

DIVISION VI

TRAFFIC SPECIFICATIONS – MATERIALS

PART 601 – PULL BOXES

601.1 DESCRIPTION

601.1.1 This work shall consist of furnishing materials and installing the pull boxes in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

601.2 MATERIALS

601.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

601.2.2 General:

A) The pull box ring and cover shall be constructed of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Internal reinforcement shall be fiberglass in the form of woven fabric or chopped strand or mat. The box and cover shall be gray in color.

B) All pull boxes shall come without mouse holes

C) All pull boxes with cracked, chipped, or broken lid, lips, or sidewalls shall be replaced at the contractor's expense.

D) Pull box covers shall be inscribed with the label "TRAFFIC SIGNALS" or "HIGHWAY LIGHTING" as appropriate.

601.2.3 Testing Requirements: Pull boxes shall meet or exceed the current material and performance requirements as outlined in the latest version of ANSI/SCTE 77 *Specification for Underground Enclosure Integrity* (Tier 15).

601.2.4 Ground Rod: A 5/8" x 8' minimum copper clad ground rod shall be installed in each pull box and shall be included in the price bid for the pull box. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

601.2.5 Concrete Apron: A concrete apron shall be installed around each pull box not located in the sidewalk or other paved area. The concrete shall be Class "A" concrete with a minimum thickness of 6", with a light broom finish. The cost of this concrete apron shall be included in the price bid for the pull box.

601.2.6 Gravel: Gravel in bottom of pull box shall meet the quality requirements specified in ODOT Section 701 or of ASTM C330, #67 for lightweight aggregate. Compact Dirt Fill shall meet the quality requirements specified in ODOT.

601.2.7 All pull boxes that need access cuts shall be saw cut by approved means (example Quickie saw, Sawzall; no hammer cuts allowed).

601.3 CONSTRUCTION METHODS

601.3.1 General: Provide underground enclosures as shown on the plans. Obtain the Traffic Engineer's approval to revise enclosure locations to fit field conditions or facilitate conduit system installation.

601.3.2 Installation:

A) Install underground enclosures on a bed of gravel as shown in the City of Tulsa Standard Drawing 601.

B) After the conduit ends are plugged, pour 6" of 3/4" washed gravel into the hole and set the pull box on the gravel to the proper elevation and pour additional 6" of gravel around the outside and inside of the pull box.

C) After cable and wire have been installed no gravel shall be added unless traffic or other personal are present. Push pennies or duct seal must be used to seal conduits before gravel is added.

D) When installing pull boxes in sidewalks or other surfaced areas, make the tops of the pull boxes flush with the finished surface.

E) When installing pull boxes in unpaved areas, make the tops of the pull boxes flush with the top of the ground or no greater than 1" above the ground. Provide all pull boxes not installed in surfaced areas with concrete aprons.

F) Pull boxes shall be installed without bolts in the cover.

G) Inside compartment of installed pull box shall be free of mud, concrete, and any material blown out of conduits or trash.

601.3.3 Location:

A) Pull box locations shall be located outside of wheelchair ramps and wheel drag path.

B) Pull boxes shall be set on a parallel or perpendicular line with the N-S-E-W axis of the intersection.

C) The maximum distance of a conduit run between pull boxes is 180'.

601.4 METHOD OF MEASUREMENT

601.4.1 The pull boxes of the size and type specified will be measured by each unit installed. Each pull box unit shall include cover, ground rod, concrete apron, gravel, excavation, and backfilling, necessary to construct and install pull boxes as shown on the Plans.

601.5 BASIS OF PAYMENT

601.5.1 Accepted pull boxes, measured as provided above, will be paid for at the contract unit price as follows:

A) Pull Box Size I EACH

B) Pull Box Size II EACH

C) Pull Box Size III EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 602 – ELECTRICAL CONDUIT

602.1 DESCRIPTION

- 602.1.1 This work shall consist of furnishing and installing all the electrical conduit, fittings, expansion devices, and miscellaneous hardware necessary to complete the electrical conduit system in accordance with these specifications and the plans, and the latest adopted edition of the National Electric Code (NEC). The location of the conduit, as shown on the plans, is diagrammatic and may be subject to adjustment as the Traffic Engineer may direct in order to conform to existing field conditions.

602.2 MATERIALS

602.2.1 General:

- A) Ensure all conduits and fittings are liquid tight. Ensure outlet boxes, fittings, entrance caps, and other accessories comply with current industry standards and are compatible with the conduit material used.
- B) Ream conduit ends to remove burrs and rough edges. Make cuts square so ends will butt together for the full circumference. All conduit ends shall be bushed.
- C) Provide factory conduit bends in accordance with the latest edition of the NEC, or bend conduit without crimping or flattening using the longest centerline radius for each installation, not less than six times the conduit inside diameter.

602.2.2 Rigid Metal Conduit (RMC):

- A) Provide a UL rated rigid galvanized steel conduit that meet the requirements shown on the plans. All exposed conduit shall be rigid galvanized steel.
- B) Galvanized conduit ends shall be threaded, reamed to remove rough edges, and bushings shall be installed prior to installing any wires.
- C) The City will not allow slip joints or running threads for coupling conduit. If standard couplings are not practical, use threaded-union couplings to couple metal conduit, as approved by the Traffic Engineer. Pop rivets, sheet metal screws, or any other unapproved method shall not be used to connect any conduit. Tighten couplings until the ends come together; do not leave threads exposed.
- D) If damage to galvanized conduit exposes bare metal, re-galvanize, metalize, or paint with zinc dust-oxide paint at no additional cost to the City.

602.2.3 Liquid Tight Flexible Metal Conduit (LFMC):

- A) Provide LFMC electrical conduit in accordance with UL-360.

- B) LFMC ends shall be reamed inside and outside to remove rough edges and bushings shall be installed prior to installing any wires.
- C) All couplers and connectors shall be approved and listed for use with LFMC.

602.2.4 Rigid Polyvinyl Chloride Conduit (PVC):

- A) Provide polyvinyl chloride (PVC) schedule 40 electrical conduit in accordance with UL-651. For solvent cement to join conduit refer to ASTM 2564.
- B) PVC conduit ends shall be reamed to remove rough edges and bushings shall be installed prior to installing any wires.
- C) Connections shall be solvent weld type. Connection point shall be properly cleaned as required by the adhesive manufacturer's directions.
- D) All PVC conduit attached to HDPE conduit shall be attached by means of E-LOC, or approved equal, coupling suited for this purpose. Normal primer and PVC cement shall be used. Payment for E-LOC coupling shall be included in the cost of HDPE conduit.
- E) All fittings shall be of the same schedule as the conduit run.

602.2.5 High Density Polyethylene Conduit (HDPE):

- A) Provide High-density polyethylene (HDPE) conduit in accordance with the requirements of NEMA TC7. HDPE conduit shall be smooth wall coilable duct meeting the requirements of ASTM D1248 Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified in the Plans.
- B) All PVC conduit attached to HDPE conduit shall be attached by means of E-LOC, or approved equal, coupling suited for this purpose. Normal primer and PVC cement shall be used. Payment for E-LOC coupling shall be included in the cost of HDPE conduit.

602.2.6 Outlet Boxes, Fittings, and Entrance Caps

- A) Outlet boxes, fittings, and entrance caps shall comply with current industry standards and be compatible with the conduit material used.
- B) Fittings and cement used with PVC and/or HDPE conduit shall be compatible with conduit material.

602.2.7 Acceptance: Conduit may be accepted on the project without testing provided it is visually inspected and all pieces are clearly labeled with the UL label or a type D certification is furnished by the manufacturer.

602.3 CONSTRUCTION METHODS

602.3.1 General: The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic Operations to obtain the address needed to obtain the permit.

602.3.2 Location:

- A) All conduits shall be installed to fit the existing field conditions. However, if major relocations are necessary that may affect the overall design of the electrical system, the contractor shall receive approval of the Traffic Engineer prior to making the relocations.
- B) Conduit runs shall not terminate in corner wheel drag paths.
- C) The maximum distance of a conduit run between pull boxes is 180’.
- D) Termination of multiple conduit runs shall be installed vertically and clustered toward the center of the pull box. Conduit runs within a pull box shall not cross one another.

602.3.3 Installation:

- A) Install conduit in accordance with the NEC. Install direct runs with no less than the minimum size shown on the plans. The use of a larger conduit for the entire length of the run will be allowed, at no additional cost to the City.
- B) If conduit is installed on top of slab surface, it shall be anchored or staked every 8’ to prevent rising (floating) during island forming. Conduits shall be installed 1’ from one edge of the island if not centered in island. See Standard Drawing 602 for details.
- C) No long radius 90° or 45° bends will be allowed unless specified in the plans.
- D) There shall be no more than three 90° bends or 270° total of all the bends in a single run of conduit.
- E) All conduits shall have a green #12 THHN electrical conductor installed to be used as a pull wire (wire to be paid for separately).
- F) Complete all potentially damaging work before installing conductors or cables in the conduit system.

- G) All conductors or cables in a damaged conduit shall be replaced to the next joint of undamaged conduit at contractor's expense. No exceptions shall be made.
- H) All 90-degree bends in conduit shall be galvanized rigid steel conduit.
- I) All conduit stub ups above concrete foundations and in pull boxes shall be PVC, unless approved otherwise by the Traffic Engineer. Galvanized conduit stub ups, if approved by the Traffic Engineer, shall be properly bonded and grounded via a #4 bare copper wire connected to 5/8" x 8' minimum copper clad ground rod. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

602.3.4 Termination of Conduit:

- A) Termination in Signal Pole or Pedestal Base: Stub base conduits 4" to 6" above finished base for mast arm bases and 2" for pedestal bases. All conduit ends shall be reamed and bushed.
- B) Termination in Pull Box: Extend conduit entering pull box sides no more than 2" inside the box wall and slope the conduit toward the top of the box. Conduit entering through the bottom of a pull box shall extend 9" to 12" below the lid and shall be located near the center of the box. All conduit ends shall be reamed and bushed.
- C) Connection to Existing Conduit: If incorporating existing underground conduit into a new system, clean with compressed air until clean air is exhausted from the conduit. This shall be an inspected process by traffic inspector.
- D) For Future Use: Cap conduit ends not terminating in a junction box or electrical enclosure.
- E) General: Cap all conduit ends with standard pipe caps until wiring starts. After removing the caps, install conduit bushings on the threaded ends.

602.3.5 Pushed or Bored Conduit:

- A) Bored conduit shall be continuous (no joints) HDPE schedule 40 and shall be extended 2' from the back of curb or edge of pavement on both ends. "No thread" couplings shall not be used under pavement.
- B) Place the conduit under pavement by approved pushing or boring methods. Do not disturb the pavement without permission from the Traffic Engineer. Keep pushing or boring pits at least 2' clear of the edge of any type of surface area whenever possible.

- C) Excessive use of water, such that the pavement might be undermined or the subgrade softened, will not be permitted. If pits are to be left overnight, cover them with substantial planking and mark them in a manner approved by the Traffic Engineer.
- D) Unless otherwise shown on the plans, install bored conduit or pushed conduits a minimum depth of 30" below top of ground line.
- E) Restoration and repair of right-of-way damage by boring operations shall be included in the price for boring.
- F) Damaged bored HDPE conduit shall be re-bored at the contractor's expense; no under pavement repairs shall be made.

602.3.6 Trenched Conduit and Backfilling:

- A) Conduit installed in a trench shall be of the type and size specified on the Plans.
- B) Excavate trenches deep enough to provide for 30" minimum cover over the conduit, unless otherwise specified. Do not use cinders, broken concrete, or other hard or abrasive materials in backfilling. Also, clear the trench of such materials before the conduit is placed.
- C) Excavate immediately before installing conduit, placing the material in a position where there is the least damage and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage. Be careful not to excavate the trenches wider than necessary for the proper installation of the electrical conduits or cables.
- D) Dispose of all surplus excavated material in a manner approved by the Traffic Engineer.
- E) When rock is encountered during trenching and the required trench depth cannot be attained the trench depth or location may be altered at the discretion of the Traffic Engineer. The minimum trench depth shall meet NEC minimum requirements.
- F) Reconstruct all disturbed surfaced areas, base materials, and sodded areas using replacement materials of equal or better quantity; this is to be done at the expense of the Contractor and to the satisfaction of the Traffic Engineer.
- G) Whenever a part of an existing concrete sidewalk or driveway is broken or damaged, remove the entire square or slab unless otherwise specified by the Traffic Engineer, and reconstruct the concrete as specified above.
- H) If trenched conduit must cross under existing guardrail it should be between posts and as close to perpendicular to the rail as feasible.

- I) Backfill all trenches with acceptable material as soon as possible after installation of conduit; deposit the backfill material in the trench in layers not to exceed 6" in depth and compact to 95% density of the surrounding earth. The first layer shall be free of rocks and debris and compacted, and each successive layer shall be free of rock and debris and compacted before the next layer is placed.
- J) Unless otherwise directed by the Traffic Engineer, all trenches excavated across any sidewalk, driveway, parking lot or other paved area, across any traveled portion of unpaved streets or alleys, across any proposed roadways or proposed roadway fills, and as shown on the drawings shall be bedded and backfilled with 1-1/2" Type A Aggregate Base, placed in 8" maximum lifts and compacted to 95% Standard Proctor Density, as measured by the Nuclear Density Method. Compaction shall be done by a vibratory hand tamper. Trenches excavated across existing street or alley paving shall be backfilled in accordance with the City of Tulsa Standard Detail for Pavement Removal and Replacement.
- K) Utility marking tape shall be installed 6" below finished grade and conduit shall be blown clear of water and debris after backfilling. Utility marking tape shall be a minimum of 4 mil thickness, 6" wide polyethylene tape; color shall be in accordance with AWWA uniform color code. Tape used to mark underground electrical cable shall be safety red color with printed legend "caution electrical cable buried below" The cost of the tape shall be included in the cost of trenching.

602.3.7 Exposed Conduit:

- A) Refer to ODOT Standard Drawing T-302 Typical Conduit Construction Details for exposed conduit installation for installation details.
- B) When conduit is to be installed on the surface of structures, poles, or other exposed locations, use rigid metal-type unless otherwise specified.
- C) Run surface-mounted conduit straight and true, so that it's horizontal or vertical on the surface of the structure or pole. Support it at intervals of not more than 5', unless otherwise specified, using galvanized malleable iron conduit clamps and bolts with expansion shield anchor devices approved by the Traffic Engineer.
- D) Lag or machine bolt shields and percussion driven anchors in concrete or masonry will not be accepted.
- E) When conduit installed on a concrete structure crosses an expansion joint in the structure, install an expansion device of the type and size shown on ODOT Standard Drawing T-302.
- F) Use only Approved Products List approved supporting devices for conduit that is attached to structural steel members.
- G) Where exposed rigid conduit installed on bridges or other structures transition to an underground trenched installation, only threaded fittings will be permissible until run

of conduit has fully turned horizontal in the trench, no PVC to rigid adaptors or fittings. No thread couplings or connectors shall be used.

602.3.8 Testing:

- A) After clearing and backfilling the conduit blow in each conduit run a 1/8" 1,000 lb. test polypropylene string the full length of the conduit. The City Traffic Inspector shall be present during blow in.
- B) The polypropylene string shall be blown in with the appropriately sized conduit position, I.E. 2" conduit use 2" piston, 3" conduit use 3" piston, etc.
- C) Blowing the string shall be in the direction away from the controller cabinet. This is an inspection point required by Traffic Operations.
- D) After clearing and installing string, conduit ends shall be capped with PVC cap or sealed bushings to prevent entry of debris. Duct tape is not an approved method of capping. If capping is removed before cable is installed, contractor shall reprove conduit with inspector present.
- E) For conduit not accepted contractor shall replace conduit to the next joint and have the new conduit inspected and wired pulled before it will be accepted.

602.4 METHOD OF MEASUREMENT

Electrical conduit of the size and type specified will be measured by the linear foot along a horizontal plane of the centerline of the installed conduit from end to end, and shall include all fittings, outlets, entrance caps, pull wires, conduits, expansion devices, and other miscellaneous hardware necessary to complete the conduit system. Each size and type of conduit shall constitute a separate pay items, unless otherwise provided. Unless otherwise provided, trenching and backfilling and boring will not be measured for payment.

602.5 BASIS OF PAYMENT

Accepted quantities of electrical conduit, measured as provided above, will be paid for at the contract unit price as follows:

- A) 2" PVC Sch 40 Conduit (Trenched).....LINEAR FOOT
- B) 3" PVC Sch 40 Conduit (Trenched).....LINEAR FOOT
- C) 2" HDPE Sch 40 Conduit (Directional Bore).....LINEAR FOOT
- D) 2 – 3" HDPE Sch 40 Conduit (Directional Bore).....LINEAR FOOT
- E) 3" HDPE Sch 40 Conduit (Directional Bore).....LINEAR FOOT

- F) 2 – 3" PVC Sch 40 Conduit (Trenched).....LINEAR FOOT
- G) 1-1/2" Galv. Steel Electrical Conduit (Exposed).....LINEAR FOOT
- H) 2" Galv. Steel Electrical Conduit (Exposed).....LINEAR FOOT
- I) 3" Galv. Steel Electrical Conduit (Exposed).....LINEAR FOOT
- J) 1" PVC Sch 40 Conduit (Trenched).....LINEAR FOOT
- K) 1" HDPE Sch 40 Conduit (Directional Bore).....LINEAR FOOT
- L) 1-1/2" PVC Sch 40 Conduit (Trenched).....LINEAR FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

PART 603 – SIGNAL POLE FOOTINGS

603.1 DESCRIPTION

- 603.1.1 This work shall consist of furnishing materials and installing concrete footings for traffic control devices in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

603.2 MATERIALS

- 603.2.1 Materials used shall meet the requirements specified in the following City of Tulsa Standards and Specifications, ODOT Standards and Specifications, Section 700-Materials and AASHTO Specifications:

Portland Cement Concrete, Class A	ODOT 701
Reinforcing Steel	ODOT 723
Electrical Conduit	COT 602
Anchor Bolts and Nuts	AASHTO M 183
Galvanizing (Bolts, Nuts, & Washers)	AASHTO M 232

603.3 CONSTRUCTION METHODS

- 603.3.1 Footings: Construct concrete footings in accordance with ODOT Section 509 so that they rest on firm ground with the top of the footing level, to minimize the amount of shimming required later. Construct the footings in locations as shown on the Plans and to the grade established by the Traffic Engineer. If an obstruction prevents the construction of a footing at the planned location, construct it at a location approved by the Traffic Engineer prior to drilling. Construction methods or materials designed to extend the length of the base to meet height requirements shall not be accepted. The H-frame and template shall be left in place a minimum of eight hours. Once the H-frame and template are removed the concrete shall be finished with a stone. Footings shall be circular in shape $\pm 1/4$ " maximum tolerance. Any footing that is not circular will not be accepted, and shall be replaced at the contractor's expense.

- 603.3.2 Anchor Bolts: Use anchor bolts of the size and quantity specified in City of Tulsa Standards 603 and 617 and ~~648~~. Locate them accurately and securely in the footing by means of a template. Anchor bolts shall be square or centered as called for in the design and plumb. Anchor bolts shall be placed into the concrete base per the design shown in City of Tulsa Standard Drawing 603. Construction methods and hardware designed to extend the manufactured length of the anchor bolts shall not be accepted.

Anchor bolts shall extend out of the base to ensure that the anchor extends the full depth of the base nuts.

NOTE: Do not weld on any portion on the body of the anchor bolt.

