shall be construed to mean the latest revision of said standard specification, as amended, that is in effect on the date the Plans are approved, except as otherwise shown on the Plans or specified in the Special Provisions.

**.3 Other Applicable Specifications:** Work incidental to the installation of a traffic signal system shall be preformed in accordance with the following Technical Specifications:

Division 2100	Grading and Site Preparation
Division 2200	Erosion and Sediment Control
Division 2300	Paving
Division 2500	Incidental Construction
Division 2700	Site Restoration
Division 2800	Street Lighting
Division 2950	Traffic Signal Interconnect

**.4 Modification of Specifications:** These Specifications may be modified or deleted by notes on the Plans, by appropriate items in the Special Provisions, or by written authorization of the City Project Engineer.

- .5 Plans:** These Specifications and the Standard Drawings shall be considered a part of the approved Plans.
- A. Conflicts: Whenever any part of the Plans shall conflict with any other part of the Plans, or whenever any part of these Specifications shall conflict with any other part of these Specifications, or whenever any of the items proposed to be constructed shall seem impracticable, or impossible to construct, then the matter shall be immediately reported to the City Project Engineer. The Engineer's decision in the matter shall be final, and the Contractor shall follow the Engineer's directions to avoid any such conflict in the Plans or Specifications.
  - B. Incidental Parts: All incidental parts, which are not shown on the Plans or specified herein and which are necessary to complete the traffic signal system, shall be supplied and installed as though such parts were shown on the Plans or specified herein. All systems shall be complete and in operation to the satisfaction of the Project Engineer at the time of acceptance of the work.
  - C. Appurtenances: All appurtenances shall be installed as shown on the Plans and the Standard Drawings, or as specified in the Special Provisions. Any deviations must be established and authorized by the Engineer in the field.
  - D. Plans Available: The Contractor shall always have a copy of the approved Plans at the work site accessible to the Engineer.
  - E. As-Built Plans: Prior to the acceptance of the work, the Contractor shall submit an "As-Built" or corrected plan showing in detail all construction changes, especially the location and depth of the conduit.
- .6 Shop Drawings:** Before commencing the installation of any material or equipment, the Contractor shall submit two (2) copies of complete shop drawings for manufactured materials and equipment to the Engineer for approval. Manufacturers' bulletins, leaflets and other descriptive data that contain cuts, dimensions, specifications and wiring diagrams will be acceptable for standard cataloged equipment. Such bulletins, leaflets and other descriptive data shall be clearly marked to show the item to be used to satisfy a required item in the schedule of materials shown on the Plans, or as specified in the Special Provisions. The Engineer may require other descriptive data, drawings, and diagrams for non-cataloged equipment or materials. In the event any items of material or equipment contained on the shop drawings fail to comply with the specification requirements, such items may be rejected by the Engineer. Orders for material and equipment shall not be placed until written approval is obtained from the Engineer.

- .7 Electrical Permits and Inspections:** The Contractor is responsible for obtaining an electrical building permit from the City's Codes Administration Division before any excavation for the control center foundation or the service feed takes place. The Contractor shall contact the City's Codes Administration Division for an electrical inspection when the control center is ready.

The Contractor is responsible for obtaining such permits and approvals as may be required by the appropriate electrical utility company and is responsible for all costs associated with extending electrical power from the service point to the control center whatever the distance. The Contractor shall notify the appropriate electrical utility company ahead of when the system needs to be energized.

The City Project Engineer will assign an address for the control center, which the Contractor shall use when obtaining permits and when dealing with the electrical utility company.

- .8 System Testing:** The Contractor is responsible for testing the completed traffic signal system and for contacting the Engineer to request City inspections.
- .9 Maintenance Work:** The Contractor is responsible for making all repairs and replacements regardless of the cause or responsible party, until the entire system is completed, inspected and accepted by the City.

**2902 MATERIALS AND EQUIPMENT:** Unless otherwise noted in the plans, all equipment, materials and incidental parts shall be new and of similar manufacturer. The cost of incidental materials not mentioned in the Plans shall be included in the traffic signal installation lump sum bid price.

- .1 Concrete:** All concrete supplied for the work shall be Class JCCB-4K. All reinforcing steel shall meet the requirements of steel bars for concrete reinforcement.
- .2 Signal Poles:** Traffic Signal Poles shall conform to these Specifications, the plans and the latest edition of AASHTO's Standard Specifications For Structural Supports For Signs, Luminaires and Traffic Signals. The pole and arm shall be a round, tapered monotube made only of one length of the best grade, structural steel sheet of not less than 7 Manufacturing Standard Gauge. Only one longitudinal weld and no transverse welds shall be permitted in the fabrication of the shaft or arm.

The steel anchor base of adequate strength, shape and size shall be secured to the lower end of the shaft by welding in such manner as to develop the full strength of the adjacent shaft section to resist bending action.

The steel poles shall be galvanized to ASTM A-123 standards. All accessories shall be galvanized to ASTM A-153 standards. The tapered steel shaft shall include high strength anchor bolts and nuts that meet the following requirements:

Tensile Strength, min. psi (min. kPa)	75,000 (517,125)
Yield Strength at 0.2% offset, min. psi (min. kPa)	55,000 (379,225)
Elongation in 8" (205 mm), min.	18%
or 2" (50 mm), min.	21%

The anchor bolts shall be hot dipped galvanized on the threaded end after threading. The galvanizing shall include all threads and not less than six inches (150 mm) of the adjacent unthreaded portion of the bolts. Anchor bolts shall be threaded to a length shown on the plans or in the Standard Details. Threads shall be Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling. Nuts for anchor bolts shall be Heavy Hex leveling nuts and Heavy Hex nuts as specified in ANSI B18.2.2. Nuts shall comply with the proof load or Brinell hardness requirements of ASTM A307. After galvanizing, the thread fit of the bolt-nut combination shall be snug and shall be such that the nuts can be turned on the bolts without the application of excessive torque.

The pole shaft shall also include a handhole and cover, cast pole top, a J-hook wire support, and a suitable bolt-on type device for attaching the mast arm to the shaft as shown on the Traffic Signal Detail sheets in the accompanying plans. The tapered steel arm shall include a removable end cap.

Where a combination lighting/signal pole is specified on the plans, the above applies with the luminaire arm to be mounted in the same vertical plane as the signal arm (except where otherwise noted on the plans). The vertical shaft of the combination lighting/signal pole shall be a one-piece design and shall contain an additional handhole located 4 inches (102 millimeters) above the mast arm on the opposite side of the pole from the mast arm.

When fully loaded with all equipment as shown on the plans, all mast arms shall be between horizontal (level) to one and one-half degrees (1-1/2 °) above horizontal. No perceptible bending of the arm shall be observed when fully loaded, as determined by a visual inspection by the Engineer. All traffic signal poles shall be detailed on shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate.

- .3 Aluminum Pedestals:** Shall consist of aluminum, die cast or sand cast square base and a 4-inch (100 mm) diameter shaft for mounting vertical signal heads or a standard controller cabinet. The pedestal shall be capable of withstanding wind loadings of 100 mph (160 kph).

The cast aluminum bases shall meet the requirements of ASTM B108 Alloy 356-T6, ASTM B-26, SG70A-T6, S5A.F, or ASTM B-108, SG70A-T6. The base and post shall be joined by welded connections. The aluminum shaft shall be spun from one piece of seamless tubing, meeting the requirements of ASTM Alloy 6063-T6 and having a minimum nominal 0.125-inch (3.2mm) wall thickness. The shaft shall have no longitudinal welds, nor circumferential welds. The shaft shall have a uniform polished finish. Each shaft shall be tire-wrapped with a heavy water-resistant paper for protection during shipment and installation.

- .4 Vehicle Signal Heads:** Each vehicle signal head shall be a weathertight assembly of one or more signal faces of the sizes shown on the plans. All brackets and fittings necessary for proper mounting with the type of signal support designated on the plans shall be furnished. Each signal face shall consist of one or more signal sections, rigidly and securely fastened together, capable of being positively positioned to control the movement of one direction of traffic. Each signal section shall be a self-contained assembly consisting of an optical unit with housing, housing door, and visor. All signal heads on a project shall be the product of one manufacturer and shall be a single model number for like items. For signal modification projects, new signal heads shall match existing signal heads with respect to manufacturer and model. Terminal blocks of suitable size shall be placed in the middle section of the signal head.

The housing for each signal section shall be made of a durable polycarbonate and shall be yellow in color. It shall be clean, smooth and free from cracks, and other imperfections. It shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections securely fastened together. It shall be equipped with round openings in the top and bottom so that it may be rotated between waterproof supporting brackets and thus be capable of being directed at any angle in the horizontal plane. It shall be equipped with positive locking devices to maintain a specific angle of direction when in place. The doors shall be black in color and consist of polycarbonate construction. They shall be suitably hinged and held securely to the body of the housing by simple stainless steel locking devices. All other door parts, such as hinge pins, lens clips, screws, etc., shall also be of stainless steel material. Neoprene gasketing shall be used between the lenses and reflectors to exclude dust and moisture.

The visors for each signal section shall be durable polycarbonate, black in color, not less than 0.05 inches (1.25 mm) in thickness and shall be tunnel-

type. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be at least 9.5 inches (240 mm) long for 12-inch (300 mm) diameter signals and shall angle slightly downward.

The optical unit and visor shall be designed as a whole so as to eliminate the return of outside rays entering the unit from above the horizontal.

Lenses shall meet the requirements of ANSI D-10.1-1966 optical specifications and shall be glass for incandescent style. Lettering shall not appear on lenses. Nominal 12-inch (300 mm) diameter signal lenses shall be furnished, unless otherwise shown on the accompanying plans.

All traffic signal indications for new signal installations as well as signal modification projects shall be LED displays. LED indications shall be 12-inch (300 mm) diameter, 120-volt LED's in a self-contained enclosure with a 10-year life expectancy. LED indications shall comply with the latest edition of ITE's Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules.

- .5 Pedestrian Signal Heads:** The construction materials and colors for pedestrian signal heads shall conform to those listed in the previous section with the following additions outlined below.