603.3.3 Conduits: When conduit must be installed as part of the footing, it shall be of the quantity, size and type shown on the Plans. The conduit required in the footing will be paid for in the cost of other materials in the footing. Conduits installed in poured signal bases shall be plumb ± 5 degrees maximum tolerance, and centered $\pm 1/2$ " maximum tolerance in the base pour. Conduit height above the finished base shall be 4" to 6" for a mast arm pole base and 2" for a pedestal pole base. Stub-outs for pedestal footings shall be 2" conduit.

603.3.4 Ground Rod: Copper clad ground rod is required (Copperweld or approved equal); it shall be of size shown in the Plans. Ground rods installed in poured signal bases shall be plumb in the base pour and far enough away from the conduit that a grounding connector can be installed. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified. Ground rod height above the finished base shall be 4" to 6" for mast arm signal pole bases and 2" for pedestal signal pole bases.

603.3.5 Poles, Posts, or Breakaway Bases:

A) Do not erect poles, posts, or breakaway bases until the foundation reaches 100% of the required 28-day compressive strength and has set at least 72 hours unless they are required to be set directly into the footing. After the footing has been completed, restore the surrounding area to an acceptable appearance.

B) All mast arms installed shall be aligned as shown on the plans or installed parallel or perpendicular to the axis of the intersection. If the mast arm is more than 2° out of alignment due to the placement of the anchors in the base, the base shall be replaced at the contractor's expense.

603.3.6 Bases poured in sidewalk shall have the bottom of the chamfered edge flush with the top of sidewalk grade. Bases poured outside of sidewalks shall not extend any further than 4" 5" $\pm 1 \frac{1}{2}$ " above the finished grade of the surrounding area. Bases below finished grade shall not be accepted.

603.3.7 The Traffic Engineer shall inspect the ground rods, conduit, reinforcing steel and proper alignment of anchor bolts for proper placement and approve the installation prior to pouring concrete. At the Traffic Engineer's discretion, concrete testing may be required for pole bases.

603.4 METHOD OF MEASUREMENT

Reinforced concrete footings of various sizes and shapes will be measured by the each. The footing unit shall include concrete, reinforcing steel, anchor bolts, nuts, washers, ground rod, conduit, all labor, tools, equipment, excavation, backfilling, and incidental work necessary to construct the footing as shown on the Plans.

603.5

BASIS OF PAYMENT

Accepted reinforced concrete footings, measured as provided above, will be paid for at the contract unit price as follows:

A) Signal Footing.....EACH

Such payment shall be full compensation for finishing all materials, equipment, labor, and incidentals to complete the work as specified.

PART 604 – LOOP DETECTORS

604.1 DESCRIPTION

- 604.1.1 This work consists of providing and installing a solid-state inductive vehicle loop detector, loops, and lead in wire in accordance with these specifications, the latest NEMA TS-1 or TS-2 Specifications, and as shown on the Plans.

604.2 MATERIALS

- 604.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.
- 604.2.2 Detector Loop Wire: The detector loop wire that is embedded in the pavement for the detector loop shall be a single conductor, rated for heavy traffic applications with a nominal outer diameter of .240". Insulation and outer jacket shall be orange in color.
- 604.2.3 Loop Lead-in Cable: The loop lead in cable shall be two-conductor #16 AWG with a double jacket made of cross link polyethylene and shall include water block gel and moisture resistant binder tape. The conductors shall be twisted eight times per foot and the conductor insulation colors shall be black and white. The inner and outer jacketed color shall be orange.
- 604.2.4 Shelf Mounted Detector: Provide a self-contained, self-tuning, solid state digital detector that automatically compensates for temperature variations and environmental conditions as described in the 2019 ODOT Specification 828.02 (B).
- 604.2.5 Card Rack Detector Unit: Provide two channel-self tuning, solid state, digital card rack detector units as described in the 2019 ODOT Specification 828.02 (C).
- 604.2.6 Card Rack Assembly: Provide a card rack, cross wired for two or four channel operations as described in the 2019 ODOT Specification 828.02 (D).
- 604.2.7 Power Supply: Provide a 24 V (DC) power supply as described in the 2019 ODOT Specification 828.02 (E).
- 604.2.8 Conduit: Conduit shall be paid for separately and shall meet the requirements of City of Tulsa Specification Drawing 602.
- 604.2.9 Vehicle Loop Wire Sealant:
- A) This section shall govern for furnishing and installing loop wire sealant for use in the installation of vehicle detector loop in asphaltic and concrete pavement as shown on Plans. The sealant shall be a one-part polyurethane material and shall be suitable for use in both asphaltic and concrete pavement. The sealant shall be designed to enable traffic to pass over the filled slot immediately after application without tracking or stringing. The sealant shall not shrink in volume during or after its curing process.

B) The sealant shall have a minimum shelf life to 12 months. The sealant shall have certain physical properties in its uncured and cured states. They are as follows:

1) Uncured (wet) Sealant: The physical properties of the uncured (wet) sealant are as follows:

Property	Requirement	Standard
Weight	717.87 lbs./cy +/-1.0 lb. (1210 kg/cu.m+/-0.45 kg)	ASTM E201
Total Solids by Weight	75-86%	ASTM D1353 18 Hours at 200° F
Viscosity	0.00073-0.0123 psi-s	Brookfield RVF No 6 Spindle at 20 RPM, 77° F 50% Rel. Hum.
Curing Time	Touch: 24 Hour Max Complete: 36 Hours Max 4 mil film, 77°, 50% Rel. Hum.	ASTM D1640

2) Cured Sealant: The physical properties of the cured sealant are as follows:

Property	Requirement	Standard
Hardness (Indentation)	65 – 85	ASTM D2240 Model 1700, 25C 50% Relative Humidity.
Tensile Strength	125 psi Minimum	ASTMD412 Die C Pulled at 20 IPM
Elongation	200% Minimum	ASTM D412 Die C Pulled at 20 IPM
Adhesion (Peel Strength)	15 lb./in width	ASTM D903 Canvas to Concrete
Application Temp Range	+41° F to 131° F	
Service Temp. Range	-40° F to 150° F	

3) Resistance: The cured sealant shall have the following chemical resistances:

Deicing	No Effect	ASTM D471*
Gasoline	Slight Swell	ASTM D471*
Hydraulic Brake Fluid	No Effect	ASTM D471*
Motor Oil	No Effect	ASTM D471*
Sodium Chloride (5%)	No Effect	ASTM D471*
*The ASTM Test shall be conducted at 70° F to 77° F for a period of 22 hours.		

604.3 CONSTRUCTION METHODS

604.3.1 Location: Locate the loop detection system as shown on the plans. Mark the exact location on the roadway with chalk string, spray paint or some suitable and legible marking device that can withstand weather and traffic until such time as the locations have been approved by the Traffic Engineer.

604.3.2 Saw Cuts:

- A) Disable old loops when cutting new loops, the existing cuts shall be properly sealed using approved sealant over a long period of time.
- B) Contractor will saw the induction loop slot, including corner cuts, to the exact depth as shown on City of Tulsa Traffic Standard Drawing 604. All loop corners shall be cut as shown in the saw cut corner diagram shown on City of Tulsa Traffic Standard Drawing 604.
- C) Saw cut shall be made with a blade that is a maximum of 3/8" in width. The minimum width cut shall be 5/16".
- D) Saw cuts that pass-through changes in surfaces (example, asphalt to concrete) or expansion joints shall be drilled with a minimum of 1-1/2" bit and excess loop wire installed to allow loop to move with road surfaces.
- E) Clean and dry the slot with compressed air to remove all water and debris before loop wire is installed.
- F) Use a blunt wood instrument for placing the wire into the slot so that the insulation is not damaged in any way.
- G) The loop detector saw cut shall be sealed with loop wire sealant filled to the top of each saw cut.

604.3.3 Loop Detector Wire Installation:

- A) Wind all non-quadrupole loops in a clockwise direction as shown in City of Tulsa Traffic Standard Drawing 604 with four wraps.

- B) The beginning end of the loop winding shall be marked with a colored tie wrap, inside the pull box. If there are multiple loops terminating in the pull box, the loop nearest the pull box shall have a red tie wrap on the "beginning end" of the winding, the second loop from the pull box shall have an orange tie wrap, the third loop shall be marked with a green tie wrap and the fourth loop shall have a blue tie wrap.
- C) All loop wire shall be one continuous length to the pull box where it shall be connected to the lead-in cable.
- D) After the loop has been completed, the two wires extending into the pull box shall be twisted together with five turns per foot. These wires shall extend into the pull box a minimum of 6', with 6" of wire exposed from the ducting.

604.3.4 Connection to Lead-In Wire:

- A) Drill or pour in place 1" conduit (to be paid for separately) for each loop detector spaced 2" apart for loop wire. Backfill the conduit with asphaltic joint sealer. See City of Tulsa Standard Drawing 602 for installation details.
- B) Place the loop detector lead-in cables in conduit from each loop detector pull box to the traffic signal controller. At each loop detector pull box, splice the loop wire to the loop detector lead-in cable with a waterproof, self-insulating connection using soldered connections and epoxy, or gel cast splice kits as shown on City of Tulsa Standard Drawing 604B.
- C) All connections that are made from loop wire to the lead-in cable shall be made only in the pull box. No pull box lid, lips, or sidewalls shall be saw cut to gain access to an existing loop pull box.
- D) All loops shall be left disconnected in the pull box for inspection. After inspection, solder the connection with a 60/40 alloy, resin core solder. Take care while soldering not to damage the insulation of the wire and cable.
- E) Lead-in cable shall be a continuous run without any splices
- F) Lead-in cable shall be installed with a minimum of 4' of slack cable per pull box and 8' of slack at the controller. No damaged or skinned cable will be accepted.
- G) When the connection has been completed, place a watertight connector sealing packet over it. After carefully placing the loop wire in the slot and checking the circuitry, seal the slot with a sealer that meets the requirements of this specification.

604.3.5 Color Coding in the Cabinet:

- A) Each cable shall be color coded at the cabinet with colored marking tape placed on the end of the jacket at the point where the installation is stripped. This color code designates the cable origin as it relates to the direction of traffic.

- 1) North Bound Left Turn Loop = Red/White
- 2) North Bound Through Loop = Red
- 3) South Bound Left Turn Loop = Orange/White
- 4) South Bound Through Loop = Orange
- 5) East Bound Left Turn Loop = Green/White
- 6) East Bound Through Loop = Green
- 7) West Bound Left Turn Loop = Blue/White
- 8) West Bound Through Loop = Blue

604.3.6 Sealant: Unless otherwise shown on the Plans, the Contractor shall apply the sealant using his own equipment. The City reserves the right to perform any or all of the tests described in this specification to ensure compliance. Failure of a sample will require that the loops be removed and replace with new sealant meeting this specification.

604.4 METHOD OF MEASUREMENT

604.4.1 Loop Detector Wire: The loop detector wire will be measured by each loop installed and connected to the loop detector. All items necessary to connect the loop wire to the lead in wire; including all connectors, splices, curb cuts and any incidentals necessary shall be included in the loop detector.

604.4.2 Lead-In Wire: Lead-in wire will be measured by the foot from the splice to the loop wire to the loop detector in the cabinet.

604.4.3 Shelf Mounted Detector Unit: Shelf Mounted Detector Unit shall be paid for by each and shall include all connections and a card rack assembly if necessary.

604.5 BASIS OF PAYMENT

The accepted vehicle loop detector unit and loop detector wire, measured as provided above, will be paid for at the contract unit price as follows:

- A) 6' x 6' Loop Detector.....EACH
- B) 6' x 30' Loop Detector.....EACH
- C) 6' x 50' Quadrupole Loop Detector.....EACH
- D) Loop Lead-In Wire.....LINEAR FOOT
- E) Shelf Mounted Detector Unit.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 606 – PRE-EMPTION AND SIGNAL PRIORITY SYSTEMS

606.1 DESCRIPTION

- 606.1.1 This item consists of furnishing materials and installing emergency pre-emption and low-level priority systems for traffic signal systems as shown on the Plans.

606.2 MATERIALS

- 606.2.1 General: The priority control system shall interface with the traffic controller to give emergency vehicles approaching the intersection a green with all other indications being red. The system shall be capable of two priority levels and green sensing. The low-level priority system shall be capable of both green extension and red truncation. It shall log the last 1,000 events with time date stamp. All equipment must be plainly marked as to the manufacturer of the equipment to provide clear identification as to the manufacturer's model and serial number of each unit. NEMA certification, test reports shall be provided upon request by the Traffic Engineer. All equipment in the system shall meet NEMA environmental standards.
- 606.2.2 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.
- 606.2.3 Compatibility: If an alternate brand is requested for consideration, the priority control system shall be completely compatible with the existing system currently being used by the City. It shall include full compatibility of preempt codes and provision of on-card history of 1,000 events.
- 606.2.4 Cable: Cable shall be GTT #739 or approved equal. All cable shall be color coded per City of Tulsa Specification and Standard 611 direction color tape chart.
- 606.2.5 Detectors: The manufacturer or manufacturer's representatives shall provide assistance to the contractor or agency installing the equipment as to the best location for the detector placement at each intersection involved in the project. Detector locations shall be approved by the Traffic Engineer. If infrared detectors are used, single detectors shall be provided for each direction of travel at a minimum. Mounting brackets for the detector heads shall be an ASTRO Mini-Brac AB-0163-42-SS or approved equal. All hardware shall be stainless steel.
- 606.2.6 Emitters: Emitter shall be selectable to transmit up to 9999 vehicle codes.
- 606.2.7 Phase Selectors: The phase selector shall be a four-channel card capable of interfacing with GPS and infrared emitters with an auxiliary interface panel, adapter cable, and any other equipment necessary to make it operational in the signal cabinet provided at the intersection. The card supplied shall provide for database upload to a laptop computer using the City of Tulsa Traffic Operations Division's existing software.

606.3 CONSTRUCTION METHODS

606.3.1 The pre-emption and signal priority system shall be installed as per manufacturers' recommendations.

606.3.2 No splices shall be allowed in the cable. The cable run from the detector head to the cabinet shall be continuous.

606.4 METHOD OF MEASUREMENT

606.4.1 The cable will be measured by the linear foot installed and connected from the detector to the phase selector. The detector will be measured by the unit, complete in place, including wiring and all hardware. The emitter will be measured by the unit, delivered to the Traffic Operations Division. The phase selector will be measured by the unit, complete in place and operational, including programming.

606.4.2 Contractor installing the pre-emption and signal priority system shall perform a field operation test using a vehicle emitter inspected and approved by the Traffic Engineer prior to conducting the test. Each individual detector shall be tested with City of Tulsa Traffic Operations personnel present to ensure the system and programming are fully functional.

606.5 BASIS OF PAYMENT

The accepted pre-emption and signal priority cable, detectors, emitters, and phase selectors, measured as provided above, will be paid for at the contract unit price as follows:

- A) Pre-Emption Cable.....LINEAR FOOT
- B) Infrared Pre-Emption Detector.....EACH
- C) GPS Pre-Emption Detector.....EACH
- D) Infrared Pre-Emption Emitter.....EACH
- E) Pre-Emption Phase Selector.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 607 – POWER SUPPLIES

607.1 GENERAL

607.1.1 This work shall consist of furnishing materials and installing power supply systems of the various types in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

607.2 MATERIALS

607.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

607.2.2 General:

A) Materials used shall meet the requirements specified in the following sections, subsections of ODOT Specifications, and external references.

Wood Poles	American National Standards Institute 05.1
Electrical Conduit and Fitting	COT Section 602
Portland Cement Concrete, Class A	ODOT Section 701
Reinforcing Steel	ODOT Section 723
Conductors	COT Section 611

B) Control equipment shall conform to NEMA Specifications, as applicable.

607.2.3 Conductors:

A) Conductors shall conform to City of Tulsa Specification 611.

B) All conductors shall be copper and properly sized for the load.

C) Number 8 THHN stranded black, white, and Green or UF cable of the same size with ground shall be used to supply power from the power sources to the controller.

D) The primary wiring shall be provided by the local utility company.

607.2.4 Conduit:

A) All conduit, conduit fittings, and electrical work shall conform to the NEC and City of Tulsa Specification and Standard Drawing 602.

B) All conduit clamps shall be galvanized malleable iron and installed according to the NEC.

607.2.5 Circuit Breakers:

- A) When a traffic signal system without luminaries is installed a single circuit breaker shall be furnished. When the signal system includes luminaries, two circuit breakers shall be furnished: one for each system.
- B) The enclosure for the circuit breaker shall be a NEMA 3R rain tight enclosure; GE compatible 4 circuit 125 amp, installed according to the NEC, metal boxes only.
- C) The breakers shall be sized for the load requirements.

607.2.6 Service Poles: Service poles shall be treated full length in accordance with American Wood Preservers Association Specifications, to be at least 7.5 lbs. per cubic foot retention of creosote or .38 pentachlorophenol measured by the empty cell process. Wood poles shall comply with the latest revisions of ANSI Standard 05.1.

607.2.7 All miscellaneous pole line hardware required to complete the installation as planned shall be standard material manufactured for pole line construction. All metal parts shall be hot-dipped galvanized or other non-corrosive metals and shall be in accordance with the power company requirements.

607.2.8 Concrete: Concrete construction shall be in accordance with ODOT Section 509. Reinforcing steel construction shall be in accordance with ODOT Section 511.

607.3 CONSTRUCTION METHODS

General: The construction of power supplies shall be in accordance with NIST Handbook 81 Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines. When in conflict, these specifications shall supersede. Contact local "excavator alert" organizations prior to trenching or boring operations.

Coordination with American Electric Power (AEP): The contractor shall install the required metering equipment furnished by the local utility company. The service shall be single wire 110 volt and the contractor shall jumper the breaker box accordingly and wire meter can per local utility company requirements. The contractor shall coordinate with the power company to get the connection at the proper time. Contractor shall cooperate with AEP in locating, installing, and connecting all power supplies. Traffic Engineer must also approve locations before installing.

607.3.1 Electrical Inspections and Permitting: The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic operations to obtain the address needed to obtain the permit.

607.3.2 Voltage Requirements:

- A) All 110-volt electrical connections excluding luminaire connections in the controller cabinet shall be field lug style.
- B) The contractor is required to supply a minimum of 110 volts to the signal cabinet under full load of the intersection.
- C) The voltage for the permanent or temporary service pole(s) shall be as shown on the Plans.

607.3.3 Pedestal Service:

- A) The equipment, construction and installation of the pedestal and service shall be subject to the approval of the City of Tulsa Electrical Inspector and AEP.
- B) Traffic Operations Personal shall approve the conduits placement on bases before the pour.
- C) The conduit shall be plumbed in two different directions. No offset nipples shall be used.
- D) The pedestal service shall be installed on a F1 concrete base, using pad-mount bracket (CHPADEXT or approved equal) and 4-1/2" x 5" stainless steel wedge anchors. See City of Tulsa Standard Drawing 607B.
- E) Primary service shall be furnished underground to a service pedestal. The installation shall include two ground rods, meter can, insulators, cables, conduit, service disconnect, weather head, service bracket, circuit breakers, pull box, wires, and all other items necessary to complete the work.
- F) Ground Rod: (2) 5/8" x 8' minimum copper clad ground rods shall be installed for electrical services and shall be included in the price bid for the electrical service. A minimum length of 8ft of the ground rods shall be embedded into and in direct contact with soil. Increase the overall length of the ground rods as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rods. Ground rods shall not be cut or modified.

607.3.4 Overhead Service to Service Pole:

- A) The service pole shall be installed as close to the right-of-way as possible. Location shall be approved by the traffic engineer prior to construction.
- B) Primary service shall be furnished to a service pole. The installation shall include two ground rods, meter can, insulators, cables, conduit, service disconnect,

weather head, service bracket, circuit breakers, pull box, wire, and all other items necessary to complete the work.