The WALK symbol shall be LED-style and lunar white in color. Pedestrian symbols shall be a minimum of 9 inches (230 mm) high for 12-inch (300 mm) lenses. The DON'T WALK hand symbol shall be LED-style and orange in color. LED indications shall comply with the latest edition of ITE's Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules. The legends shall conform to the ITE Specification Pedestrian Traffic Control Signal Indications. All lenses shall be 12 inches (300 mm) unless indicated otherwise in the accompanying plans.

The pedestrian signal door and visor shall be black in color. All 12-inch (300 mm) pedestrian signals shall have 9-inch to 9.75-inch (230 mm to 250 mm) tunnel visors. All visors shall be a minimum of 0.06 inches (1.5 mm) thick.

The DON'T WALK and WALK indications shall be 120-volt LEDs in self-contained enclosures and shall have a 10-year life expectancy.

- .6 Signal Head Mounting:** Vertical bracket mounted signal heads, as shown on the plans, shall be supported by a one-piece mounting bracket watertight assembly made entirely of a durable polycarbonate and be yellow in color. Each bracket shall be either plumb or level, symmetrically arranged and securely assembled. Each bracket shall have serrations for positioning traffic

signals in increments of 5 ° . Construction shall be such that conductors are concealed within the assembly. Brackets shall be attached to the pole or pedestal by approved stainless steel banding and brackets.

Mast arm signal head assemblies shall be rigid mounted utilizing a universally adjustable bracket consisting of both top and bottom brackets with a center vertical extruded aluminum support tube attached to the mast arm by means of a clamp kit with steel cable. The vertical support tube shall allow wire entry at any point and be equipped with a vinyl insert that conceals the wiring. The lower bracket arm shall be hollow for wiring entry into the signal head.

**.7 Signal Backplates:** Where shown on the plans, 5-inch (125 mm), one-piece backplates shall be furnished and attached to the signal section to provide a dark background for signal indications. Backplates shall be attached to the signals as per the manufacturer's recommended practice.

**.8 Pedestrian Push Buttons:** Pedestrian push buttons shall be direct push contact type. Each push button shall be a removable contact assembly mounted in a durable natural aluminum finished case, yellow in color. Contacts shall be normally open, entirely insulated from the case and operating button, and have connecting terminals. The operating button shall be brass or other corrosion resistant metal alloy and shall be sturdy. The operating voltage shall not exceed 18 volts. The entire assembly shall be weatherproof, secure against electrical shock to the user, and of such construction as to withstand hard usage. The pedestrian push button shall be mounted directly to the pole in a watertight assembly with no external pipe or mounting hardware and shall be the large button type meeting ADA requirements.

**.9 Electrical Cable:**

A. Multi-conductor signal cables: shall conform to Specification 19-1 of the latest edition of the International Municipal Signal Association, Inc. (IMSA) requirements, except all conductors supplied shall be stranded copper with a minimum size of No. 14 AWG. The number and size of conductors per cable shall be as shown on the plans.

B. Power lead-in cables: shall be of the sizes and number of conductors as shown on the plans. The power lead-in cable shall be for operation on a 600 volt maximum and suitable for use at conductor temperatures not exceeding 75 ° C. Material, construction, and tests shall be in accordance with the applicable requirements of the IPCEA Standard S-66-524 "Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".

Conductors for power lead-in cable shall be stranded, annealed coated copper. Copper wire, before insulating or stranding, shall meet the requirements of the latest edition of ASTM B-33 (for coated wire). Stranding shall be Class B, in accordance with the latest edition of ASTM B-8.

Insulation for power lead-in cable shall consist of cross-linked thermosetting polyethylene, meeting the requirements of column B of IPCEA and listed by UL as Type USE RHW-75 ° C.

- C. Detector Lead-In Cables: shall be 2 conductor #14 stranded and shielded cable. The conductor and drain wires shall be tinned copper wires with conductors shielded by a layer of aluminized polyester. All wires shall be insulated with cross-linked polypropylene or polyethylene and provided with a vinyl jacket.
- D. Detector Loop Wires: shall be No. 14 AWG, stranded copper, conforming to IMSA Specification 51-5 (Single conductor PVC/Nylon with tube jacket). Sealant for loop detectors shall be prepared and installed in accordance with the manufacturer's instructions. The Contractor shall submit the manufacturer's instructions to the Engineer for review and approval. Regardless of the manufacturer's instructions, the sealant shall be squeegeed into the saw cuts. All curb cuts shall be sealed with duct seal.

- .10 Service Enclosure:** The service enclosure shall be a combination meter socket breaker box, raintight enclosure equipped with a 100-amp main breaker and a 50-amp traffic signal breaker to be operated at 120 volts AC. The unit shall be capable of receiving 120/240 volt AC electrical line service. The unit shall be equipped with separate lockable compartments for the meter socket and the breaker box. Corbin locks shall be installed for parts of the enclosure that are accessed by the City. The unit shall be UL listed and the enclosure shall be natural aluminum.

In addition to the requirements above, the service enclosure shall be equipped with a 240-volt, 30-amp street light circuit breaker, photocell and mercury contactor, test switch and appropriate terminal blocks for street light circuit connection when street lights are powered through the signal controller. The enclosure shall be specified on the Plans.

- .11 Service Boxes:** All service boxes shall be fiberglass reinforced polymer concrete boxes of the size and shape as shown on the Standard Detail sheet in the accompanying plans. Service box material shall be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material must have the following mechanical properties:



Compressive Strength - 20,000 psi (137,895 kPa)  
Tensile Strength - 1,700 psi (11,722 kPa)  
Flexural Strength - 7,500 psi (51,713 kPa)

Service boxes with adjustable top ring may be permitted if approved by the Engineer. Junction boxes shall be either Type I or Type II as shown on the plans and shall be fiberglass reinforced polymer concrete of a size and shape as indicated on the Standard Detail sheet in the accompanying plans. Junction box material to be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material must have the following mechanical properties:

Compressive Strength - 20,000 psi (137,895 kPa)  
Tensile Strength - 1,700 psi (11,722 kPa)  
Flexural Strength - 7,500 psi (51,713 kPa)

**.12 Signal Controller and Cabinet:** The actuated controller and cabinet shall be a 170E Type Traffic Signal Controller System meeting the State of California "Traffic Signal Control Equipment Specifications" dated January, 1989, as modified by the November, 1992 Revision as modified by the December 1992 Addendum, to the 1989 Specifications with the following additions or modifications.

A. Controller: shall be a Type 170E furnished in Configuration Number 1 and furnished with a 412C Program Module. The 170E operating software shall be as indicated in these Specifications. In addition to the operating software, each Model 170E shall be furnished with Diagnostic and Acceptance Test (DAT) Programs per the State of California Specification.

B. Cabinet: shall be a Model 332 or 336 as called for in the accompanying plans, equipped with the appropriate number of the following equipment to allow for the traffic signal operation as shown in the accompanying plans:

1. Model 200 switch pack
2. Model 204 flasher
3. Model 420 flash transfer relay
4. Model 242 two-channel isolator
5. Loop Detectors
6. Model 210P conflict monitor
7. Hubble Generator Outlet (HBL360P4W)

The cabinet shall be equipped with a combined power supply and power distribution assembly (PDA #2). The output file back panel shall be handwire instead of printed circuit board. The flasher program plug shall be accessible without dropping the output file back panel.

The generator outlet shall be installed on the side of the cabinet 12 inches from the bottom of the controller. The side of cabinet shall not be the side adjacent to the roadway.

A red monitor board assembly shall be attached to the rear panel of the output file. A 20-conductor cable assembly for monitoring the red outputs of all signal load switches shall be provided and attached to the red monitor board assembly. The cable is to be routed to the front of the output file and plugged into the connector provided in the front of the conflict monitor.

A means of selecting the active red monitor channel shall be provided on the red monitor board assembly. Selection is accomplished by a two-position jumper (shunt) with the center position wired to a red monitor input and a select of 115 VAC to the right and the red load switch output to the left. Moving the jumper to the right will provide a continuous red input and override, while moving the jumper to the left will attach the monitor channel to the corresponding load switch output. The jumper assembly shall be accessible while the intersection is in operation. Twelve selectors (12) shall be provided; eight phase selections and four overlap selections.

A pull-out, hinged-top drawer having sliding tracks with lockout and quick-disconnect features, shall be provided as shown in the cabinet drawings. The pull-out drawer shall extend a minimum of 14 inches (355 mm) in order to facilitate removal of the processor by providing the processor with an aluminum platform covered by a Formica-type, chemical-proof plastic sheet while the rear connector is being removed. It shall be possible to lift this hinged platform in order to gain access to the interior of the drawer. Minimum interior dimensions of the drawer shall be 1 inch (25 mm) high, 13 inches (330 mm) deep, and 16 inches (405mm) wide. The drawer shall be capable of supporting a 40-pound (18 kg) controller when fully extended.

The Actuated Controller Operating Software shall be the latest version of WAPITI, as specified on the City's pre-approved list of materials, and shall already be programmed on the Program Module. Licensure of the program shall be included and made part of the controller unit in the name of the City of Shawnee, Kansas.

The cabinet and doors shall be fabricated from 0.125-inch (3.2mm) minimum thickness unpainted aluminum. The cabinet shall be supplied with CORBIN #2 locks. Two 15-watt fluorescent light fixtures and bulbs shall be provided one each near the top front and back of the cabinet. The light shall be activated by an automatic switch. The light fixture shall have a cold weather type ballast. The cabinet shall be provided with lightning protection on the power input.