- C) The equipment, construction and installation of the service pole and service shall be subject to the approval of the City of Tulsa Electrical Inspector and AEP. The cost of materials and installation of the service pole, as described above, including any permits or charges for the connection shall be included in the price bid for the service.
- D) If the service pole is to be located more than 75' from the Utility Company's pole a down guy may be required. Contact AEP for their requirements.
- E) Ground Rod: (2) 5/8" x 8' minimum copper clad ground rods shall be installed for electrical services and shall be included in the price bid for the electrical service. A minimum length of 8ft of the ground rods shall be embedded into and in direct contact with soil. Increase the overall length of the ground rods as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rods. Ground rods shall not be cut or modified.

607.3.5 Overhead Service to Signal Standard:

- A) Where electrical service is planned to be mounted on a signal standard the meter and disconnect shall be located on the non-traffic side of the pole and the push buttons shall be installed on a separate pole and base.
- B) Weather head shall be mounted above the point of attachment of service drop conductors.
- C) Service drop conductors shall have minimum clearance of 18' above final grade and must be mounted above all cable TV and fiber optic lines.
- D) Drip loops shall be formed on the individual conductors to prevent the entrance of moisture.
- E) Conduits shall be strapped to the pole at intervals not to exceed 4'-0".

607.4 METHOD OF MEASUREMENT

Power Supplies of the various types will be measured by each unit installed, including any permits or charges for the connection shall be included in the price bid for the service as shown on City of Tulsa Standard Drawing 607A or B depending on what type of service is installed.

607.5 BASIS OF PAYMENT

607.5.1 The accepted power supply items, measured as provided above, will be paid for at the contract unit price as follows:

- A) Pedestal Service Installation.....EACH
- B) Service to Signal Standard.....EACH
- C) Portland Cement Concrete, Class A.....SEE SECTION 701
- D) Overhead Service to Service Pole.....EACH

Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.

PART 608 – TRAFFIC SIGNS

608.1 GENERAL

- 608.1.1 This work shall consist of furnishing materials and installing traffic signs in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Standards, Plans, or established by the Engineer.
- 608.1.2 Signs shall be designed in accordance with the 11th Edition of the Manual on Uniform Traffic Control Devices (MUTCD), December 2023 with revisions.
- 608.1.3 Street name sign proofs shall be submitted to the Traffic Engineer for review and approval prior to fabrication.

608.2 MATERIALS

- 608.2.1 General: Signs shall be composed of aluminum metal sheeting overlaid with cut-out film and a reflective sheeting material. Mounting shall be with posts, hardware and brackets as specified.
- 608.2.2 Sheet Aluminum: Provide 0.080-ga sheet aluminum signs in accordance with ASTM B209, alloy 6061-T6 or alloy 5052-H38 with mill finish. Use the dimensions, filleted corners, and hole, filleted corners, and hole sizes and locations as shown on the sign standards, with the following exceptions: All holes shall be 3/8" diameter, and all corner radiuses shall be 1 1/2". Ensure panels are flat and straight within commercial tolerances. Treat sheet aluminum signs with a chromate type chemical conversion coating in accordance with ASTM B449, Class II.
- 608.2.3 Reflective Sheeting:
 - A) Post-Mounted Signs: Sheeting shall be High Intensity Prismatic meeting ASTM D4956 Type III / IV (3M 3930 or approved equal).
 - B) Mast-Arm Mounted Signs: Sheeting shall be Diamond Grade meeting ASTM D4956 Type XI (3M DG3 or approved equal).
 - C) All sheeting shall have a Class I adhesive backing.
- 608.2.4 Overlay: Electronic cuttable sign film designed for use with electronic sign plotters (3M ElectroCut Series 1170 Film or approved equal).
- 608.2.5 Mounting Hardware: Bolts, nuts, washers, brackets, and all other hardware needed for mounting shall be suitable for long-term outdoor use:
 - A) Bolts: 5/16" x 3", hex head
 - B) Nuts: Flanged, self-locking, size as needed

C) Washers: 3/4" O.D., maximum

D) Brackets: For mast-arm mounting, use a prefabricated mounting system (Pelco Structural Astro-Bracket® or approved equal). See City of Tulsa Standard Drawing 616.

608.2.6 Posts: Signposts shall be perforated square tube (Telespar® or approved equal). Signs shall be composed of new hot-rolled carbon sheet steel, structural quality, ASTM A1101. Provide a finish that is in-line, hot-dip galvanized zinc coating in accordance with AASHTO M 120, followed by a chromate conversion coating, and a clear organic exterior coating. Provide posts with 1/2" (± 1/16") diameter holes spaced 1" on center along the center of each of the four sides.

608.3 CONSTRUCTION METHODS

608.3.1 General: Construction methods shall involve fabrication and mounting of the sign to the appropriate type mount.

608.4 METHOD OF MEASUREMENT

608.4.1 Signs of the size and type specified will be measured by the square foot of area of the vertical front face with no deduction for rounded corners or bolt holes.

608.4.2 Posts of the size specified will be measured by the linear foot between the ends of the installed post.

608.5 BASIS OF PAYMENT

608.5.1 Accepted signs, measured as provided above, will be paid for at the contract unit price as follows:

608.5.2 Signs:

Ground Sign.....	SQUARE FOOT
Overhead Sign.....	SQUARE FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

608.5.3 Posts:

1-1/2" Signpost.....	LINEAR FOOT
1-3/4" Signpost.....	LINEAR FOOT
2" Signpost.....	LINEAR FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 610 – TRAFFIC SIGNAL CONTROLLER CABINET ASSEMBLY

610.1 GENERAL REQUIREMENTS

- 610.1.1 Description: This specification describes the minimum acceptable requirements for a fully actuated traffic controller assembly with the options specified on the Plans. The controller cabinet assembly shall include the ground rod, conduit with bushings, aluminum base, base anchor bolts, caulking, cabinet, a solid state fully-actuated controller unit, switch packs, flasher, conflict monitor, detectors, all auxiliary equipment required to control the system and pertinent documentation. The controller assembly shall meet the latest, applicable requirements of Caltrans Transportation Electrical Equipment Specifications and Standards unless otherwise directed in these specifications or in the project plans.
- 610.1.2 Serial Numbers: Each individual piece of equipment including the cabinet unit shall have a unique serial number that is permanently and neatly displayed on the unit. A printed list of all serial numbers for the equipment provided for the controller cabinet assembly shall be provided by the contractor or supplier.

610.2 MATERIAL REQUIREMENTS

- 610.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.
- 610.2.2 332 Cabinets: The 332 controller cabinets shall be base mount. The location and orientation of the cabinet shall be approved by the Traffic Engineer prior to installation. 332 Cabinet shall meet the Caltrans Specification with noted exceptions:
- A) The Control Cabinet shall come with a Hesco/RLS HE1750 TEES AC Suppressor or approved equal. This unit carries the full intersection load; the Suppressor shall have a 30 amp circuit breaker between the HE1750 TEES and the public utility service to provide the ability to disconnect the Control Cabinet from the power source; mount near the HE1750 TEES for access.
 - B) The Control Cabinet shall come with three Pedestrian Isolator Model 242 cards or approved equal.
 - C) The controller in control cabinet shall have communications to Centracs.
 - D) Six Position Output File – The Output file shall have MOV's. The Odd Phase Reds and Ped Walks and Don't Walks shall have snubbers attached to the switch packs output to prevent going to flash for an odd phase Red, Walk or Don't Walk out. The Snubbers shall be "General Electric" GE 42L1151 capacitor, or approved equal, rated at 1.5 microfarads at $\pm 5\%$ tolerance and 850 VDC rated and high current or equivalent.
 - E) The outside of cabinet exterior shall be anodized aluminum or gray powder coat.

- F) The interior shall be powder coated white.
- G) The Control Cabinet shall not have a Police panel.
- H) The Control Cabinet shall come with 18 switch packs.
- I) The Control Cabinet shall come with 8 flash transfer relays.
- J) The Control Cabinet shall come with 4 flashers.
- K) The Control Cabinet shall come with auxiliary output file for six overlaps.
- L) The Control Cabinet shall come with an 18" high adapter base for mounting.
- M) The Control Cabinet shall come with a 206L power supply.
- N) The Control Cabinet shall come with a flip-down drawer mounted directly on the front door, at a height of no higher than 5' above the concrete pad. A 9" x 14" heavy duty, all-weather, heat resistant, protective, transparent sleeve with a zipper shall be included to protect the field charts and timing card. Note, all 332 controller cabinets are mounted on an 18" base.
- O) The Control Cabinet guard shall not be more than 36" above the pad to ensure that the door of a UPS mounted on the cabinet will open properly.
- P) The Control Cabinet shall come with a duplex outlet with GFCI protection mounted to front power supply. A GFCI protection duplex outlet shall also be provided on the back, in addition to the duplex outlet that powers the controller.
- Q) Yellow / Red or all Red may be programmed through the use of Flash Plugs. Both red and yellow flash plugs shall be provided.
- R) Cabinet shall have two LED Cabinet Light Fixtures mounted in top of the cabinet, one at the front and the other at the rear, and also two LED cabinet light fixtures minimum, mounted on the vertical rails at the terminal side of the cabinet. The mounting hardware shall not penetrate the exterior of the cabinet shell. The light fixtures shall not interfere with access to any cabinet component or terminal blocks. The light fixtures power shall be switched "ON" when any cabinet door is opened.
- S) Cabinet shall come with two Thermostatic Control 100 CFM Fans and 12 x 16 Air Intake in one door with one filter.
- T) Operating voltage ranges shall be between 90V and 135V.
- U) The input terminal blocks shall be mounted at the rear rack and will require SRA 6-LCB Surrentors or approved equal

V) Type 332 Test Switch – The Control Cabinet shall have all input detection device outputs pass through a 3-position switch to allow for isolation of device output to controller. The 3-position switch shall have (a) “Momentary”, down position, (b) “On”, up position, (c) “Off”, center position. The switch shall be placed in the mount with the top terminal as number 1. With the switch toggle in the “UP” position, this will be “On”.

1) The input file switches shall be set up in the following manner:

- a) Switch 1 terminal 3 to I6-W,
- b) Switch 2 terminal 3 to I7-F,
- c) Switch 3 terminal 3 to I3-W,
- d) Switch 4 terminal 3 to I2-F,
- e) Switch 5 terminal 3 to I7-W,
- f) Switch 6 terminal 3 to I6-F,
- g) Switch 7 terminal 3 to I2-W,
- h) Switch 8 terminal 3 to I3-F,
- i) Switch 9 terminal 3 to I12-F,
- j) Switch 10 terminal 3 to I12-W,
- k) Switch 11 terminal 3 to I13-F,
- l) Switch 12 terminal 3 to I13-W.

2) This allows for manipulating the output of all the input devices. The Input switches shall be mounted at the top of rack above the controller for easy access while being able to view the controller display.

3) Switches:

- a) The switches shall be wired as follows: The center terminal of the switch shall be wired to the C1 cable, Switch 1 terminal 2 to C1-45, Switch 2 terminal 2 to C1-65, Switch 3 terminal 2 to C1-76, Switch 4 terminal 2 to C1-39, Switch 5 terminal 2 to C1-78, Switch 6 terminal 2 to C1-41, Switch 7 terminal 2 to C1-43, Switch 8 terminal 2 to C1-63, Switch 9 terminal 2 to C1-67, Switch 10 terminal 2 to C1-69, Switch 11 terminal 2 to C1-68, Switch 12 terminal 2 to C1-70.

- b) The switch terminal number 1 for momentary operation shall be wired to Logic Ground on all 12 switches.
- c) The wire bundle shall be long enough to allow for maintenance of the switch panel for switch replacement if necessary. There must be a terminal block on the back side for manipulation of C-1 controller inputs. Terminal block shall contain one additional terminal connector for Logic Ground to be tapped.

W) Cabinet Base, Pad, and Apron:

- 1) All hardware shall be stainless steel.
- 2) Controller cabinet adapter base to concrete pad hardware shall consist of:
 - a) Quantity four of 3/4" x 5-1/2" Stainless Steel Wedge Anchors,
 - b) Quantity four of 2-1/2" O.D. x 1-1/16" Stainless Steel Flat Washers,
 - c) Quantity four of 1-7/8" O.D. x 3/4" Stainless Steel Flat Washers,
 - d) Quantity four of 3/4" Stainless Steel Lock Washers,
 - e) Quantity four of 3/4" Stainless Steel Hex Nuts.
- 3) Controller cabinet adapter base shall be secured to controller cabinet using the hardware provided by the signal cabinet manufacturer with the base.

- X) Cabinet Door Lock: The controller cabinet doors shall be equipped with a CL-TC1 Gen 2 Cyberlock cylinder and either A15481RS CCL Traffic Cabinet Lock RH, or A15481LS CCL Traffic Cabinet Lock LH. The contractor will be required to purchase a Cyberkey Blue 3, or they can use one that has been previously purchased. The cyberkey shall be programmed by the Traffic Signal Maintenance Supervisor at the Traffic Operations facility located at 4015 N Harvard Ave, Tulsa, OK for the specific individual projects.

610.2.3 336S Cabinets: The 336S controller cabinets shall be base mount. The location and orientation of the cabinet shall be approved by the Traffic Engineer prior to installation. 336S Cabinet shall meet the Caltrans Specification with noted exceptions:

- A) The 336S cabinet shall come with a 337 rack.
- B) The Control Cabinet shall come with a Hesco/RLS HE1750 TEES AC Suppressor or approved equal. This unit carries the full intersection load; the Suppressor shall have a 30 amp circuit breaker between the HE1750 TEES and the public utility service to provide the ability to disconnect the Control Cabinet from the power source; mount near the HE1750 TEES for access.

- C) The Control Cabinet shall come with three Pedestrian Isolator Model 242 cards.
- D) The input terminal block shall be mounted on the rear of rack and will require SRA 6-LCB Surrestors or approved equal.
- E) Six Position Output File – The Output file shall have MOV's. The Odd Phase Reds and Ped Walks and Don't Walks shall have snubbers attached to the switch pack output to prevent going to flash for a Red, Walk or Don't Walk out. The Snubbers shall be "General Electric" GE 42L1151 capacitor, or approved equal, rated at 1.5 microfarads at plus or minus 5% tolerance and 850 VDC rated and high current or equivalent.
- F) Cabinet shall be anodized aluminum or gray powder coat on the outside.
- G) Interior of Cabinet shall be powder coated white.
- H) Cabinet shall not have a Police Panel.
- I) The Control Cabinet shall come with six switch packs.
- J) The Control Cabinet shall come with six Flash Transfer Relays.
- K) The Control Cabinet shall come with two Flashers.
- L) Cabinet shall come with an 18" high adaptor base for 336S.
- M) One power distribution assembly.
- N) The Control Cabinet shall come with a pull-out drawer mounted directly below the Controller. Top drawer shall be 29.5" above bottom of Cabinet.
- O) The Control Cabinet shall come with a duplex outlet with GFCI protection.
- P) Yellow / Red or all Red may be programmed through the use of Flash Plugs. Both red and yellow flash plugs shall be provided.
- Q) Cabinet shall have two LED Cabinet Light Fixtures mounted in top of the cabinet, one at the front and the other at the rear. The mounting hardware shall not penetrate the exterior of the cabinet shell. The light fixtures shall not interfere with access to any cabinet component or terminal blocks. The light fixtures power shall be switched "ON" when any cabinet door is opened.
- R) Cabinet shall come with Thermostatic Control 100 CFM Fan and 6 x 16 Air Intake in each Door with two filters.
- S) Operating voltage ranges shall be between 90V and 135V.

T) TYPE 336S Test Switch – The Control Cabinet shall have all input detection device outputs pass through a 3-position switch to allow for isolation of device output to controller. The 3-position switch shall have: (a) “Momentary”, down position, (b) “On”, up position, (c) “Off”, center position. The switch shall be placed in the mount with the top terminal as Number 1 this will be the “On” position. The Input switches shall be mounted at the top of rack above the controller for easy access while being able to view the controller display and allows for manipulating the output of all the input devices. The wire bundle shall be long enough to allow for maintenance of the switch panel for switch replacement if necessary.

U) Wiring:

- 1) All cable and wiring shall meet the requirements of City of Tulsa Specification 611.
- 2) The Input file switches shall be set up in the following manner:
 - a) Switch terminal 1 shall be wired to Logic Ground on all six switches.
- 3) The switch terminal 2 shall be wired in the following manner:
 - a) Switch 1 terminal 2 to I1-S,
 - b) Switch 2 terminal 2 to I2-S,
 - c) Switch 3 terminal 2 to I3-S,
 - d) Switch 4 terminal 2 to I4-S,
 - e) Switch 5 terminal 2 to I9-S,
 - f) Switch 6 terminal 2 to I10-S.
- 4) The switch terminal 3 shall be wired in the following manner:
 - a) Switch 1 terminal 3 to I1-F,
 - b) Switch 2 terminal 3 to I2-F,
 - c) Switch 3 terminal 3 to I3-F,
 - d) Switch 4 terminal 3 to I4-F,
 - e) Switch 5 terminal 3 to I10-F,
 - f) Switch 6 terminal 3 to I10-W.

V) Cabinet Base, Pad, and Apron:

- 1) All hardware shall be stainless steel.
- 2) Controller cabinet adapter base to concrete pad hardware shall consist of:
 - a) Quantity four of 3/4" x 5-1/2" Stainless Steel Wedge Anchors,
 - b) Quantity four of 2-1/2" O.D. x 1-1/16" Stainless Steel Flat Washers,
 - c) Quantity four of 1-7/8" O.D. x 3/4" Stainless Steel Flat Washers,
 - d) Quantity four of 3/4" Stainless Steel Lock Washers,
 - e) Quantity four of 3/4" Stainless Steel Hex Nuts.
- 3) Controller cabinet adapter base shall be secured to controller cabinet using the hardware provided by the signal cabinet manufacturer with the base.

W) Cabinet Door Lock: The controller cabinet doors shall be equipped with a CL-TC1 Gen 2 Cyberlock cylinder and either A15481RS CCL Traffic Cabinet Lock RH, or A15481LS CCL Traffic Cabinet Lock LH. The contractor will be required to purchase a Cyberkey Blue 3, or they can use one that has been previously purchased. The cyberkey shall be programmed by the Traffic Signal Maintenance Supervisor at the Traffic Operations facility located at 4015 N Harvard Ave, Tulsa, OK for the specific individual projects.

610.2.4 Controller Units shall be Econolite ATC Cobalt Controllers and shall meet the Caltrans Specification with noted exceptions:

A) The Econolite ATC Cobalt controller shall come with the latest EOS version of the software, or approved equivalent, that is capable of interfacing with the central software in use by the City of Tulsa.

610.2.5 Conflict Monitors and Auxiliary Equipment. Conflict Monitor and Auxiliary Equipment shall meet the Caltrans Specification. Cabinet shall be wired for an EDI 2018 E-Clip with extended features or approved equal. Printed Circuit board shall have sockets for the Integrated Circuits.

610.2.6 Cables and Wiring in Signal Cabinets. All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

610.2.7 Modifications: Any requests to modify the requirements for the equipment listed in this specification must be submitted in writing to the Traffic Engineer. Modifications to the models listed, new models not listed and other equipment or technologies not discussed in this specification will be approved on a case by case basis for each project, unless the equipment is added to the Approved Products List.

610.3 CONSTRUCTION METHODS

610.3.1 Cabinets:

A) General Cabling Requirements (see Standard Drawing 610C for more information on these wiring requirements).

- 1) Cable jacket shall extend no more than 1/2" above the bottom of the auxiliary file.
- 2) Drill 1/4" holes in the bottom of the cabinet lip and the bottom of the rack support and secure cables with cable ties.
- 3) Within 1" of end of the wire insulation individual wires shall be color coded per corner tape chart. (See City of Tulsa Standard 611)
- 4) Only one neutral conductor shall be terminated per AC- buss connection point.
- 5) A minimum of 8" of insulated conductors shall be exposed for termination. The UF ground must be insulated from the cabinet rack.
- 6) Conductors shall be stripped, twisted, and insulated with the appropriately sized wire nut.
- 7) Bundle all wires or cables with tie wraps and clip off the excess tie (example locations are shown on Standard Drawing 610C).
- 8) Follow the following procedure for installing all tape on jackets: Begin tape installation on jacket, tape forward 1/2" past end of jacket then reverse direction and tape 1-1/4" of cable jacket reverse and end where it started.
- 9) All individual, conductor wiring shall follow the same uniform path. If conductors are cut short, no splices shall be allowed, re-stripping of extra cable is required.
- 10) All cable jackets shall extend a minimum of 1" above the bottom of the cabinet rack.
- 11) Cable fastened to the rack shall not hinder the lowering of the back panels.

B) Specific Cabling Requirements:

- 1) 20#14 IMSA 20-1 signal cable shall be stacked and color coded per corner tape chart. (See City of Tulsa Standard 611)
- 2) A 2" I.D. wire loop shall be installed in #8 Blk AC+ and the #8 Wht AC- and the #8 Green Ground power wires.

- 3) 7#14 IMSA 20-1 push button cables shall be stacked and color coded per corner tape chart (See City of Tulsa Standard 611). Spare wires shall be secured with tie wraps to cable jacket and not cut off.
 - 4) 5 – UF 2#12 with ground street light cables shall be stacked and secured to rack with tie wraps, a minimum of 6” of cable. Jacket shall extend above the bottom of the rack. Cable shall be taped yellow then also taped and color coded per corner tape chart. (See City of Tulsa Standard 611)
 - 5) Green #12 pull wires shall be bow tied and stored next to the conduit they originate from.
 - 6) Install jumper to tie Ped isolator returns together.
 - 7) Cabinet install shall include 12’ of 20#14, 7#14, PWR, and street light cable, do not cut extra off.
 - 8) All cabling for vehicle heads, pedestrian heads and push buttons shall be a solid conductor wire. And all connections in cabinets shall be connected with Cat #Ideal 87.002 MD#LA-6A Alscu lug.
- C) Spares: 20#14 cable spares shall be left full length and run straight up the right side of the output file and secured with cable ties. Cable spares shall be secured every 6” with tie wraps. Cable spares and cables shall be color coded per corner tape chart. (See City of Tulsa Standard 611). Spare wires in cables shall not be wrapped around cable jackets, they shall be left full length and stored neatly, and marked with proper corner coding tape.
- D) All cable shall be neatly sorted and organized in a workman like manner before cabinet wiring begins, like cables shall occupy the same path to their termination point. The cables and conductors shall be arranged so that the base conduits shall be, visibly and physically, readily accessible. Excellent craftsmanship is required to complete cabinet wiring, City of Tulsa reserves the right to define Excellent Craftsmanship, examples will be provided upon request.
- E) Cabinet and base shall be fully cleaned and vacuumed upon completion of wiring cabinet.

610.3.2 Cabinet Base, Concrete Pad, and Concrete Apron:

- A) The concrete portions of the cabinet base, the concrete pad, the cabinet guard and the apron shall be paid for separately from the traffic signal controller assembly and shall meet the requirements of City of Tulsa Specification 612 for Cabinet Bases, Aprons, and Guards. All other parts of the cabinet base shall be provided for as required in this specification.

- B) Traffic Operations shall inspect for proper placement and alignment of the controller cabinet adapter base, concrete pad, ground rod, and conduit prior to pouring of the concrete.
- C) 3" conduits and ground rod in cabinet base shall not exceed 3" in height.
- D) Conduit in cabinet base shall be bushed on the ends. The bushed edge of all conduits shall be stubbed up level.
- E) Ground rod shall be 5/8" x 8' minimum copper clad. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.
- F) The joint between the controller cabinet and the adapter base and the joint between the adapter base and the concrete pad shall be caulked with Dow Corning 795 Silicone Building Sealant with Limestone Color or approved equal. It shall have a minimum of a 1/4" bead or, if it is more than a 1/4" bead, it shall be worked with a caulking tool.
- G) Aluminum bases shall not be modified in any way except drilling of anchor bolt holes.
- H) The concrete controller base shall be installed level and plumb with the controller cabinet adapter base and the cabinet door shall open and close without lifting or forcing the door.
- I) The cabinet shall be free of dust and debris prior to acceptance.
- J) The cabinet and cabinet guard shall be oriented and positioned to leave adequate space to access the cabinet and have good visibility of the signal.
- K) The space between the energized terminal block and the cabinet guard and/or any other grounded part shall be a minimum of 36". The cabinet door shall be capable of opening at least 90 degrees and shall be a minimum width of 30".

610.3.3 Cabinet Inspections:

- A) Signal cabinets shall be set up and wired by the manufacturer or contractor to meet or exceed these specifications and Traffic Operations Division Standard Practices then delivered by the contractor to the City of Tulsa Traffic Operations Division prior to installation for inspection and approval of all equipment and cabinet wiring.
- B) If deficiencies are found, the Traffic Engineer or designee shall inform the contractor and provide a list of the deficiencies that must be corrected prior to approval.

- C) The cabinet will be picked up from the Traffic Operations Division by the contractor to correct the deficiencies, and then the cabinet shall be delivered by the contractor to the Traffic Operations Division again for re-inspection and approval after the corrections are made.
- D) The contractor will be responsible for picking up the cabinet from the Traffic Operations Division for final installation in the field after it is approved.
- E) Traffic Signal Controller Cabinet Assemblies must meet the requirements of this specification and of the Standard Practices for Cabinet Preparation and Installation. Contact the Traffic Operations Division for a copy of the written Traffic Operations Division Standard Practices for Cabinet Preparation and Installation.

610.4 METHOD OF MEASUREMENT

610.4.1 Each traffic signal controller cabinet assembly shall include the installation of the ground rod, conduit with bushing, cabinet base, cabinet, detectors, surge suppressor, traffic signal controller unit with auxiliary equipment, and any other appurtenances necessary to make the signal cabinet operational in the field. The signal cabinet controller assembly will be measured by the unit, operational and complete in place.

610.5 BASIS OF PAYMENT

Traffic signal controller cabinet assemblies, measured as provided above, will be paid for at the contract unit price as follows:

- A) Traffic Signal Controller Cabinet Assembly.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified. Specifics of which controller cabinet and which signal controller units shall be supplied will be detailed in the project plans or prior to ordering.

PART 611 – ELECTRICAL CONDUCTORS TRAFFIC SIGNAL

611.1 DESCRIPTION

- 611.1.1 This item consists of furnishing materials and installing electrical conductors for traffic signal systems as shown on the Plans.

611.2 MATERIALS

- 611.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.
- 611.2.2 Traffic and signal electrical cable shall comply with the requirements of the International Municipal Signal Association (IMSA) Specification Number 20-1. Traffic and signal electrical cable shall be measured using the American Wire Gage (AWG) system, solid core with the exceptions of Number 8 and larger diameters.
- 611.2.3 Cable used for the downtown traffic signal communications interconnect system shall be industrial grade, shielded 24 AWG gel filled, twisted-pair cable, rated for outdoor use with either 6-pairs, 12-pairs, or 24-pairs, unless otherwise specified in the project plans. Ethernet cable used for wireless signal communications shall be industrial grade shielded CAT 6, rated for outdoor use, unless otherwise specified in the project plans. Shielding shall be riser rated, polyolefin insulation shield bonded to an oil resistant and sun resistant PVC jacket.

611.3 CONSTRUCTION METHODS

611.3.1 General:

- A) The installation of all electrical cables and conductors must conform to the National Electric Code. This code represents the minimum required standard. City of Tulsa or Plan requirements may exceed those of the code.
- B) The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic operations to obtain the address needed to obtain the permit.
- C) Avoid damaging the conductor and the insulation during installation. Replace damaged conductors at no additional cost to the City.

D) Complete the conduit system before installing the conductors. Provide slack in each conductor at the pole bases, pull boxes, and cabinets.

611.3.2 Installation:

A) Install traffic signal electrical conductor from the heads on each traffic signal pole to the traffic signal controller. Place the electrical cable from the traffic signal pole to the controller in conduit. Furnish electrical cable and at least one spare as shown on the Plans.

B) Complete the conduit system before installing the conductors. Provide slack in each conductor at the pole bases, pull-boxes, and cabinets, as approved by the Traffic Engineer.

C) Cable shall be installed to limit sun exposure.

611.3.3 Splices:

A) The City will only allow splices in the traffic signal conductors at the pole bases, terminal block, or controller cabinet. Any splices shall be above ground in the signal standard base, no splices will be allowed in the pull-box.

B) Cables coming from signal heads shall be continuous (without splices) to the base connection.

C) All cable runs from pole bases to controller shall be continuous with a minimum of 4' slack of cable per pull-box and 12' of extra cable at the controller.

D) Cable jacket shall not be removed more than 6" at signal head connection and 6" at base splices.

E) Vehicle and pedestrian neutrals shall remain separate.

611.3.4 Bonding: There shall be #6 green THHN stranded copper connected to the bonding point of each traffic signal standard or pedestal and the service disconnect ground buss. See City of Tulsa Specification and Standard Drawing 618 for more information.

611.3.5 Color Coding and Wire Wrapping:

A) Each conductor shall be color coded with colored marking tape placed on the end of the jacket at the point where the installation is stripped. This color code designates the corner of cable origin or direction of traffic. For all signal and pedestal poles:

1) North East corner = Red

2) South West corner = Orange

- 3) South East corner = Green
 - 4) North West corner = Blue
 - 5) Luminaire = Yellow
 - 6) Island or Interconnect (Special) = Purple
- B) Each conductor shall be wrapped with white or gray tape at the base of the traffic signal standard as shown in City of Tulsa Standard 611 and stated below:
- a) Far End Signal Head = 3 wraps
 - b) Center Signal Head = 2 wraps
 - c) Far Right (Curb End) Signal Head = 1 wrap
 - d) North bound and South bound pedestrian push buttons = 1 wrap
 - e) North bound and South bound pedestrian signal heads = 1 wrap
 - f) East bound and West bound pedestrian push buttons = 2 wraps
 - g) East bound and West bound pedestrian signal heads = 2 wraps
 - h) For Downtown Signals:
 - a) East/West Vehicle Head = 2 wraps
 - b) East/West Pedestrian Head = 2 wraps
 - c) North/South Vehicle Head = 1 wrap
 - d) North/South Pedestrian Heads = 1 wrap
- C) All electrical connections shall be made in standard base by twisting wires and using appropriately sized wire nuts. All splices shall be placed with wire nuts in an upright vertical position. This splice shall extend 3' ±6" out of the hand hole. Strip the outside sheathing back 6" and each conductor 1". All splices shall be taped up before stuffing into base (the wire nuts shall remain un-taped).

611.3.6 Luminaires: All luminaire electrical conductors from the controller to each traffic signal pole shall be separate runs of 2/c #12 UF with ground. Conductor ran between luminaire arm and pole base fuse holder shall be identified with yellow tape. Leave 26" of 2 conductor #14 in base.

611.3.7 Communications: Extreme caution shall be used when working with communications cable to prevent bending or crimping the cable.

611.4 METHOD OF MEASUREMENT

611.4.1 The electrical conductors will be measured by the foot for each of the various types specified and installed, and shall include all connectors, splices, and incidentals necessary to complete the traffic signal system as provided on the Plans.

611.5 BASIS OF PAYMENT

The accepted electrical conductors, measured as provided above, will be paid for at the contracted unit price as follows:

- A) 4#14 Traffic Signal Electrical Cable.....LINEAR FOOT
- B) 5#14 Traffic Signal Electrical Cable.....LINEAR FOOT
- C) 20#14 Traffic Signal Electrical Cable.....LINEAR FOOT
- D) White #10 THHN Electrical Conductor.....LINEAR FOOT
- E) White #12 THHN Electrical Conductor.....LINEAR FOOT
- F) Green #12 THHN Electrical Conductor.....LINEAR FOOT
- G) 2#12 UF Electrical Conductor with Ground.....LINEAR FOOT
- H) 7#14 Traffic Signal Electrical Cable.....LINEAR FOOT
- I) 10#14 Traffic Signal Electrical Cable.....LINEAR FOOT
- J) 22 AWG Filled BJFA, BJFC, PE-39, 6-Pair.....LINEAR FOOT
- K) 24 AWG Filled BJFA, BJFC, PE-39, 6-Pair.....LINEAR FOOT
- L) 2 #14 Shielded Electrical Conductor.....LINEAR FOOT
- M) Green #6 THHN Electrical Conductor.....LINEAR FOOT
- N) 24 AWG Filled, BJFA, BJFC, PE-39, 6-Pair.....LINEAR FOOT
- O) 24 AWG Filled, BJFA, BJFC, PE-39, 12-Pair.....LINEAR FOOT
- P) 24 AWG Filled, BJFA, BJFC, PE-39, 24-Pair.....LINEAR FOOT
- Q) CAT 6 Ethernet Cable.....LINEAR FOOT

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 612 – CABINET BASES, APRONS, AND GUARDS

612.1 GENERAL

- 612.1.1 This work consists of furnishing materials and installing the concrete pad, the cabinet guard, the concrete portions of the cabinet base, and the apron for a traffic controller cabinet in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

612.2 MATERIALS

- 612.2.1 All concrete to be Class “A” with light broom finish.
- 612.2.2 The cabinet guard shall be constructed using 4” Schedule 80 steel tubing.
- 612.2.3 The cabinet guard footings shall be fully encased in Class “A” concrete.
- 612.2.4 The completed cabinet guard shall be painted with two coats of “Bronze” Rustoleum exterior paint or approved equal. Concrete splatter or over-pour shall be removed from the guard prior to painting.

612.3 CONSTRUCTION METHODS

- 612.3.1 Shop drawings shall be submitted prior to installation of cabinet guard if cabinet guard does not meet the standard dimensions exactly.
- 612.3.2 The Control Cabinet guard shall not be more than 36” above the pad to ensure that the door of a UPS mounted on the cabinet will open properly.
- 612.3.3 Prior to painting, the upright tubing shall be filled with concrete and the ¼” steel caps shall be welded into place.
- 612.3.4 The tolerance of the cabinet guard shall be 1/4” measured from the diagonal. Horizontal numbers shall be plumb and level. The guard shall be centered on the controller cabinet base. The cabinet guard shall not be more than 36” above the top of the concrete pad to ensure that the door of a UPS mounted on the cabinet will open properly.
- 612.3.5 The location of the cabinet base, apron, controller cabinet, and guard shall be approved by the Traffic Engineer prior to installation. Traffic Engineer shall inspect for proper placement and alignment of the controller cabinet adapter base, concrete pad, ground rod, and conduit prior to pouring of the concrete.
- 612.3.6 Any backfill under or around the concrete pad and apron shall be filled in 6” layers and tamped to 95% density of the surrounding earth.
- 612.3.7 Apron slope shall be a minimum of 1” per foot from the concrete pad. The apron must be configured so that it maintains negative slope on all four sides to keep water draining

away from the cabinet base. If the standard design does not accommodate this a special design must be provided in the plans for the concrete pad, apron, and guard.

- 612.3.8 All concrete pads and aprons shall be vibrated from top to bottom.
- 612.3.9 Screed board shall be used on all poured aprons and pads before finish is applied.
- 612.3.10 If Sonotube concrete forms, or approved equal, are used to pour the cabinet base or foundation, it shall not extend into the concrete pad.
- 612.3.11 Concrete over pour around or in between materials used to seal or support conduits shall be removed from stubbed up conduits and ground rod above the finished grade of concrete base.
- 612.3.12 The controller cabinet and base shall be covered during the pouring of the concrete to prevent splatter.
- 612.3.13 The joint between the controller cabinet and the adapter base and the joint between the adapter base and the concrete pad shall be caulked with Dow Corning 795 Silicone Building Sealant with Limestone Color or approved equal. It shall have a minimum of a 1/4" bead or, if it is more than a 1/4" bead, it shall be worked with a caulking tool.
- 612.3.14 The concrete controller base shall be installed level and plumb with the controller cabinet adapter base and the cabinet door shall open and close without lifting or forcing the door.

612.4 METHOD OF MEASUREMENT

- 612.4.1 The cabinet guard of the size and type specified will be measured by the Each unit installed, which includes all items shown in Standard Drawing 612 – CABINET GUARD DETAIL.

612.5 BASIS OF PAYMENT

Accepted cabinet guards, measured as provided above will be paid for at the contract unit price as follows:

A) Cabinet Base, Apron, and Guard.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 613 – PEDESTRIAN PUSH BUTTON

613.1 GENERAL

- 613.1.1 The work shall consist of furnishing materials and installing pedestrian push buttons and signs on traffic signal installations in accordance with these specifications and as shown on the Plans.

613.2 MATERIALS

- 613.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

- 613.2.2 Pedestrian Signal (APS) Push Buttons shall meet the requirements of the latest edition of the Public Right-Of-Way Accessibility Guidelines (PROWAG), ADA, and the 11th Edition of the Manual on Uniform Traffic Control Devices (MUTCD) and shall meet the following requirements:

- A) They shall be vibrotactile and shall have the capability of both speech-walk messages and rapid ticks.
- B) They shall include an MUTCD compliant R10-3 series sign with a yellow housing and internal speakers, LED confirmation light, and adjustable raised tactile arrows.
- C) They shall include the central control unit (CCU) and voice IC chip per intersection (diamond interchanges are counted as two intersections for the purpose of pedestrian push button equipment).
- D) If audible push button equipment is mounted within 10' of another pushbutton, they shall be factory programmed with a speech message in accordance with MUTCD section 4K.03 paragraphs 18 and 20, including the names of the street; otherwise they shall be programmed for a rapid tick. Messages shall be capable of being reprogrammed.
- E) Audible pedestrian push buttons shall be programmable via internet or other software over an Ethernet connection or on-site in the controller cabinet via a laptop or configurator unit.

- 613.2.3 Non-Audible Pedestrian Push Buttons: Non-audible pedestrian push buttons shall meet the requirements of the latest Manual on Uniform Traffic Control Devices (MUTCD) and shall meet the following requirements:

- A) They shall be vibrotactile.
- B) They shall include an MUTCD compliant R10-3 series sign with a yellow housing, LED confirmation light, and adjustable raised tactile arrows.

613.2.4 Push Button Cables and Wiring: All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

613.3 CONSTRUCTION METHODS

613.3.1 Install pedestrian push buttons in accordance with the latest edition of PROWAG, ADA and the MUTCD.

613.3.2 Construct the pedestrian push button so that it is tamper proof. Design it to prevent an electrical shock under any weather conditions.

613.3.3 Attach the pedestrian push button and sign to a traffic signal pole, push button pole or pedestal pole as shown on the Plans. Align the arrows parallel to the crosswalks that the push buttons are to serve.

613.3.4 Audible pedestrian push buttons shall be delivered with the signal cabinet to the City of Tulsa Traffic Operations Division prior to installation for inspection and approval.

613.3.5 The location and mounting height of pedestrian push buttons shall be approved by the Traffic Engineer prior to installation.