- C. Conflict Monitor: In addition to the standard specifications, the conflict monitor shall be capable of monitoring the red signal outputs as described below:
- (1) Any dark signal head (that is loss of signal output to field terminals) shall cause the monitor to trip.
  - (2) The green, yellow and red indications for each phase shall be brought into the monitor individually and shall be monitored separately with respect to a loss of signal on any of the three (3) inputs per channel.
  - (3) The monitor shall have the required circuitry to allow the early detection of a conflict caused by a green or yellow signal "hang up" (that is any green or yellow output which shall remain on when the controller has transferred to a yellow or all red output respectively) by starting the fault timers as soon as a yellow appears with the corresponding green still energized. The monitor shall not wait until a conflicting green is displayed to time the conflict. This shall preclude the presentation of a conflicting signal display at the intersection.
  - (4) During the "All Red" clearance period, the monitor shall check all inputs for faulty signal display and shall react to these faulty indications during the all red clearance period. Since the only inputs that should be active during this period would be the reds, the monitor shall detect any faults such as red/green, red/yellow, green/yellow and green/red/yellow.
  - (5) The monitor shall be capable of monitoring for incorrect signal applied at the field terminals of each vehicular movement (green, yellow, red). Should a voltage be present on more than one, or none, of the inputs (green, yellow, red) of a channel, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for 1,000 milliseconds or more, the unit shall trigger. If this condition exists for 700 milliseconds or more, but less than 1,000 milliseconds, the unit may or may not trigger.
  - (6) When the unit triggers, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output.

(7) The minimum indicators shall be as follows:

- (a) Power - Shall be illuminated when the +24 VDC input from the controller is present and AC+ is applied to the monitor.
- (b) Watch Dog Error - Shall illuminate when the monitor detects a watch dog error, and shall be a 1.5 second watch dog circuit.
- (c) Conflict - Shall illuminate when a conflict has been detected by the monitor.
- (d) Red Failure - Shall illuminate when a red failure has been detected by the monitor.
- (e) Switch Fail - Shall illuminate when a faulty load switch has been detected by the monitor.
- (f) PCA - Shall illuminate when the program board is not installed or not installed properly.
- (g) PIAF - Shall illuminate when the unit has detected a failure, then experiences a power interruption.
- (h) The monitor shall include signal status indicators. These indicators (one per channel) shall illuminate when a signal is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status shall lock up, displaying the status of each channel at the time the conflict occurred. Should the monitor trip due to the absence of red or a faulty load switch output, the signal status indicators shall display the channel (channels) which is (are) at fault. If the monitor detects a load switch fault condition, the switch failure indicator shall be illuminated on and the signal status indicators will display the exact channel of the load switch that failed. The red inputs shall be brought into the monitor via a front panel connector. The Red Enable shall be brought into the monitor via the same front panel connector as the red inputs.
- (i) The monitor will be compatible with LED technology.

**.13 Conduit:** The size of the conduit used shall be as shown on the plans. It shall be the privilege of the Contractor, at his own expense, to use larger size conduit if desired. Where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

All conduit for traffic signal installations shall be either metallic conduit, Schedule 40 or 80 polyvinyl chloride (PVC) conduit, or Schedule 40 high density polyethylene (HDPE) conduit as indicated on the plans.

A. Metallic Conduit: Shall be rigid steel conduit meeting the requirements of American Standard Specifications C-80-1. Metallic conduit is only approved for extension of existing metallic conduit runs.

- B. PVC Conduit: PVC conduit shall bear an Underwriters' Laboratories (UL) label.
- C. HDPE Conduit: HDPE conduit shall be smooth-walled inside and out. The conduit shall be manufactured to ASTM D2447 and NEMA TC7 specifications and shall meet the following applicable requirements:

Minimum Wall Thickness:	3" (75 mm) Sch. 40 - 0.216" (5.5 mm)	
Tensile Strength	3300 psi (22.75 Mpa)	ASTM D-638
Elongation	800 %	ASTM D-638
Density	0.955 g/cm <sup>3</sup>	ASTMD-1505
Melt Index	0.320 gms/10 min.	ASTM D-1238(E)
Brittle Temp.	<-103° F (<-75° C)	ASTM D-746
ESCR (Bell Test)	>1500 F50 hrs.	ASTM D-1693(C)
Rockwell Hardness L	49	ASTM D-785
Shore Hardness D	61	ASTM D-2240

**.14 Emergency Preemption:** The Contractor shall furnish and install Opticom emergency preemption equipment as shown in the plans and as specified in the Traffic Signal Quantities. The cable shall be run continuous from the detector to the controller cabinet with no splices. The detector shall be installed as shown in the plans or by a method approved by the Engineer. The Contractor shall be responsible for the proper alignment of the detector to ensure maximum detection time for the emergency preemption equipment.

**.15 Video Detection:** The video detection system shall be manufactured by Econolite, or approved equal. The equipment shall include a processing unit, high-resolution video detection cameras, a telephone modem, a six-outlet power strip and any other appurtenances necessary for the installation of a complete operational video detection system.

**.16 Street Lighting:** All lighting equipment including, but not limited to luminaires, lamps and poles shall conform to the City of Shawnee's Street Lighting Design Criteria and Plan Requirements as well as the Specifications.

**.17 Traffic Signing:** All permanent traffic signing and traffic control signing shall conform to the requirements of the MUTCD. All signs shall be fabricated from standard aluminum blanks utilizing high intensity reflective sheeting as called for in the accompanying plans. Overhead street name signs shall be provided and installed on all mast arm poles. These signs shall be constructed of 0.125-inch (3.2mm) aluminum sheeting of the size as indicated on the plans. Minimum size requirements for any sign shall be 24" x 60" (600 mm x 1500 mm). All sign faces shall be high intensity reflective sheeting. All sign legends shall be uppercase 12-inch (300 mm) series E lettering or numbers and shall be white in color. All signs shall have a white 0.75-inch (19 mm) wide border and shall have green backgrounds. All signs shall have the legends centered on the face with the letters or numbers spaced to produce a

readable, professional quality sign. Actual size drawings of the proposed signs shall be submitted to the Engineer for approval. Bolt hole locations shall be field located and drilled or punched for proper installation. Signs shall be mounted to the mast arms using Astro-Brackets. There shall be a minimum of two brackets per sign placed no more than 3 feet (1 meter) apart with a maximum of 1 foot (0.3 meters) from the edge of the sign.

**2903 CONSTRUCTION REQUIREMENTS:** Before commencing the installation of the traffic signal installation, a complete schedule of materials and equipment proposed for installation shall be submitted to the Engineer for approval. This schedule shall include catalog cuts, diagrams, drawings, and other such descriptive data that may be required by the Engineer.

All submittals shall include the manufacturer brand name and part number where applicable. Where more than one item is present on a submittal sheet, the appropriate item or items shall be circled, not highlighted. All submittals shall be organized as much as practical in order with the summary of quantities sheet in the plans. New submittals on rejected items shall be supplied to the Engineer for approval.

A pre-construction conference shall be held with the Contractor and the Engineer as directed by the Engineer. During this meeting, a copy of the City's most current pre-approved list shall be furnished to the Contractor. At the earliest possible time all electrical conduit, service boxes, pole foundations and junction boxes shall be installed at the correct grade.

Traffic signal heads shall remain covered with ORANGE bags during construction until the entire installation is placed in operation. Black bags shall not be used to cover the new signal heads during construction. Signal heads are to be covered to convey to drivers that they are not operational.

The Contractor is hereby advised that the work to be done shall be completed with full knowledge of the schedule made available to the Engineer. The Engineer may, at his option, cause any work completed without his knowledge or inspection, to be dismantled and inspected.

No new fixture shall be constructed as part of this contract which is in conflict with any existing utility facility, or the code required thereby, unless approved by the Engineer.

**.1 Service and Junction Boxes:** shall be installed as shown on the plans and on the Standard Detail sheets and at such additional points as the Contractor, at his own expense and with the approval of the Engineer, may desire to facilitate the work. Unless otherwise directed by the Engineer, all service and junction boxes shall be installed level to 1 inch (25 mm) above the finish grade.

Boxes subject to traffic (located in the street) have been denoted “traffic-rated junction box” on the plans and shall be installed by the Contractor at his expense.

- .2 Excavation:** The Contractor shall perform all excavations for installing underground conduits, cable, boxes and pole bases in whatever substances encountered, to the depths indicated on the drawings or as approved. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the excavation to avoid slides. Excavated materials shall be kept off sidewalks and out of the street where possible. Excavated material that is piled on sidewalks or in streets shall be removed by the end of the same working day. The Contractor shall pile excavated materials such that drivers' visibility will not be obstructed. All excavated materials not required or unsuitable for backfill shall be removed and wasted on a site obtained by the Contractor. Excavations and trenches shall not be larger or wider than necessary for the proper installation of the foundations or electrical appliance. Excavation shall not be performed until immediately before the installation of conduit, bases or other appliances.

All areas excavated shall be backfilled and compacted in accordance with these Specifications. Backfill shall be deposited in not over 6 inch (150 mm) layers and tamped to 95 percent density +3 percent of optimum moisture. The top 6 inches (150 mm) of backfill shall be select soil suitable for sod. All areas excavated shall be backfilled at the earliest possible time or as directed by the Engineer. After backfilling, all disturbed areas shall be kept well filled and maintained in a smooth and well drained condition until permanent repairs are made. Where trenches are excavated in established sod areas, the area shall be backfilled the same day excavation occurs. Approved methods are intended to reduce damage to the established sod area.

- .3 Concrete Foundations:** The bottom of the concrete foundations shall rest on firm ground; foundations shall be poured monolithic except the top 6-inch (150 mm) pole cap. The exposed portions shall be formed to present a neat appearance. Forms shall be true to line and grade. The top of concrete foundations, except special foundations, shall be finished to either sidewalk grade or 1 inch (25 mm) above finished grade. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position, to proper heights, and held in place by means of a template until the concrete sets. Both forms and ground which will contact the concrete shall be thoroughly moistened before placing concrete. All conduits shall be securely covered prior to pouring concrete. All threaded portions of anchor bolts shall be taped during the concrete pour. Any concrete splashed on poles when pouring the pole cap shall be immediately cleaned off.