613.3.6 Non-audible push buttons shall be drilled and secured with pop rivets, 1/4" x 1-1/4" long with a 1/2" wide head.

613.3.7 Audible push buttons shall be installed according to manufacturer's instructions.

613.3.8 Push buttons shall not be installed until the finished grade of the sidewalk is installed.

613.4 METHOD OF MEASUREMENT

613.4.1 The pedestrian push button will be measured by the unit operationally complete in place, connected, including signs and all software and hardware.

613.5 BASIS OF PAYMENT

The accepted pedestal poles and pedestrian push buttons, measured as provided above, will be paid for at the contract unit price as follows:

A) Non-Audible Pedestrian Push Buttons Station and Sign.....EACH

B) Audible Pedestrian Push Buttons Station and Sign.....EACH

C) Audible Pedestrian Push Buttons Configuration/Programming Device.....EACH

D) Audible Pedestrian Push Buttons Control Card/Unit.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 614 – LED TRAFFIC SIGNAL HEADS AND PEDESTRIAN SIGNAL HEADS

614.1 GENERAL

- 614.1.1 This item shall consist of providing and installing Light Emitting Diode (LED) traffic signal heads and LED pedestrian signal heads on various types of supports at locations shown on the Plans and in conformance with these specifications and the Institute of Transportation Engineers (ITE) Standard Specifications.

614.2 MATERIALS

- 614.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.
- 614.2.2 General: The traffic signal heads and all component parts shall be in compliance with the requirements contained in this specification and the standards contained in the publication No. ST-017, *Equipment and Material Standards of the Institute of Transportation Engineers*.

614.2.3 Housing:

- A) Traffic signal head housing shall be fabricated from a one-piece engineering plastic equal in strength and performance to polycarbonate resin material with LED Indications.
- B) All Acrylonitrile-Butadiene-Styrene (ABS) sheet material shall be UV stabilized.
- C) The sides, top and bottom of each head section shall be integrally molded.
- D) The traffic signal head shall consist of the number of sections and the lens configuration(s) specified in the Plans. The heads shall be designed for vertical installation.
- E) The sections shall be designed so that they can be locked in position in increments not exceeding 5° of rotation. The individual sections shall be fastened together by means of bolts extending through each section and shall be positively locked when the bolts are tightened down. When assembled, together with doors, LEDs, and mounting attachments the housing shall be completely dust and moisture proof.
- F) The top and bottom of each section shall be provided with an opening to accommodate standard 1-1/2" pipe brackets. Any open end of an assembled traffic signal head shall be plugged with a pinnacle cap and gasket. Any other unused openings shall be made watertight by a method approved by the Traffic Engineer.
- G) All bolts, nuts, washers, and other hardware used for securing the signal head sections shall be completely rust proof.

- H) Traffic Signal Backplates shall be aluminum with a durable factory applied non-reflective black finish (powder coated, baked enamel, or other finish as approved by the traffic engineer.) Backplates shall be a minimum thickness of 0.05" and shall have louvers. At the front side of the backplate a 2" wide strip of fluorescent yellow retro-reflective tape shall be installed at the perimeter. The retro-reflective tape shall be Type XI.
- I) All 5-section heads top and bottom backplate butt joints shall have a minimum of two screw and clip nuts per joint, a minimum of one is required for 3-section heads and 4-section heads.
- J) All 5-section cluster signal backplates must be reinforced with a minimum of a 5/8" flange on all sides.
- K) Each traffic signal vehicle section shall have four appropriately sized stainless-steel washers and fasteners.
- L) Traffic signal heads and visors shall have the appropriate color completely impregnated in the resin material. The exterior shall be Federal Yellow in color and the interior surface of all visors shall have a flat black finish.

614.2.4 Traffic Signal Doors:

- A) Each signal lens shall be mounted in a door fabricated of the same material as the housing. The doors shall be suitably hinged and shall be latched with a latch bolt of the adjustable pressure type. Hinges shall be located to the left side for 3-section signal heads and 4-section signal heads, and toward the outside edges for a 5-section signal head. The outer face of the door shall have at least four tapped holes equally spaced around the lens opening to receive the screws, which hold the visor in place.
- B) Each door shall be provided with a visor approximately 12" in length. Traffic signal head visors shall be the tunnel type. All visors shall be fabricated of the same material as the head sections.
- C) Neoprene or superior material shall be provided for gasketing between the body of the housing and the doors, to exclude dust and moisture.

614.2.5 Pedestrian Signal Heads:

- A) Pedestrian signal heads shall be Single-Section with LED indications.
- B) Single-Section design shall be provided with a band type mounting bracket for each signal head. The pole half of the assembly shall not weigh more than 44 ounces and shall be designed to adapt to a wide range of pole configurations (4" minimum diameter).

- C) The mounting hardware shall be a two piece, cast aluminum alloy assembly. The two separate casting shall be joined in the final assembly by the use of stainless-steel spring pins. The spring pins shall be factory installed into the hinge ears which shall be integrally cast into the pole half of the assembly. Final mating of the two halves shall be accomplished by inserting the spring pins into the drilled hinge ears of the head half of the assembly (loose fit).
- D) Band type mounting shall be provided by integrally casting two recessed slots near the top and bottom of the pole half of the assembly. The corners of this slot shall be relieved to prevent damage to the band strapping material. Approximate dimensions of each slot shall be 7/8" wide and 1/8" deep thus adequately retaining 3/4" strapping material.
- E) Lenses shall be rectangular with a nominal size of 16", as specified in the Plans. Lens design shall conform to the provisions of the latest edition of the standard "Pedestrian Traffic Control Signal Indications" from ITE publication ST-17 and the Manual on Uniform Traffic Control Devices.
- F) Single-Section pedestrian heads shall be equipped with egg crate visors.
- G) Pedestrian signal heads shall conform to the applicable requirements contained herein for traffic signal heads.
- H) The pedestrian traffic control signal indications shall use the international symbols.
- I) The pedestrian signal indications furnished shall include countdown timers.
- J) Pedestrian signal heads and visors shall be flat black.

614.2.6 LED Units:

- A) Provide LED lamps in accordance with the most recent version of the ITE standard "*Vehicle Traffic Control Signal Heads*" (VTCSH) and "*Pedestrian Traffic Control Signal Indications*" (PTCSI). Unless otherwise shown on the plans.
- B) Lenses shall be of hard coated and UV stabilized polycarbonate design to provide color and light output as specified in Section 8.04 and Figure 1 of the VTCSH standard. Lenses shall be securely mounted in the door with weatherproof gaskets and rust proof clips.
- C) The LED signals shall not be the screw-in type.
- D) The LED signal shall be marked "TOP" to designate the proper orientation of the LED unit in the traffic signal housing manufacturer part number, and date code shall be visible on the rear of the assembly.
- E) The colors of the LED traffic modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

- F) Traffic and pedestrian signal indications shall fail catastrophically. Pixelated LED indications shall not be accepted.
- G) The LEDs shall operate over the voltage range of 92 VAC to 125 VAC.
- H) The variation in line voltage shall not cause the light to vary more than 30%
- I) Arrow lenses shall conform to Section 9.00 of ITE publication ST-017. Lenses shall be of hard coated and UV stabilized polycarbonate with the arrow mask inserted in the lens.
- J) The LED unit shall utilize the same mounting hardware used to secure an incandescent lens and gasket assembly and only require a screwdriver to complete the mounting.

614.2.7 Wiring:

- A) The leads on the LED signal module shall be 36" long made of 20 AWG 600-volt Opticom or approved cable able to withstand temperatures of at 75° C. Use UV rated cable ties to secure excess wire and cable.
- B) The leads shall be strain relieved and have fully insulated quick disconnect female (spade) couplers.
- C) Each LED Unit shall be provided with two color coded wires. These wires shall be a minimum of 18-gauge copper. The color coding shall be as follows:
 - 1) Brown – Green or Green Arrow
 - 2) White – Common (Grounded side of power)
 - 3) Red – Red, Red Arrow
 - 4) Yellow – Yellow or Yellow Left or Right Arrow
 - 5) Green – Green, Green Arrow
 - 6) Blue – Walk
 - 7) Orange – Don't Walk
- D) The leads shall be securely fastened to the LED module and connected to a terminal block by means of solderless wire connectors. The leads shall be long enough to reach the terminal block in each of the head sections.
- E) A terminal block shall be positioned in the appropriate section of the signal head and shall have a screw terminal for each wire from the LED module and separate

terminal for each field wire. See City of Tulsa Standard Drawing 615 for more details. The terminal blocks shall be mounted vertically or horizontally.

614.3 CONSTRUCTION METHODS

- A) Make each signal head weathertight.
- B) A signal head may consist of one or more signal sections of the adjustable, LED type, with multiple signal section rigidly and securely fastened together.
- C) Each signal section shall be a self-contained assembly consisting of an LED unit with housing, housing door, visor and backplate unless otherwise specified on the Plans.
- D) Supply signal heads with all brackets and fittings necessary for proper mounting on the type signal support designated on the Plans and make them capable of being positively positioned to control the movement of one direction of traffic.

614.4 METHOD OF MEASUREMENT

The traffic signal heads and lamps will be measured by the unit, complete in place, including wiring and all hardware. The backplates and visors will be included in this pay item.

614.5 BASIS OF PAYMENT

The accepted traffic signal and pedestrian heads with backplates, visors and LEDs, and all materials, labor, equipment, and incidentals necessary to complete the work as specified will be paid for at the contract unit price as follows:

- A) LED 3-Section Traffic Signal Head (#25).....EACH
- B) LED 3-Section Traffic Signal Head (#33).....EACH
- C) LED 3-Section Traffic Signal Head (#36).....EACH
- D) LED 3-Section Traffic Signal Head (#36) (Louvered).....EACH
- E) LED 3-Section Traffic Signal Head (#37).....EACH
- F) LED 3-Section Traffic Signal Head (#54L).....EACH
- G) LED 3-Section Traffic Signal Head (#54L) (Louvered).....EACH
- H) LED 3-Section Traffic Signal Head (#54R).....EACH
- I) LED 3-Section Traffic Signal Head (#54R) (Louvered).....EACH

- J) LED 3-Section Traffic Signal Head (#64R).....EACH
- K) LED 3-Section Traffic Signal Head (#64L).....EACH
- L) LED 4-Section Traffic Signal Head (S-13L).....EACH
- M) LED 4-Section Traffic Signal Head (S-13L) (Louvered).....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 615 – BASE COVERS

615.1 DESCRIPTION

615.1.1 This work consists of furnishing materials and installing base covers around traffic signal poles at the locations shown on the Plans or established by the Traffic Engineer to prevent damage to the wiring at the base of signal poles due to vandalism, protection from the elements and wildlife and other hazards.

615.2 MATERIALS

615.2.1 General: Base Covers shall be a full base cover that covers the underside of the traffic signal pole as well as the anchor bolts and nuts. It shall be designed for easy removal and shall be manufactured specifically to fit the existing or planned signal poles on which they are to be installed. Base covers shall be either aluminum or galvanized steel. All hardware shall be stainless steel.

615.2.2 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

615.3 CONSTRUCTION METHODS

615.3.1 Base covers shall be installed per manufacturer’s specifications and shall be installed such that they are flush to the ground and firmly in-place on the pole and do not rotate or wobble.

615.4 METHOD OF MEASUREMENT

615.4.1 The base covers will be measured by the unit installed complete in place, including all hardware and any incidental items necessary for secure installation.

615.5 BASIS OF PAYMENT

The installation of base covers, measured as provided above, will be paid for at the contract unit prices as follows:

A) Base Covers.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 616 – MAST ARM BRACKETS

616.1 DESCRIPTION

This item consists of furnishing materials and installing mast arm brackets for signs, signal heads, and any other signal equipment, as necessary. Details and information on mast arm brackets are provided in City of Tulsa Standard Drawing 616.

616.2 BASIS OF PAYMENT

All materials, labor, equipment, and incidentals necessary for providing and installing mast arm brackets shall be paid for as part of the cost of the signs, signal heads, or other signal equipment.

PART 617 – SIGNAL POLES AND MAST ARMS

617.1 GENERAL

- 617.1.1 This work shall consist of furnishing materials and installing poles, mast arms, luminaire arms, push button poles and pedestal poles for traffic signals in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

617.2 MATERIALS

- 617.2.1 General: Mast arm and pole assemblies, with the exception of pedestal poles, shall be multi-sided, tapered steel monotube traffic signal mast arms and poles. Pedestal poles may be without taper. All material and workmanship for these products must be United States origin.

- 617.2.2 Standards: Materials shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs 2009, Luminaries and Traffic Signals and ODOT Section 700. Mast arms and poles shall be designed for a minimum of 90 MPH wind velocity and Fatigue Category II with galloping not considered. The following ASTM Standards shall also be met:

A) Shaft: ASTM A570-50.

B) Base and Flange Plates: ASTM A36.

C) All Other Bolts: ASTM A325 (Thread per UNC Series).

D) Pole Top Plate: ASTM A36.

- 617.2.3 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

- 617.2.4 Signal Poles: Unless otherwise specified, furnish each pole with a reinforced handhold and weatherproof cover. Signal poles shall not have a terminal block in the handhole. Anchor bases may be either cast or structural plate.

- 617.2.5 Signal Mast Arms: Signal mast arms over 50'-0" shall be two sections slipped together after galvanizing and held in place with one 5/8" diameter pin bolt. The arm is to be shipped assembled. Mast arms shall be of the length shown on the Plans. Signal mast arm poles shall be designed to support signals and/or signs of the weight and area as indicated on the plans.

- 617.2.6 Signal Pole Anchor Bolts: Anchor bolts shall meet manufacturer's specifications and shall be installed square to roadway centered in the base, with a 6" hook, two hex nuts (A-563-GR-A), two flat washers (F436), and one lock washer, or approved equals. Bolts for mast arm bases shall be ASTM A325 (thread per UNC series). The holes in the base plates shall be oversized holes (diameter of anchor bolt plus 5/16") to allow

for future raking of the signal pole for oversized loads. Raking is defined as loosening the nuts on the anchor bolts at the base plate of the signal pole so the signal pole may be pushed or pulled to a maximum of 3 degrees out of plumb.

- 617.2.7 Pedestal Poles: All pedestal poles and push button poles shall have a stabilizing collar. Pins shall be installed.
- 617.2.8 Pedestal Pole Anchor Bolts: Anchor bolts for pedestal pole bases shall be stainless steel wedge anchor bolts or approved equal and shall include the following hardware:
- A) Quantity four of 3/4" x 8-1/2" stainless steel wedge anchors,
 - B) Quantity four of 2-1/2" O.D. x 1-1/16" stainless steel flat washers,
 - C) Quantity four of 1-7/8" O.D. x 3/4" stainless steel flat washers,
 - D) Quantity four of 3/4" stainless steel lock washers, and
 - E) Quantity four of 3/4" stainless steel hex nuts.
- 617.2.9 Luminaire Arms: Luminaire arms shall support the weight of a 75 lb. luminaire with a projected area of 3.3 square feet and provide a smooth raceway for the wiring and each shall come with a slip-fitter tenon.
- 617.2.10 Finish: Each assembly shall be galvanized to ASTM A123. The top portion of the anchor bolts shall be galvanized to ASTM A153. All threaded fasteners shall be galvanized to ASTM A153.
- 617.2.11 Welds: All welding must be performed at the manufacturer's place of business by AWS Certified welders. All welds shall conform to the latest AWS D1.1 requirements.
- 617.2.12 Pole and Mast Arm Identification Markings: All mast arms shall be permanently marked with the length of the arm on the flange plate. Poles are to be permanently marked with the arm length range on the top side of the base plate. All parts (top, end, caps, hand hole covers and attachment hardware), with the exception of the anchor bolts, are to be packed on a per pole basis and identified for the mast arm assembly that corresponds with the parts. All sections shall be color coded per the marking legend shown in City of Tulsa Standards Drawings 617 and 618 in the following locations:
- A) Bottom of the base plate.
 - B) Bottom of the arm flange plate.
 - C) Bottom of the luminaire flange plate.
 - D) Inside of the luminaire extension.
 - E) Inside of the arm extension.

617.2.13 Inspection: All materials shall be inspected by an authorized agent of the City of Tulsa Traffic Operations Division to ensure compliance with the specifications.

617.3 CONSTRUCTION METHODS

617.3.1 The manufacturer shall submit shop and design drawings, and calculations in accordance with ODOT Subsection 105.02.

617.3.2 Mast arms may be mounted to the pole prior to erection of the pole. Care shall be taken not to damage the pole, mast arm, luminaire arm, or finish during erection. If the finish is damaged, repair it at no additional cost and in a manner approved by the Traffic Engineer.

617.3.3 All unused, drilled holes in the poles or mast arms shall be resealed by non-ferrous rain-tight materials and methods as approved by the Traffic Engineer.

617.3.4 Level anchor base poles with double nuts leveling.

617.3.5 Install all fasteners in accordance with the manufacturer's specifications.

617.3.6 Cast all structural casting in permanent molds.

617.3.7 The nominal mounting height of the luminaries or traffic signal shall be as indicated in City of Tulsa Standards and Specifications or as shown on the Plans. Luminaires shall be installed at the end of the luminaire arm. 110 volts shall be supplied on a separate circuit from the cabinet to the standard base and identified with yellow tape. A 5-amp fuse shall be installed in the signal base. The Contractor shall provide the LED luminaire(s) and related equipment (LED Fixture(s), 120V photocell, inline fuse holder, and 5-amp ktk fuse).

617.3.8 Make sure poles are straight and centered on the longitudinal axis. Install a removable pole cap on each signal pole (except pedestal signal poles where slip fitters are used).

617.3.9 Provide all metallic poles with a bonding connection inside the base of the signal pole and ground them as shown on the Plans.

617.3.10 Traffic signal poles shall be grounded to a ground rod located in the foundation. No. 4 AWG stranded copper wire shall be installed from the ground rod to the pole grounding lug.

617.3.11 The Traffic Engineer shall inspect the pole rake and mast arm installation after all equipment has been installed on the mast arm before final approval.

617.4 METHOD OF MEASUREMENT

617.4.1 Poles and mast arms, push button poles, pedestal poles, and post top poles of various types, sizes, and lengths will be measured by each unit installed.

617.5 BASIS OF PAYMENT

The accepted poles and mast arms, measured as provided above, will be paid for at the contract unit price as follows:

- A) Modular Traffic Signal Mast Arm Poles with Luminaire Extension.....EACH
- B) Modular Traffic Signal Mast Arm Poles without Luminaire Extension.....EACH
- C) Six Foot Pedestrian Push Button Pole.....EACH
- D) Ten Foot Pedestal Pole.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as shown on the Plans and these specifications.

PART 618 – BONDING

618.1 GENERAL

- 618.1.1 This pay item shall consist of furnishing all conductors, split bolts, miscellaneous hardware and connections necessary to bond the traffic signal standards and/or pedestals from the bonding point and the service disconnect buss as shown in City of Tulsa Standard Drawing 619, Bonding Detail.

618.2 MATERIALS

- 618.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.
- 618.2.2 Bonding Wire: Use a #6 THHN stranded wire as the bond wire. See City of Tulsa Specification 611 Conductors for more details.
- 618.2.3 Split Bolts and Hardware: Split bolt standard connections shall be copper, and UL rated for the right size multiple conductors. No zinc coated hardware allowed. Use stainless steel hardware to fasten split bolts to poles.

618.3 CONSTRUCTION METHODS

- 618.3.1 There shall be #6 green THHN stranded copper connected to the bonding point of each traffic signal standard or pedestal and the service disconnect ground buss (see City of Tulsa Standard Drawing 607)
- 618.3.2 If the bonding connection is inadequate standard or base shall be drilled away from traffic.
- 618.3.3 Service #8 green THHN shall be isolated with connection at service ground and cabinet suppressor (check this matches the service standard/specifications).
- 618.3.4 There shall be no connection made to the ground rod in the traffic signal cabinet. It is for test purposes only.
- 618.3.5 Bonding wires do not go to grounding rods in pedestals, standards, or pull boxes.
- 618.3.6 All bonding wires shall be installed oriented to the corner of the service, not the control cabinet.
- 618.3.7 All bonding wire connections shall be made above finished grade, no splices allowed in pull boxes.
- 618.3.8 All bonding wire shall be wrench tight.

618.4 BASIS OF PAYMENT

All materials, labor, equipment, and incidentals necessary to complete the work as specified herein for bonding shall be paid for as part of the cost of the wiring, per City of Tulsa Specification 611.

PART 619 – TEMPORARY SIGNALS

619.1 GENERAL

- 619.1.1 This work consists of furnishing material and installing a temporary traffic signal when an existing signal must be taken out of service.

619.2 MATERIALS

- 619.2.1 Existing poles and mast arms may be used as part of the temporary signal, span wires may be attached to existing poles, or wooden poles may be provided with span wire equipment.

619.3 CONSTRUCTION METHODS

- 619.3.1 Temporary signals should be installed in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

619.4 METHOD OF MEASUREMENT

- 619.4.1 Temp Signal Span: This item includes all equipment and installation necessary for a temporary signal across one leg of an intersection using overhead signal cable from one standard or temporary wooden pole to another standard or temporary wooden pole. This includes all equipment and installation necessary for a temporary signal across one leg of an intersection including, but not limited to, a guy span, cable, signal heads, and any hardware or incidental items needed to connect the span and cables and make it operational. This item does not include payment for standards, poles, cabinet, or service.
- 619.4.2 Temp Signal Pole: This item includes temporary wooden poles and hardware as necessary to install a temporary signal.
- 619.4.3 Temp Signal Cabinet: This item includes all equipment and installation necessary for a traffic signal control cabinet with controller needed to operate a temporary traffic signal when the existing cabinet cannot be utilized. The temporary cabinet is the property and responsibility of the Contractor and will be retained by contractor after job completion.
- 619.4.4 Temporary Signal Service: This item includes any necessary meters or service connections to provide electrical service to the temporary signals. All electrical service connections must meet the applicable requirements of the NEC, PSO, and City of Tulsa Electrical Requirements as detailed in City of Tulsa Specification 607 unless otherwise authorized by the City Traffic Engineer.

619.5 BASIS OF PAYMENT

Temporary signal items, installed and operational in place, measured as provided above, will be paid for at the contract unit price as follows:

- A) Temp Signal Span.....PER EACH
- B) Temp Signal Pole.....PER EACH
- C) Temp Signal Cabinet.....PER EACH
- D) Temp Signal Service.....PER EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 620 – VIDEO DETECTION SYSTEM

620.1 GENERAL

- 620.1.1 This work consists of furnishing materials and installing a video detection system in accordance with these specifications. For the purposes of video detection systems, signals at interchanges are considered separate intersections at each end of the interchange.

620.2 MATERIALS

- 620.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.
- 620.2.2 The video detection system provided shall be fully compatible with existing City of Tulsa video equipment and cabinets and shall include built-in Ethernet communications capability for remote monitoring and setup of the system as well as the capability to zoom and focus the image both in the cabinet and remotely at an off-site location.
- 620.2.3 The video detection shall be wired in the controller cabinet and shall be installed according to manufacturer's specifications. Video detection systems shall come with Video Filter/ Power Panel for video detection. When required, each video camera shall have a separate appropriately sized circuit breaker for camera power. The video filters shall be "EDCO" Video Filter CX06-BNCY, CX06-M or an approved equal will also be accepted. Each video camera shall have a separate appropriately sized circuit breaker for camera power. Manufacturer specific video detection system requirements shall be detailed on the Approved Products List.
- 620.2.4 Video cable shall meet the requirements of City of Tulsa Specification 611.
- 620.2.5 Video cards shall be provided for each intersection. The number of cards to be provided may vary by system and shall be designated on the Approved Products List.
- 620.2.6 If video detection is to be installed in a NEMA style cabinet, it shall be PEAK video track IQ, Autoscope, or approved equal with two 4-channel video cards supplied per intersection.
- 620.2.7 Where a controller cabinet is not already wired to accept video detection a rack and any other equipment necessary for installation of the video detection shall be provided as part of the video detection system.

620.3 CONSTRUCTION METHODS

- 620.3.1 Video detection assembly shall be installed per manufacturers' recommendation.
- 620.3.2 The minimum mounting height for video cameras shall be 25' above the roadway surface.

- 620.3.3 A 6" x 6" junction box shall be provided on the mast arm near the video camera mount. Junction boxes shall either be powder coated metal or UL F1 rated NEMA 3 gray polycarbonate.
- 620.3.4 The Traffic Engineer shall approve all camera locations and elevations prior to installation.
- 620.3.5 The Traffic Engineer shall approve the video image of each camera prior to acceptance of the signal by the City.
- 620.3.6 For signals currently in operation, video cameras shall be put into operation a maximum of two weeks after installation.
- 620.3.7 For new signals or signals out of operation, video detection shall be operational when the signal is put into operation.
- 620.3.8 During construction, the contractor shall set up and adjust the detection zones to accommodate shifts in traffic due to work zone traffic control adjustments. Once construction is complete on the project and the permanent pavement markings are in place, the contractor shall realign the video detection zones to their permanent configuration as directed by the Traffic Engineer.

620.4 METHOD OF MEASUREMENT

- 620.4.1 The video detection system shall include the installation of video detection per intersection, including but not limited to one or more cameras per approach as indicated by the plans or as directed by the Traffic Engineer, set-up and installation equipment, pole extension, mounts, brackets, cable, wire, hardware, monitor, keyboard, video cards, and any other appurtenances necessary to make the vehicular detection operational.

620.5 BASIS OF PAYMENT

The accepted video detection system, measured as provided above, will be paid for at the contract unit price as follows:

A) Video Detection System.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

PART 621 – HIGHWAY, STREET, AND PEDESTRIAN LIGHTING

621.1 GENERAL

- 621.1.1 This work consists of providing and installing electrical conductors, poles, luminaires, high-mast poles, and high-mast lowering devices for street, trail, pedestrian, and highway lighting systems.

621.2 MATERIALS

- 621.2.1 Approved Products List: All materials shall be new, unused, and undamaged. All materials provided for highway lighting shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL). All poles, ballasts and lights on City streets must also be types that American Electric Power (AEP) / Public Service Company of Oklahoma (PSO) will maintain.

- 621.2.2 Electrical Conductors for Lighting: Provide Materials in accordance with ODOT Section 738.02 and City of Tulsa Standard Specification 611. For wiring inside of the poles, wire shall be #12 Copper THWN Black and #12 Copper THWN White. For wiring between the poles, wiring shall be #4 Aluminum XHHW Black and #4 Aluminum XHHW White. Ground wires shall be either #12 Copper THWN Solid Green, #4 Aluminum Stranded XHHW Green, or solid bare copper wire sized in accordance with the National Electric Code (NEC). Other configurations of wiring may be used only with approval of the Traffic Engineer.

621.2.3 Conduit and Underground Infrastructure:

- A) Junction boxes for 1" plastic coated rigid metallic conduit shall be as follows: two-gang, feed-thru, deep, three-threaded hubs, with cover.
- B) Liquid tight metallic conduits shall not be stainless steel or aluminum.

621.2.4 Lighting Controllers:

- A) 480 Volt Services: The magnetic controller for 480 Volt services shall be in a cast aluminum rain tight enclosure as shown on City of Tulsa Standard Drawing 621A and be composed of:
 - 1) 480/120 Volt potential transformer.
 - 2) Magnetic relay having a 120-volt operating coil and normally open 480-volt DPST contacts rated as shown in City of Tulsa Standard Drawing 621A.
 - 3) Three-pole polarized twist lock photoelectric control.
 - 4) Fuse clips for two renewable link type fuses.

- 5) All control wire shall be copper #12 AWG. All power conductors shall be aluminum #4 XHHW.
 - 6) Terminals suitable for #12 AWG standard copper conductors. Terminals shall be labeled.
 - 7) Line, load, and neutral terminals shall be #4 XHHW aluminum conductors.
 - 8) Line and load lightning arrestors shall be externally mounted.
 - 9) Circuitry in the controller shall be according to the wiring diagram shown on City of Tulsa Standard Drawing 621A.
 - 10) The enclosure shall be a hinged door with two door fasteners and locking capabilities and a mounting bracket for attachment to the pole with two 5/8" diameter lag screws.
 - 11) Enclosure shall be 24" x 24" x 10".
 - 12) Photoelectric Control shall be either an Intermatic LC4536C or approved equal.
 - 13) The "Auto Manual" test switch shall be a 3-wire, 2-pole, 20-amp outdoor circuit breaker in either a NEMA 3R or 4 enclosure with provisions for padlocking.
 - 14) Lighting arrestor shall be a 1-pole, 600 or 650-volt rated with 3/4" NPT pipe nipple with lock nut and brushing washer and 1'-6" long leads.
 - 15) The disconnect switch shall be a fusible 60-amp, 3-pole, 600-volt, in a NEMA 3R enclosure with provisions for padlocking the switch handle and door. The switch shall be provided with the appropriately sized fuse to fit the load and shall be equipped with the appropriate conduit hubs. 600-volt services shall require a second disconnect above the meter that is unfused.
- B) 240 Volts: If the secondary voltage is 120 or 120/240 the controller shall be the same as the above described unit except the potential transformer may be eliminated and the model number changed accordingly.

621.2.5 Poles:

- A) Galvanized steel poles: Provide materials in accordance with ODOT 806.02.
- B) Wood poles: Provide wood poles in accordance with ANSI 05.1.
- C) High mast poles: Provide Materials in accordance with ODOT Section 812.02.
- D) High mast lowering devices: Provide materials in accordance with ODOT Section 813.02. All high mast lowering devices shall be top latching.

E) Break away base: Provide Materials in accordance with ODOT 807.02.

621.2.6 Anti-theft Devices:

- A) All handhold covers and lighting pole transformer base doors shall be the Pelco Copper Safe System, or approved equal, and shall come with all associated hardware and locking kits needed for installation and proper use of the system, sized to fit the pole where it is to be installed.
- B) Anti-theft cabling devices shall be the Pelco Copper Safe Retainer System, or approved equal, and shall come with all associated hardware needed for installation and proper use of the system.

621.2.7 Luminaires:

- A) Roadway Luminaire – Provide Materials in accordance with ODOT 809.02.
- B) Underpass Luminaire – Provide Materials in accordance with ODOT 809.02.
- C) High Mast Lighting – Provide Materials in accordance with ODOT 809.02.
- D) Post Top Lighting – Provide Materials in accordance with ODOT 809.02.

621.2.8 LED Luminaires:

- A) LED replacement fixtures shall replace the entire fixture. Retrofit kits shall not be accepted.
- B) All specified equipment shall be purchased new directly from an authorized distributor/reseller or manufacturer of luminaires product.
- C) All referenced national standards, including but not limited to IES, ANSI, ASTM, IESNA, FTC, and NEMA are to be the most current versions and shall be superseded by updated versions as they become available.
- D) LED luminaires shall meet the following requirements:
 - 1) Luminaires shall include a housing, ballast, reflector, refractor, and lamp of the type and lumen rating as indicated on the materials request.
 - 2) LED luminaires shall come with a seven-pin receptacle and shall be designed to have a photocell for each fixture instead of only at the lighting controller.
 - 3) Luminaire shall meet foot candle and uniformity values as outlined in ANSI/IESNA RP-8-14, American National Standard Practice for Roadway Lighting, or the most current version.

- 4) Where LED fixtures are to be installed on existing poles luminaires shall meet the design parameters as close as possible utilizing the existing spacing.
- 5) LED luminaires shall have a minimum luminaire efficacy of 100 lumens per watt.
- 6) Luminaire shall be rated for operation in -40° C to 40° C ambient temperature.
- 7) Transmissive optical components shall be applied in accordance with OEM design guidelines to ensure suitability for the environment (e.g., electromagnetic, thermal, mechanical, chemical).
- 8) Luminaire shall be designed for ease of component replacement and end-of-life disassembly.
- 9) Electrical components shall come with disconnect connectors for ease of installation and maintenance.
- 10) Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
- 11) Luminaire shall accept the voltage or voltage range specified at 50/60 Hz and shall operate normally for input voltage fluctuations of $\pm 10\%$.
- 12) All internal components shall be assembled and pre-wired using modular electrical connections.
- 13) The following shall be in accordance with corresponding sections of ANSI C136.37.
 - a) Terminal blocks for incoming AC lines (electrical mains wires)
 - b) Photocontrol receptacle (when applicable)
 - c) Latching and hinging
 - d) Mounting provisions
 - e) Ingress protection
- 14) Luminaire shall have an external label per ANSI CI 36.15 and an internal label per ANSI C136.22.
- 15) Fixture must have an IESNA luminaire classification not to exceed TM-15: B2 U2 G3.

E) LED housings shall meet the following requirements:

- 1) The housing shall be cast aluminum and shall be rust resistant and powder coated.
 - 2) Driver shall be mounted internally and field replaceable.
 - 3) All screws shall be stainless steel.
 - 4) All components that require regular maintenance will require captive screws.
 - 5) Painted or furnished luminaire surfaces shall achieve a scribe creepage rating of eight per ASTM D1654 after 5,000 hours exposure to salt fog chamber per ASTM B117.
 - 6) Meets minimum vibration withstand and capability as outlined in ANSI C136.31, 3G rated.
- F) Optical requirements for LEDs shall be as follows:
- 1) The lens shall be clear, tempered, shock resistant glass. The optical system shall be sealed to protect against water and dirt with an IP66 Enclosure rating. The optic life should last as long as the other fixture components.
 - 2) Optic Assembly shall be rotatable to provide alignment of asymmetric distributions to the roadway.
- G) Color attributes and color shift for LEDs shall be as follows:
- 1) Color Rendering Index (CRI) shall be no less than 70.
 - 2) Nominal Correlated Color Temperature (CCT) shall be 4,100 K +/- 300 K.
- H) LED drivers shall meet the following requirements:
- 1) The minimum power factor of the power supply shall be .90 or greater at full input power and across specified voltage range.
 - 2) Electronic driver has an expected life of 100,000 hours at 25° C, L83.
 - 3) LED light engines are rated >100,000 hours at 25° C ambient temperature.
 - 4) Driver meets maximum harmonics distortion (THD) of 20% and is RoHS compliant.
 - 5) Provide a three-stage terminal block for ease of installation.
- I) Photocontrol receptacles and control interfaces for LEDs shall be as follows:
- 1) Photocontrol provided must be specifically designed for use with LED fixtures.

- 2) Luminaire designation(s) indicated "ANSI C136.41, 7-pin" shall be fully prewired and shall incorporate an ANSI C136.41 compliant receptacle. If a dimmable LED driver is specified, its 0-10V or DALI control wires shall be connected to the receptacle pads as specified in ANSI C136.41; connection of the two remaining pads shall be by Supplier, as directed by Owner.
 - 3) Provide a long-life solid-state locking-style photocontrol with a minimum 20-year rated life.
- J) Interference and power quality for LEDs shall be as follows:
- 1) Luminaire shall comply with FCC 47 CFR Part 15 interference criteria for Class A digital devices.
 - 2) Luminaire shall comply with Section 5.2.5 (luminaires rated for outdoor use) interference criteria of ANSI C82.77 at full input power and across specified voltage range.
- K) Thermal management for LEDs shall be as follows:
- 1) Luminaire shall start and operate in ambient temperature range specified.
 - 2) Maximum rated case temperature of driver and other internal components shall not be exceeded when luminaire is operated in ambient temperature range specified.
 - 3) The thermal management system shall facilitate hose-down cleaning and be resistant to debris buildup.
 - 4) No liquids or moving parts shall be accepted.
- L) Electrical safety and immunity requirements for LEDs shall be as follows:
- 1) Luminaire shall be listed for wet locations.
 - 2) A surge device shall be included and shall be designed to meet ANSI/IEEE C62.41, Category C, with a high exposure level.
 - 3) Luminaire shall meet the performance requirements specified in ANSI C136.2 for dielectric withstand, using the DC test level and configuration and electrical immunity, using the combination wave test level – Basic (6kV / 3kA).
 - 4) Manufacturer shall indicate on submittal form whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

621.2.9 Concrete Footings for Lighting Poles: Provide materials, including concrete, steel, and anchor bolts in accordance with ODOT Section 700, "materials", and the latest edition

of the AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals. Footings shall be constructed in accordance with ODOT detail sheet No. T-304, design number GMF1-2, with the exception that all conduit ends shall be reamed and bushings shall be installed prior to installing any wires. All concrete footings shall be cast-in-place. Pre-cast concrete footings will not be accepted.

621.2.10 Electrical Services: Electric Service shall be provided in accordance with City of Tulsa Specification and Standard Drawing 607A and B and current AEP requirements. All electrical services shall be bonded to #4 bare copper wire connected to (2) – 5/8" copper clad ground rods, spaced 6' apart, and each ground rod shall extend a minimum of 8' into the soil. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

- A) Disconnect switches shall be as follows: 60-Amp, 600-Volt, 3-Pole, NEMA 3R.
- B) Channel Strut shall be as follows: Galvanized, half-slot, 1-5/8" x 10' sections.
- C) Band Straps shall be stainless steel with the following dimensions: 3/4" wide x 3/10" thick.
- D) Band Strap Clips shall be stainless steel.
- E) Grounding clamps shall be acorn style. Ground rods shall be copper clad with the following dimensions: 8' long minimum and 5/8" diameter.

621.2.11 Padlocks:

- A) Padlocks shall be secured with a specialized key to better secure the lighting controllers. Contact the Traffic Operations Division for specific details on the size and type of padlock typically used and for approval of any other equivalent systems.
- B) Padlocks shall be considered incidental to the cost of the lighting controller or service.

621.2.12 Tests and Acceptability of Materials:

- A) Submittals for materials and parts not included in the Approved Products List shall be provided as set forth in this specification. Any substitutions or changes must be approved by the Traffic Engineer prior to acceptance of the products or services.
- B) To have LED luminaires considered for addition to the Approved Products List or for consideration as an approved equal on a project, provide five copies of the following materials schedule and proposed equipment including catalog cuts, diagrams, drawings and the following:

- 1) LM-79 luminaire photometric report(s) shall be produced by the test laboratory. The test laboratory must hold National Voluntary Laboratory Accreditation Program (NVLAP) accreditation for the IES LM-79 test procedure.
 - 2) Complete luminaire catalog number.
 - 3) Goniophotometry – Backlight-Uplift-Glare (BUG) ratings shall be for initial (worse-case) values, i.e., Light Loss Factor (LLF) – 1.0.
 - 4) Lumen Depreciation in accordance with the most current version of IES LM-80 and IES TM-21.
 - 5) Computer generated point by point photometric analysis of maintained light levels per ANSI/IES RP-8. Calculations shall be for maintained values, i.e. Light Loss Factor (LLS) < 1.0, where $LLF = LLD \times LDD \times LATF$ and Lamp Lumen Depreciation (LLD) based on the TM-21 data and 50,000 hours of operation, with the following requirements:
 - a) Luminaire Dirt Depreciation (LDD) = 0.90,
 - b) Luminaire Ambient Temperature Factor (LAT F) = 0.96, and
 - c) Listing and labeling by applicable testing bodies as determined by the U.S. Occupational Safety and Health Administration (OSHA) as a Nationally Recognized Testing Laboratory (NRTL) which includes: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).
 - 6) Documentation supporting any U.S. origin claims for the product, in accordance with FTC guidance.
 - 7) Summary of reliability testing performed for LED driver(s).
 - 8) Safety certification and file number indicating compliance with UL 1598.
 - 9) Written product warranty.
- C) In addition, for LED products, before approval and purchase, the City may request luminaire samples identical to product configurations submitted for inspection. The City may request IES LM-79 testing of luminaire samples to verify performance is within manufacturer-reported tolerances. Vendors must electrically test fully assembled luminaires before shipment from factory and provide documentation to the City prior to acceptance of the product. After installation, the City may perform IES LM-50 (field measurements) to verify performance requirements, giving consideration to manufacturing tolerances and measurement uncertainties as outlined in IES LM-61 and NEMA LSD 63.