- .4 Wiring:** Installation of wiring shall be in accordance with the plans and specifications and appropriate articles of the National Electrical Code. No splicing of cables will be permitted unless shown on the plans or approved by the Engineer. Where splices are allowed, they shall be made by a method approved by the Engineer. Wire nuts shall be used in the base of any signal pole for wire connections. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, orange to yellow, green to green and white to neutral. In addition, signal cable shall also be color-coded with marking tape as follows:

Cable runs for northbound traffic: Color code BLUE  
Cable runs for southbound traffic: Color code PURPLE  
Cable runs for eastbound traffic: Color code YELLOW  
Cable runs for westbound traffic: Color code RED  
Cable runs for northbound left-turning traffic: Color code BLUE with ORANGE  
Cable runs for southbound left-turning traffic: Color code PURPLE with ORANGE  
Cable runs for eastbound left-turning traffic: Color code YELLOW with ORANGE  
Cable runs for westbound left-turning traffic: Color code RED with ORANGE

A minimum of one (1) turn of each cable shall be left in every service or junction box for slack. In addition, slack shall be left in all poles and the controller cabinet. All slack cable shall be neatly dressed using nylon cable ties.

- .5 Bonding and Grounding:** Bonding jumpers shall be No. 6 AWG bare copper wire or equally connected by approved clamps. Grounding of neutral at service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 AWG or equal. Ground electrodes shall be provided at each signal pole and pedestal and at the controller as detailed on the plans. The controller requires an equipment ground as indicated on the Standard Detail sheets in the plans.
- .6 Poles and Pedestals:** All poles and pedestals are to be installed as shown in the plans and the Standard Detail sheets. All attachments are to be located in the field and all wire entrances shall be drilled or punched in the field. All drilled or punched surfaces shall be carefully reamed and/or deburred or threaded as appropriate before an application of one field coat of cold galvanizing. Should field adjustment of any attachment be necessary after the Engineer confirms the locations, the Contractor shall be responsible for plugging any holes caused by the initial installation. Mast arms on mast arm poles shall be installed after the mast arm poles are erected.
- .7 Signal Heads:** Signal heads shall be installed as shown on the plans and the Standard Detail sheets. The Engineer shall approve the location, mounting and mounting height of all signal heads. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in



place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered (refer to the beginning of "ORDER OF WORK").

The signal heads shall be adjusted in the field such that a person standing on the pavement, a distance of four times the speed limit (mph) in feet (0.8 times the speed (km/h) in meters) from the stop bar, shall see the brightest image of the red section. All heads shall be plumbed as viewed from the direction in which they face.

- .8 Loop Detectors:** Loop detector installation shall conform to the details and notes shown on the plans and the Standard Detail sheets. All loop conductors shall be wound in the same direction with the start and end clearly marked on the conductors at the junction or service box. Conductors of all loops shall run continuous to and from the nearest junction or service box. The loop conductors for each loop shall be spliced in the junction or service box to a detector lead-in cable running from the box to a sensor unit mounted in the controller cabinet.

When construction of a loop is started, it shall be completed the same construction day. Should the Contractor start a loop installation and fail to satisfactorily complete it, the entire loop may be subject to replacement at the discretion of the Engineer. Construction of loops shall only be started when the ambient air temperature is 40 ° F. (4.5 ° C.) and rising.

Saw cuts for loop wires shall be made with a self-propelled, water-cooled power saw. The water is used to cool and lubricate the blade and eliminate blowing saw dust. Water shall be provided by the Contractor. All jagged edges or sharp corners and protrusions shall be removed using a small chisel and hammer. The saw cut shall be cleaned to remove cutting dust, grit, oil and other contaminates. The saw cut and entire loop area shall be flushed clean with water and dried with compressed dry air immediately after cutting. Care shall be taken during the cutting and cleaning operation to avoid blowing debris at passing pedestrians and vehicles or onto private property. All corners of loops will be drilled with 1.5 inch to 2 inch (38 mm x 50 mm) hole drill to the depth of saw cut, or corner cuts at 45 degree angles.

Wire shall be installed so as to minimize stress at corner locations. Wire shall be kept dry when installing in the saw slot and shall be inserted by use of a blunt, preferably nonmetallic, flat paddle.

After conductors are installed in the slots cut in the pavement, the slots shall be filled with the approved sealant to within 1/8 inch (3.2 mm) of the pavement surface. The sealant shall be prepared and installed in accordance with the manufacturer's recommendations. The sealant shall be between 1-1/2 inches (38 mm) and 2-1/4 inches (57 mm) thick above the top conductor in the

saw cut as determined by the saw cut depth and as indicated in the plans. Before setting, surplus sealant shall be removed from the adjacent road surfaces without the use of solvents. The Contractor shall allow time to let the sealant set before opening the lane(s) to traffic. Approved absorbent material shall be spread over the sealant if traffic is allowed over the loop before the sealant is completely set.

- .9 Conduit:** Traffic Signal Conduit. Conduit shall be installed as shown in the plans, on the Standard Detail sheets and in conformance with appropriate articles of the National Electric Code and the National Electrical Safety Code.

The ends of all conduit shall be well-reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof.

An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit. The coupling shall be of high density polyethylene. The coupling shall have individual reverse-locking threads with a built-in center stop. The ends of the conduit shall be grooved with a grooving tool to match the reverse-locking threads of the coupling to provide for greater pull-out resistance. The coupling shall be installed with a factory recommended coupling tool to ensure an airtight and watertight lock.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable and utilizing an appropriate conduit bending tool.

Conduit shall be installed under street pavement sections at a depth not less than 48 inches (1200mm) below the bottom of the curb, and under other pavement sections at a depth not less than 24 inches (600 mm); and where laid in trenches on shoulders and in park areas, conduit shall be laid to a depth of 24 to 30 inches (600 to 750 mm) below natural ground level or finish grade.

The conduit shall be installed continuous from outlet to outlet or as otherwise shown on the plans. With respect to HDPE conduit, no couplings or joints will be allowed at intermediate points unless approved by the Engineer in charge of construction. The conduit may be directional bored to minimize disruption to the existing improvements or may be trenched.

Conduit shall be placed under existing pavement by approved pushing or drilling methods. Pavement shall not be disturbed without the written permission of the Engineer and then only in the event insurmountable obstructions are encountered. Pushing or drilling pits shall be kept 2 feet (0.6 meters) clear of the edge of any type of pavement wherever possible.

Excessive use of water such that pavement might be undermined or subgrade softened, will not be permitted.

Conduit set in concrete bases shall extend approximately 3 inches (75 mm) above the foundation vertically. Conduit entering through the bottom of a junction box shall be located near the ends to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

HDPE conduit entering equipment shall be continuous into the service box, junction box and control center. A factory 90° PVC conduit elbow shall be used for installation into a control center foundation. At a traffic signal service box or junction box, the conduit shall enter and exit the sides of the box tangentially such that the cable can enter, be coiled, and exit without exceeding an 8-inch (205 mm) bending radius. For straight through connections, the conduit shall enter one side of the box and exit the opposite side of the box. For changes in direction, the conduit shall enter tangentially and exit tangentially at a 90° angle to the entrance.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.

Conduit runs shown on the plans are for bidding purposes only and may be changed with permission of the Engineer to avoid underground obstructions. The conduit shall generally be installed parallel to the street lighting conduit or direct-buried cable. Installation in the same trench is acceptable.

**.10 Signal Turn-On:** The signal turn-on shall be performed by the Contractor, City personnel shall be present at the activation. The Contractor shall be present for signal turn-on and be prepared to respond to any technical difficulties that may be encountered due to construction of the traffic signal. The signal turn-on shall not occur on Fridays, holidays or weekends and shall be completed between the hours of 9:00 a.m. and 2:00 p.m. unless otherwise noted in the plans or directed by the Engineer. At locations without previous traffic signal control, the new traffic signal shall flash for a period of two to three business days prior to full signal system turn-on.

All traffic signal installation elements shall function properly as a complete system for a minimum period of fifteen (15) calendar days before acceptance by the City.

The fifteen (15) calendar day test period shall be continuous without malfunctions. Any malfunction observed or recorded shall stop the test period as of the time of the malfunction and the test period shall not resume until all components are satisfactorily operating.

The Contractor shall be present to assist and participate in inspections of the traffic signal installation prior to final acceptance.

**.11 Improvement Policies:** The work included in this project may involve modification of existing traffic signal equipment at locations which are presently controlled by operating traffic signals. If portions of the existing traffic installations are to be incorporated in the proposed signal installations, the following policies are to be observed during the installation of the proposed modifications and improvements:

- A. The existing signal controls shall be kept in operation during installation of the proposed signal modifications and improvements, except for shutdowns to allow for alterations as required for installation of the proposed improvements.
- B. Some periods of disruption to existing signal operations can be tolerated during installation of the proposed improvements. However, the Contractor shall coordinate planned disruptions of signal operations with the Engineer a reasonable time in advance of such disruption of operations. The Contractor shall be responsible for maintaining adequate traffic control during any period of disruption to the existing signal.
- C. All existing wiring within existing controller cabinets shall be identified by the Contractor and each conductor properly labeled prior to de-energizing the existing controller to install the proposed modifications and improvements.
- D. Planned disruptions of signal operations shall be restricted during off-peak time periods as directed by the Engineer. The signal controls shall be operable during all other periods.

All existing salvageable equipment (i.e. signal heads, luminaires, poles, arms, controllers and cabinets) in excess of the requirements of this project shall be completely removed from the project, and the Contractor shall deliver same equipment to the City of Shawnee Public Works Traffic Division. All new equipment purchased as spare parts under the requirements of this project shall be delivered new and undamaged to the City of Shawnee Public Works Traffic Division, and stockpiled as per the instructions of the Engineer. The Contractor shall exercise care in the removal and delivery of any existing or new equipment to be delivered to the City. All non-salvaged items of existing equipment shall become the property of the Contractor.

All concrete bases removed on this project shall be broken up and removed to a depth of twenty-four (24) inches (0.6 meters) below grade. Holes resulting from this operation shall be filled to the proper grade with suitable material approved by the Engineer.

**2904 MEASUREMENTS AND PAYMENTS:** This section governs the method of measurement and basis for payment for all labor, tools, material and equipment and for the performance of all work necessary to construct and install a complete and operational traffic signal system.

- .1 Method of Measurement:** The traffic signal installation as indicated on the plans, complete-in-place and accepted, will be measured as a unit lump sum quantity for all work necessary.
- .2 Basis of Payment:** The traffic signal installation measured as provided above will be paid for at the contract lump sum price bid.