621.2.13 Warranties:

- A) Materials shall come with either a one-year warranty or a standard manufacturer's warranty, whichever is longer.
- B) LED products shall come with a minimum five-year warranty covering maintained integrity and functionality of the following:
 - 1) Luminaire housing, wiring, and connections.
 - 2) LED Light source(s) – Negligible light output from more than 10% of the LED packages constitutes luminaire failure.
 - 3) LED Driver(s).

621.3 CONSTRUCTION METHODS

621.3.1 Electrical Conductors: Follow construction methods as outlined in ODOT Specification 811.04 Electrical Conductors for Highway Lighting with the following exceptions:

- A) City of Tulsa will require the use of a grounding conductor as specified in the National Electrical Code. See City of Tulsa Standard Drawing 621B for installation details.
- B) In addition to the internal fuse located within each light pole base as directed in ODOT Specification 810.04 D install fuse holders and fuses in line with the light wiring, in series with the 240V or 480V feed. The length of the circuit shall be divided into three lengths: the fuse located closer to the controller shall be a 30-amp fuse. The second fuse installed shall be a 20-amp fuse and the fuse located furthest away from the controller shall be a 10-amp fuse. See City of Tulsa Standard Drawing 621 for fuse locations. In line fuses shall be included in the cost of the Conductor.

621.3.2 Lighting Controllers:

- A) Provide control equipment in accordance with NEMA 3R or 4 and UL Specifications.
- B) All connections shall be of either bolted type or compression type.
- C) Conduits shall be strapped to the pole at intervals not to exceed 4'-0".
- D) See plan sheets for service pole locations, number of controllers required, and contact ratings.
- E) 6ft tall chain link fence, a gate, razor wire, and 6" thick concrete housekeeping pads shall be installed around lighting controllers and service poles. Price for all these items shall be included in the cost of the lighting controllers.

621.3.3 Poles:

- A) Galvanized steel poles: Follow construction methods outlined in ODOT 806.04.
- B) Wood poles: Follow construction methods outlined in ODOT 810.04.
- C) High mast poles: Follow construction methods outlined in ODOT 812.04.
- D) High mast lowering devices: Follow construction methods outlined in ODOT 813.04.
All high mast lowering devices shall be top latching.
- E) Break away base: Follow construction methods outlined in ODOT 807.04.
- F) Concrete Footings for Light Poles: Construct lighting pole foundations in accordance with ODOT 804.04.
- G) Concrete housekeeping pads shall be installed at all light pole footings. These housekeeping pads shall be 4" thick minimum and extend a minimum of 2ft all around the light poles. Price for housekeeping pads shall be included in the cost of the light pole footing.

621.3.4 Luminaires:

- A) Roadway luminaire: Follow construction methods outlined in ODOT 809.04.
- B) Underpass luminaire: Follow construction methods outlined in ODOT 809.04.
- C) High mast lighting: Follow construction methods outlined in ODOT 809.04.
- D) Post top lighting: Follow construction methods outlined in ODOT 809.04.
- E) LED Luminaires: Install in accordance with Manufacturer's recommendations.

621.4 METHOD OF MEASUREMENT

- 621.4.1 Electrical Conductors: The electric conductors will be measured by the foot for each of the various types specified and installed, and shall include all in line fuses, connectors, splices, and incidentals necessary to power the lighting system as provided in the plans.
- 621.4.2 Lighting Poles and Bases: Poles and bases shall be paid for by each.
- 621.4.3 Lighting Controllers: The Lighting Controllers shall be paid for by each fully installed. Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.
- 621.4.4 Luminaires: Luminaires shall be paid for as each complete fixture installed.

621.4.5 Concrete Footings: Foundations for lighting poles shall be in accordance with ODOT 804.

621.5 BASIS OF PAYMENT

The accepted lighting items, measured as provided above, will be paid for at the contract unit price as follows:

- A) 1/C #12 Copper THWN Electrical Conductor, Black.....LINEAR FOOT
- B) 1/C #12 Copper THWN Electrical Conductor, White.....LINEAR FOOT
- C) 1/C #12 Copper THWN Electrical Conductor, Green.....LINEAR FOOT
- D) 1/C #4 Aluminum XHHW Electrical Conductor, Black.....LINEAR FOOT
- E) 1/C #4 Aluminum XHHW Electrical Conductor, White.....LINEAR FOOT
- F) 1/C #4 Aluminum XHHW Electrical Conductor, Green.....LINEAR FOOT
- G) 1/C #4 Copper Stranded Bare Wire.....LINEAR FOOT
- H) Lighting, Galvanized Pole and Mast Arm.....EACH
- I) Lighting, Decorative Pole.....EACH
- J) Lighting, 35' Wood Pole.....EACH
- K) Lighting, High Mast Pole.....EACH
- L) High Mast Lowering Device, Top Latching.....EACH
- M) Breakaway Transformer Base.....EACH
- N) Anti-Theft Breakaway Transformer Base Door.....EACH
- O) Anti-Theft Cable Retainer System for Breakaway Transformer Bases.....EACH
- P) Lighting Controller, 240V.....EACH
- Q) Lighting Controller, 480V.....EACH
- R) Highway Luminaire, 250W HPS Mongoose Fixture.....EACH
- S) Highway Luminaire, 400W HPS Mongoose Fixture.....EACH
- T) Highway Luminaire, 200W HPS Cobra Head Fixture.....EACH

- U) Highway Luminaire, 400W HPS Cobra Head Fixture.....EACH
- V) Highway Luminaire, LED 250W HPS Equivalent Fixture.....EACH
- W) Highway Luminaire, LED 400W HPS Equivalent Fixture.....EACH
- X) Highway Luminaire, LED 200W HPS Equivalent Fixture.....EACH
- Y) Highway Luminaire, LED 400W HPS Equivalent Fixture.....EACH
- Z) Underpass Luminaire, 100W HPS.....EACH
- AA) Underpass Luminaire, LED 100W HPS Equivalent.....EACH
- BB) Highmast Luminaire, 1,000W MH.....EACH
- CC) Highmast Luminaire, 12-LED 1,000W MH Equivalent Fixture.....EACH

Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.

PART 622 – WIRELESS TRAFFIC SIGNAL COMMUNICATIONS SYSTEM

622.1 DESCRIPTION

622.1.1 This work consists of furnishing materials and installing wireless traffic signal communications equipment per intersection.

622.2 MATERIALS

622.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

622.2.2 Communications equipment provided shall include the following per intersection:

- A) One Ethernet switch with rack power supply: Unit shall be a managed Ethernet switch hardened to NEMA TS/2 Specifications. Temperature range shall be -34° C to 74° C. Unit shall have at least 8 ethernet ports (6+2 modular is acceptable) 10/100/1000Base(T)X.
- B) One Access Point Module: Access point module shall be at a minimum point to multipoint wireless 5.7 Gigahertz devices. Unit shall have AES encryption and have Cambium software. Unit shall have PMP450i access points or better. Unit shall be compatible with existing Cambium cnMaestro management software. Unit shall come with two universal mounts and power supplies with power cords.
- C) One Subscriber Module: Unit shall be part of a point to multi-point wireless system and shall include at a minimum a 5.7 Gigahertz radio. Unit shall have AES encryption and have Cambium software. Unit shall have PMP450i access points or better. Unit shall come with two universal mounts and power supplies with power cords.
- D) Two antennas, 5Ghz PTP450i end, integrated high gain antennas.
- E) CAT 6 cable, rated for outdoor use, from the controller cabinet to the wireless equipment. All cable and wiring shall meet the requirements of City of Tulsa Specification 611.
- F) Two surge suppression modules for wireless access point and subscriber module, (one for each).
- G) If fiber is used for communications, it shall be coordinated with the City of Tulsa IT Department and Traffic Operations.

622.3 CONSTRUCTION METHODS

622.3.1 The Traffic Engineer shall locate all communications equipment prior to installation.

622.3.2 The City of Tulsa Traffic Operations Division shall install the communications equipment.

622.3.3 The Contractor shall pull CAT 6 cable from the controller to the signal pole where the communications shall be mounted.

622.3.4 Excess cable shall be stored in the handhole of the signal pole and in pull boxes.

622.3.5 Extreme cautions shall be used when working with the CAT 6 cable to prevent bending or crimping the cable.

622.4 METHOD OF MEASUREMENT

622.4.1 Wireless traffic signal communications equipment will be measured per intersection installed complete in place, including all hardware and any incidental items necessary for installation.

622.5 BASIS OF PAYMENT

The installation of a wireless traffic signal communications system, measured as provided above, will be paid for at the contract unit prices as follows:

A) Wireless Traffic Signal Communication System.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 623 – BATTERY BACKUP

623.1 DESCRIPTION

- 623.1.1 The equipment furnished under this specification shall be the latest production models conforming to the latest Standard Specifications of the Oklahoma Department of Transportation (ODOT) and the City of Tulsa. The below listed Specifications are the desired minimum. Bidder's equipment should equal or exceed these specifications. Deviations may be accepted only as approved by the Traffic Engineer.

623.2 MATERIALS

- 623.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL).

623.2.2 Standards and Testing:

A) The equipment shall conform to the requirements of the National Electrical Manufacturers Association (N.E.M.A.). Any equipment manufacturer shall supply certification showing that the particular model of equipment intended to be furnished has been tested and approved by a qualified independent testing laboratory per requirements specified in the N.E.M.A. Standard. A qualified independent testing laboratory is defined as a laboratory which clearly shows that it is capable of performing the test in accordance with the N.E.M.A. The manufacturer shall supply qualification statements and/or other documentation that indicates that the laboratory is professionally recognized, reputable in nature, and equipped with or has access to all necessary testing apparatus to supply a certified letter with delivery of the equipment (identified by location and serial number) indicating that the particular equipment furnished is identical to the equipment that was tested and approved and that all "components and parts" used in assembling the equipment are equal or superior in quality to the ones used in the testing of the equipment.

B) The battery backup system shall have manufacturer's certificates (if needed), warranty of service, instruction books, service manuals, a list of generic part numbers for service personnel, and complete installation instructions.

- 623.2.3 General: The system shall provide a 120 VAC 60 Hz pure sine wave. The system shall provide power for normal signal operation, flash operation, railroad preemption and normal/flash combination modes. The system shall be designed for outdoor applications and meet the environmental requirements as is standard in the traffic industry. It shall be compatible to N.E.M.A TS1 & TS2, 170, 332, 332S, 336, and 336S controllers and cabinets. The system shall include all necessary cables, wiring harnesses, battery cables, and all components for proper operation.

623.2.4 Equipment Requirements:

A) Output Power: 1,100 Watts (W) Minimum

- B) Active Output Power: 350 W Minimum
- C) Output/Input Voltage: 120 VAC 60 Hz
- D) Output Waveform: Pure Sine Wave, <3% THD
- E) Input Current: 30 Amps Maximum
- F) Input Voltage Variation: 85-150 VAC
- G) Typical Efficiency: >95%
- H) Max. Charge Current: 30A
- I) Operating Temperatures: -37° C to 74° C
- J) Typical Transfer Time: <33 milliseconds (ms)
- K) Audible Noise at 1M: <55 dba
- L) Lightning/Surge Protection: Must pass ANSI/IEEE C.62.41/C.62.45 Cat A&B
- M) Other Unit Protection: Automatic electronic short circuit/overload shutdown, Automatic over-temperature shutdown, Voltage adjustment due to input voltage variation (for brownout protection)
- N) Other Unit Features: L.E.D. Indicator for Online, On Battery, Low Battery Overload and Fault, or alpha numeric L.C.D.
- O) Other Unit Features: RS-232 Computer Interface Port and Ethernet Port
- P) Typical Battery Recharge Time: 90% in four hours

623.2.5 Warranty: A minimum of 36 months on all battery backup system components shall be provided when using Zinc Blue2. A minimum of 10 years on all battery backup system components shall be provided when using Super Capacitor Battery Modules. The warranty period shall begin within 30 days prior to completion of the project, after all punch-list items have been completed. The contractor shall purchase an extended warranty from the manufacturer as necessary.

623.2.6 Battery Backup System: Shall be one of the following as determined by the Traffic Engineer.

- A) The Battery Backup System shall be an Econolite Zinc Blue2 or approved equal. Battery backup system shall be certified to operate in temperature range of -34° F to 165° F. Numbers of batteries and amp-hour rating shall be sufficient to operate the battery backup system in full signal operation at 350 watts for a minimum of four hours. Batteries shall be provided with appropriate interconnect wiring and

corrosion resistant mounting trays and brackets for the cabinet into which they will be installed. Battery charging system shall be regulated, and temperature compensated. Battery backup system shall be warranted for full replacement for three full years.

B) The Battery Backup System shall be an Econolite ZX2000-48 Super Capacitor Battery Modules and DBLMXU-48 Series Double Conversion UPS or approved equal. Battery backup system shall be certified to operate in temperature range of -34° F to 165° F. The battery backup system shall be sufficient to operate the traffic signal in full signal operation at 350 watts for a minimum of four hours. Modules shall be provided with appropriate interconnect wiring and corrosion resistant mounting trays and brackets for the cabinet into which they will be installed. The charging system shall be regulated, and temperature compensated. Battery backup system shall be warranted for full replacement for ten full years.

623.2.7 Supplemental Battery Cabinet: Mountable to side of controller cabinet, 0.125" thick aluminum type 5052-H32, natural aluminum finish, sturdy, aluminum shelves, lockable cover/door. Battery cabinet shall not exceed 46.5" H x 20.5" W x 10.5" D and shall house all units associated with the battery backup. The supplemental battery cabinet shall only be allowed in specific locations as determined by the Traffic Engineer. In most locations the battery backup system will be required to fit within the controller cabinet without using a supplemental battery cabinet.

623.3 CONSTRUCTION METHODS

623.3.1 The Traffic Engineer shall identify the location for installation of battery backup system prior to installation.

623.3.2 The supplemental battery backup cabinet shall be installed such that the door will open fully. If cabinet guard modifications are necessary, they shall be included as part of the battery backup installation.

623.3.3 When the battery backup system is placed inside the controller cabinet, the cabinet shall be a 332 stretch cabinet or larger.

623.4 METHOD OF MEASUREMENT

623.4.1 Battery backup equipment will be measured per intersection installed complete in place, including all hardware, software, and any incidental items necessary for installation.

623.5 BASIS OF PAYMENT

The installation of battery backup equipment, measured as provided above, will be paid for at the contract unit prices as follows:

A) Battery Backup System.....EACH

B) Battery Cabinet.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 624 – REMOVE AND RESET EXISTING TRAFFIC SIGNAL CONTROLLER ASSEMBLY

624.1 DESCRIPTION

- 624.1.1 This work consists of removing an existing traffic signal controller assembly, removal of the existing concrete pad, conduit and apron, construction of a new concrete pad, conduit, and apron, and reinstallation of the existing controller in the new location.

624.2 MATERIALS

- 624.2.1 All materials and labor shall meet the requirements of City of Tulsa Standards and Specifications for signal construction, cabinet guards and for traffic signal controller assemblies.

624.3 CONSTRUCTION METHODS

- 624.3.1 The Traffic Engineer shall approve the new cabinet location prior to installation.
- 624.3.2 All materials, equipment, and labor necessary to make the electrical connections to the existing controller cabinet shall be included.

624.4 METHOD OF MEASUREMENT

- 624.4.1 Removal and resetting of existing traffic signal controller assemblies will be measured per intersection installed complete in place, including all hardware and any incidental items necessary for installation.

624.5 BASIS OF PAYMENT

The removal and resetting of existing traffic signal controller assemblies, measured as provided above, will be paid for at the contract unit prices as follows:

A) Remove and Reset Existing Traffic Signal Controller Assembly.....Each

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

PART 625 – REMOVAL OF TRAFFIC ITEMS

625.1 DESCRIPTION

- 625.1.1 This work consists of removing all items relating to traffic signals, street signs, and highway lighting items. This work shall meet the requirements of Section 805 of the ODOT Standard Specifications.

625.2 MATERIALS

- 625.2.1 This work shall include, but not be limited to, the removal of the following types of traffic items:

A) Traffic signal items including multi-sided, galvanized traffic signal poles, signal heads, pedestrian signal heads, pedestrian push buttons, backplates, controller cabinet assemblies, cabinet guards, pull box lids, mast arm signs, astro-brackets, span wire equipment, pull boxes, conduit, wire, and all other traffic signal equipment.

B) Street sign items including all ground-mounted street signs, street sign poles or other mounting hardware, sign toppers, sign assemblies with flashers, and sign flasher controllers.

C) Highway lighting items including poles, luminaires, high mast towers, lighting controllers, and undamaged pull box lids.

- 625.5.2 Footings, pull boxes, conduit, wire, green arm poles and all other signal poles, other than multi-sided poles, removed are to become the property of the Contractor unless otherwise specified by the Traffic Engineer. All other items that are in good condition prior to removal shall be returned in good condition to the Traffic Operations Division. Contact the Traffic Operations Division to schedule delivery appointments so the appropriate City staff may be on hand to verify the delivery.

- 625.2.3 Any traffic items not included in this specification for removal shall be handled and removed as determined by the Traffic Engineer.

625.3 CONSTRUCTION METHODS

- 625.3.1 All signal pole and sign footings shall be removed a minimum of 2ft below the ground level or as directed by the Traffic Engineer.

625.4 METHOD OF MEASUREMENT

- 625.4.1 This shall include all labor and incidental items necessary for complete removal of all items relating to traffic signals, street signs, and highway lighting items as detailed in ODOT Section 805 and in this specification. Separate payment shall not be made per item listed, but instead payment for this item shall include removal of all traffic related equipment per intersection or per block for items between intersections, both for items

specifically listed herein and for any other traffic related items found that are not specifically covered by this specification. An intersection is defined as extending to the beginning of a turn lane or 150ft, whichever is greater, unless otherwise designated in project plans.

625.5 BASIS OF PAYMENT

The removal of traffic equipment, measured as provided above, will be paid for at the contract unit prices as follows:

- A) Removal of Traffic Items per Intersection.....EACH
- B) Removal of Traffic Items per Block.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified. If a separate pay item for this work is not required by the Contract, the City of Tulsa will consider the cost to be included in the contract unit price for other relevant items of work.

PART 626 – TRAFFIC SIGNAL CONSTRUCTION AND OPERATION

626.1 GENERAL

626.1.1 This specification covers all work performed on traffic signals in the City of Tulsa. Section 626.2 outlines the requirements when no signal work is anticipated and there is not an approved Traffic Signal Contractor on the project. Section 626.3 outlines the requirements when signal work is anticipated so the project has an approved Traffic Signal Contractor or Subcontractor. The remainder of this specification covers all requirements for Contractors performing traffic signal construction, maintenance, or operations work.

626.2 SIGNAL OPERATION WHERE NO SIGNAL WORK IS ANTICIPATED

626.2.1 On projects that are not anticipated to impact the signals where construction activities will occur near existing signalized infrastructure, the Contractor shall use all due caution to avoid damage to the traffic signal infrastructure.

626.2.2 If a Contractor believes that damage is unavoidable, they should halt that operation and contact the City of Tulsa prior to damaging the infrastructure. The Traffic Engineer, or designee, will determine if other measures need to be taken to avoid the damage or if additional work is necessary on the project for the work to progress.

626.2.3 An approved Traffic Signal Contractor or Subcontractor shall perform all of the work necessary for the signal operations and performing necessary repairs according to Specification 628 Signal and Lighting Project Contractor Experience Requirements.

626.2.4 In the case that the Contractor's operations or work damages any part of the signal infrastructure, the Contractor shall be responsible for any repairs necessary. Any repairs necessary shall be performed by the Contractor at his sole expense.

626.2.5 If the damage to the traffic signal renders any part of it inoperable, the Contractor shall immediately notify the City of Tulsa Traffic Operations Division. The Contractor shall be responsible for any interruptions to the signal operation due to the Contractor's operations and shall perform all work to restore the signal to normal operation at his sole expense (this is solely intended to bring the signal to the same state of operation as it was in prior to the damage), per Section 626.4 Signal Repair and Maintenance Response Times.

626.2.6 The City Traffic Engineer, or designee, shall work with the Contractor to assess the damage, to determine what needs to be done to make the intersection safe for traffic (including vehicles and pedestrians), and to determine what repairs shall be necessary.

626.3 SIGNAL OPERATION WHERE SIGNAL WORK IS ANTICIPATED

626.3.1 For projects that are anticipated to modify or replace existing infrastructure and new signals after they are put into operation prior to acceptance by the Traffic Engineer, the Contractor shall be expected to maintain the signal in a proper working condition during

construction as directed by the Traffic Engineer. Traffic signal heads shall either be turned away from approaching traffic or shall be covered with approved traffic signal bags in a manor approved by the Traffic Engineer while signal is out of operation. Plastic garbage bags, duct tape, gunny sacks and similar methods will not be accepted.

- 626.3.2 An approved Traffic Signal Contractor or Subcontractor shall perform all of the work and maintenance according to Specification 628 Signal and Lighting Project Contractor Experience Requirements.
- 626.3.3 Beginning of Contractor's Maintenance Responsibility: The Traffic Signal Contractor shall be responsible for traffic signal maintenance from the date established for work to begin in the Notice to Proceed. The Traffic Signal Contractor MUST notify the Traffic Engineer in writing at least 24-hours prior to starting any traffic signal work at an intersection. At that point, they will be added to the list referenced above and they will assume maintenance of the traffic signal. The Traffic Signal Contractor will also sign a form indicating that they are assuming maintenance for the Traffic Signal during construction per the requirements of this procedure.
- 626.3.4 Ending of Contractor's Maintenance Responsibility: The Traffic Signal Contractor shall be responsible for traffic signal maintenance until all traffic signal work has been inspected and approved, including completion and approval of all inspections punch-list items. When the traffic signal work is fully accepted and approved by the Traffic Engineer or Designee, the project will be removed from the list referenced above and the City of Tulsa will resume maintenance of the traffic signal.
- 626.3.5 Communication and Notification: All maintenance and operations requests received while the signal is the Contractor's responsibility (as described above), shall be forwarded to the Contractor for response.

For signal outages or other immediate safety concerns, City of Tulsa Staff shall notify the Traffic Signal Contractor as soon as a trouble report is received at an intersection. Other calls shall be routed to the Contractor as soon as possible.

In order to facilitate this process, good communication must occur between the Traffic Signal Contractor and the Traffic Engineer or Designee. The Contractor shall provide a contact number that will be answered 24/7 during construction projects.

The City of Tulsa shall maintain a list of all construction projects that this procedure applies to, along with the Traffic Signal Contractor's name and information. This information shall be available to necessary Traffic Operations staff and to the Water Dispatch group in order to route calls to the proper entities. Calls shall be handled as follows:

- A) Daytime Calls: Traffic Dispatch or the Traffic Signal Inspector shall notify the Traffic Signal Contractor at the number provided whenever a call is received that is the Traffic Signal Contractor's responsibility.

- B) After-Hours Calls: All after-hours trouble calls are routed through Water Dispatch, which is staffed 24/7. Water Dispatch shall contact the Traffic Signal Contractor when any trouble is reported at an intersection under their responsibility. If the Traffic Operations Trouble Truck receives a call for one of these projects, they will notify the Traffic Signal Contractor.
- C) Logging: All calls received and all calls to the Traffic Signal Contractor shall be logged. The times discussed in the Response Times Section of this specification shall begin from the time that the Traffic Signal Contractor is notified.

626.3.6 Maintenance Responsibilities: Maintenance Responsibilities of the Contractor shall include the following:

- A) Contractor shall maintain a sufficient stock of materials to be able to respond to and perform emergency repairs to the signal in order to keep it operational.
- B) Contractor shall have on staff a Traffic Signal Field Technician, Level II IMSA Certification, with a minimum of five years of troubleshooting experience, who can assist with emergency repairs and operational problems as needed.
- C) Traffic Signal Contractors shall also be responsible for implementing and maintaining construction signal timing upon request of the City or general Contractor. The City of Tulsa may modify any signal timing at the sole discretion of the City Traffic Engineer.

626.4 SIGNAL REPAIR AND MAINTENANCE RESPONSE TIMES

626.4.1 As soon as the Contractor is notified that a signal is out of operation, the Contractor must take the following actions within the specified time frames:

- A) Deploy all-way stop signs within one hour of notification.
- B) Diagnose and perform simple emergency repairs within two hours of notification. If the repairs are more extensive, then the Contractor must contact the Traffic Engineer or designee before the end of this two-hour period.
- C) Have the signal operational within 24 hours. A signal shall not be out of operation for more than a 24-hour period without approval of the Traffic Engineer.
- D) If repairs cannot be made within 24 hours and an extension is not approved by the Traffic Engineer, temporary signals acceptable to the Traffic Engineer shall be installed per Specification 619 Temporary Signals.

626.5 SIGNAL CONSTRUCTION, OPERATIONS, AND MAINTENANCE REQUIREMENTS FOR ALL PROJECTS

626.5.1 Signal Cabinet Access: Unless the traffic signal is being maintained by the Contractor during construction as described in Section 626.2 of this Specification, the Contractor

shall request prior authorization at least 24 hours in advance before performing any work on a City of Tulsa signal cabinet. Once the work is completed, the City Traffic Engineer, or designee, must approve the work before the Contractor leaves the project.

- 626.5.2 Signal Modifications for Lane Closures: The Contractor shall notify the City of Tulsa Traffic Operations Division at least 24 hours prior to opening or closing lanes that will require enabling or disabling of a signal indication for the closure. The Contractor shall install all required traffic controls and signs including mast-arm mounted signs. All turn restrictions at signalized intersections must have appropriate mast arm mounted signs and conflicting signs must be temporarily removed or bagged with approved materials. No closures or openings requiring changes to the signal phases will be permitted on weekends. Changes to signals for weekend-only closures must be set up on Friday and removed on Monday during normal City of Tulsa business hours. Regardless of whether work is anticipated on the traffic signal or infrastructure, authorized Traffic Signal Contractors, per City of Tulsa 628 as noted above, shall be responsible for enabling and disabling signal phases, to accommodate closures during construction according to the approved Work Zone Traffic Control Plan, or as directed by the City. Pay items shall be included in the plans for this work.
- 626.5.3 Signal Heads Out of Operation: Traffic signal heads shall either be turned away from approaching traffic or shall be covered with approved traffic signal bags in a manner approved by the Traffic Engineer while signal is out of operation. Plastic garbage bags, duct tape, gunny sacks and similar methods will not be accepted.
- 626.5.4 Returning Signals Back to Operation: Signals that are out of operation shall not be put into operation on Mondays, Fridays, or holidays to allow troubleshooting during normal City of Tulsa business hours. Signals shall not be put into operation during rush hour traffic.
- 626.5.5 Concrete Work: At the Traffic Engineer's discretion, applicable concrete testing may be required for any concrete used in the construction of traffic items.
- 626.5.6 As-Built Drawings: Whenever modifications are made to a signal, the Contractor shall provide as-built drawings after the construction and installation is completed. If plans were available, the Contractor shall clearly note any and all deviations from plans by marking up a clean set of plans identified as "As-Built Plans". The notes, sketches, or attached drawings used to document the deviations shall show all necessary detail and dimensions to thoroughly and accurately depict the changes. The "As-Built Plans" must be submitted and approved by the Traffic Engineer before final acceptance of the project.
- 626.5.7 Permitting and Inspection: The contractor shall obtain the necessary permits for electrical inspection on all signal, flasher signs, and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be

available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9).

Contact the City of Tulsa Traffic Operations Division for the address to use on the permit. Requestor shall provide a location map showing the location of the signal or lighting controllers for which addressing is being requested (CAD files are preferred if available). Allow for a minimum of two weeks for this information to be provided.

626.5.8 Standards and Workmanship: The City will require excellent workmanship and precise compliance with the details provided in the plans, if available, as well as with the City of Tulsa Standards and Specifications. Requirements of the NEC, IMSA, and MUTCD that conflict with City of Tulsa Standards shall supersede at the discretion of the Traffic Engineer. Unacceptable work will be removed and redone at the contractor's expense. ODOT Standards are acceptable in matters where the City of Tulsa Standards are silent.

626.5.9 Utilities: Utilities shown in the plans are intended for information purposes only and are not to be construed as the extent or exact location and depth of utilities that may be encountered during the course of construction. The contractor shall field verify the presence, type, size, location, and depth of all existing utilities in the project area prior to construction.

The contractor shall be responsible for any damage he may inflict to the existing underground utilities within the project area as a result of his digging, trenching, boring, etc. The contractor shall meet the requirements of City of Tulsa Specification 105 and shall notify the Notification Center of Oklahoma One-Call System, Inc. of any excavation or demolition prior to the commencement of such work.

Depth of existing utilities shall be verified by the contractor prior to construction.

626.5.10 Traffic Signal Plans: Symbols and legends are diagrammatic only and locations shall be adjusted for existing field conditions, but no major alterations or relocations will be made without first consulting with the Traffic Engineer.

626.5.11 Waste Materials and Debris: All broken concrete, waste material and debris shall become the property of the contractor and shall be removed from the limits of the project and disposed of in a manner approved by the Traffic Engineer. No payment will be made for the disposal of this material.

626.6 ACCEPTANCE OF WORK

626.6.1 When all work has been completed by the Contractor and approved by the City of Tulsa Traffic Operations Division, the City of Tulsa shall provide a letter of acceptance to the Contractor. The Traffic Operations Division shall resume regular maintenance of the signal from the Contractor as of the date of acceptance specified in the letter.

626.7 METHOD OF MEASUREMENT

626.7.1 Traffic Signal Maintenance: This item includes all equipment and labor necessary to maintain and operate the signalized intersections during construction as described in Section 626.3, Signal Operation Where Signal Work Is Anticipated, of this specification. Materials shall be paid through other pay items included in the plans, as appropriate. As approved by the Traffic Engineer, except for materials that are considered incidental to the work being performed, if no pay item for the needed material is included in the plans, the Contractor shall notify the City of Tulsa so that appropriate materials may be supplied to the Contractor for repairs and maintenance. Payment shall be made per hour spent in maintenance work during construction. Depth of existing utilities shall be verified by the contractor prior to construction.

For repair work, if a pay item is included in the plans for a material and that pay item includes labor, then no separate payment shall be made for signal maintenance for that particular item. If materials are supplied by the City, then this pay item shall also cover the labor needed to install the materials and to complete the necessary repairs.

Contractors shall keep a log of all hours spent in maintenance work, including sufficient detail on what labor and materials were required, and shall submit those along with their pay estimates for approval and to document their hourly work.

626.7.2 Temporary Signals: Any temporary signals necessary during construction shall be paid for per Specification 619 Temporary Signals, unless otherwise noted in this specification or as required by the Traffic Engineer.

626.7.3 Signal Modifications for Lane Closures: This pay item shall be used to accommodate closures required by the approved work zone traffic control plan. The following work is included as a part of this pay item:

A) Modifications to the traffic signals to accommodate lane closures including bagging traffic signal heads, installation of temporary mast arm mounted signs, and signal cabinet work including minor signal timing modifications.

B) Any incidental materials or labor required to accomplish the lane closures.

C) Any work or equipment required to reopen the lane at the end of the lane closure.

Payment for this shall be made per signalized intersection.

626.7.4 All other labor and materials required as part of this specification shall be considered incidental to the work performed and no separate pay item shall be made for those items.

626.8 BASIS OF PAYMENT

626.8.1 Traffic Signal Maintenance and Signal Modifications for Lane Closures, as described in this specification, measured as provided above, shall be paid for at the contract unit price as follows:

A) Traffic Signal Maintenance.....PER HOUR

B) Signal Modifications for Land Closures, Per Signalized Intersection..PER EACH

PART 627 – PRE-QUALIFICATION FOR TRAFFIC OPERATIONS MATERIALS

627.1 APPROVED PRODUCTS LIST

627.1.1 Approved Products List: The City of Tulsa Traffic Operations Division maintains the City of Tulsa Traffic Engineering's Approved Products List of all materials conforming to the requirements of this specification. Materials appearing on the Approved Products List require no further testing, unless deemed necessary by Traffic Engineer. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project except as provided for in these specifications.

627.1.2 Bidders' and Suppliers' Requirements:

A) To be accepted on bids, materials must have approved product codes or designations and be from pre-qualified producers.

B) The supplier's facilities must be of sufficient size and staffing that all warranty repairs to the cabinet assembly can be made on a timely basis. The interpretation of 'timely return of equipment' is no more than 18 calendar days from the date of receipt by the supplier to the return receipt of the equipment at the specified location. This requirement may be met by field service. Failure to meet these requirements may result in rejection of future bids.

C) Each item delivered shall be individually packed in its own shipping container. When loose Styrofoam is used for packing the item, the item shall be sealed in a plastic bag to prevent direct contact with the Styrofoam. Each item delivered for testing shall be complete, including manuals, and ready for testing. All static sensitive materials shall be sealed in anti-static enclosures.

627.1.3 Procedure: Prospective producers interested in submitting their product for evaluation must submit a written request to the City of Tulsa Traffic Operations Division. Forms will be provided by the Traffic Engineer for submitting requests.

627.1.4 Material Requirements:

A) Controller Cabinet Assemblies:

1) Sample: Submit one signal controller assembly with the pre-qualification request. All materials submitted for pre-qualification tests will be at no cost to the City of Tulsa and must be new and unused.

2) Documentation: Provide a complete list of parts and quantities supplied along with any model numbers, serial numbers, or other identifying information.

a) Provide each cabinet with the following documentation:

1. Three complete, accurate, and fully legible diagrams and one schematic for every electronic device (This must include but not be limited to cabinet

wiring, back panel, detector panel, power panel, PE panel, flasher circuit, switch packs, card rack power supply, bus interface unit, and power supply diagrams).

2. Complete parts list including names of vendors for parts not identified by universal part numbers.

b) Provide each controller unit with the following documentation:

1. One service manual per unit that includes description of controller unit, description of its operation, and basic maintenance and troubleshooting information.
2. Two complete, accurate, and readable schematic diagrams for all circuitry in the controller unit (one set of these diagrams may be included in the service manual).
3. Complete parts list including names of vendors for parts not identified by universal part numbers (this may be included in the service manual).
4. Pictorial-of-components layout for each circuit board or individual component identification permanently printed on each circuit board. (Regardless of which of the above is provided, each electronic component on the board must be clearly identified or labeled. This may be included in the service manual).

- c) Bidders must be prepared to furnish manufacturer's certifications obtained from the producer, supplier, or an approved independent testing laboratory that it meets standards defined in this section for the complete cabinet assembly from an independent laboratory. A manufacturer's certification shall be a certified statement that the material actually shipped to the project was manufactured by production processes that are periodically and routinely inspected to assure conformance to specification requirements. When requested by the Traffic Engineer, provide additional certifications from independent testing laboratories and sufficient data to verify item meets applicable specifications. Ensure additional certification states the testing laboratory is independent of the material manufacturer and neither the laboratory nor the manufacturer has a vested interest in the other.

- d) Identify all proprietary parts in Contractor-furnished material. The Traffic Engineer reserves the right to reject material that uses proprietary components not commercially available through electronic supply houses.

3) Sampling and Testing:

- a) Signal controller cabinet assemblies must meet or exceed all applicable Standards and Specifications of the National Electrical Manufacturers Association (NEMA), Caltrans Transportation Electrical Equipment

Specifications, Oklahoma Manual on Uniform Traffic Control Devices (MUTCD), National Electric Code (NEC), Institute of Transportation Engineers (ITE) and the City of Tulsa Standards and Specifications. In addition to testing of pre-shipment samples, complete testing of signal controller assemblies may be required at any time before acceptance.

- b) Burn-in each controller cabinet assembly for a period of 48 hours at a temperature of 140° F or for a period of 96 hours at a temperature of 73.4° C. A certification must be included with or attached to each controller cabinet indicating the dates of the burn-in period, number of hours, burn-in temperature, and results.
- c) The Traffic Engineer may test any controller cabinet assembly under load in a shop environment for a period of at least 120 hours. During this time, the entire controller cabinet assembly will be inspected for compliance with the specifications.
- d) The Traffic Engineer may then require the results of testing as detailed in the Caltrans Transportation Electrical Equipment Specifications, Chapter 1 – Section 8 on Electrical, Environmental, and Testing Requirements.
- e) Testing will be performed in the normal operating (i.e., non-flashing) range of 95-135 VAC. All traffic signal cabinet assembly components must operate normally at 95 VAC, just as the unit would operate at 120 VAC.
- f) Provide Traffic Operations Division with closed-loop software, hardware, and cables needed to monitor controller operations during testing.

B) All Other Materials:

- 1) Sample: Submit one material sample with the pre-qualification request. All materials submitted for pre-qualification tests will be at no cost to the City of Tulsa and must be new and unused.
- 2) Documentation: Provide a complete list of parts and quantities supplied along with any model numbers, serial numbers, or other identifying information. Provide any manufacturer's documentation available on the product.
- 3) Sampling and Testing: All materials must meet or exceed all applicable Standards and Specifications of the National Electrical Manufacturers Association (NEMA), Caltrans Transportation Electrical Equipment Specifications, Oklahoma Manual on Uniform Traffic Control Devices (MUTCD), National Electric Code (NEC), Institute of Transportation Engineers (ITE) and the City of Tulsa Standards and Specifications. In addition to testing of pre-shipment samples, complete testing of submitted materials may be required at any time before acceptance. Length of testing necessary shall depend on the equipment and shall be determined by the Traffic Engineer, standard evaluation times shall be documented on the Approved Products List.

- 627.1.5 Warranty: All equipment on the Approved Products List must have no less than 95% of the manufacturer's standard warranty remaining on the date that the contractor submits equipment invoices for payment. The Traffic Operations Division will not accept any equipment with less than 95% of its warranty remaining.
- 627.1.6 The cabinet assembly including all contents must be fully warranted for parts and labor for a minimum of five years from the date of acceptance. Software and firmware updates must be included as part of the warranty.
- 627.1.7 Other material warranties will be evaluated based on the materials as part of the approval process and will be listed on the Approved Products List, as necessary.
- 627.1.8 Evaluation: Material evaluation falls into two categories: Equal or New. When a request for material evaluation is received by the Traffic Engineer, the information will be reviewed to determine if it is an Equal Product or a New Product. Traffic Engineer will notify prospective bidders and suppliers after completion of the material evaluation.
- A) Equal Product: Equal Products are similar to materials that are currently used by the Traffic Operations Division and are covered by existing Specifications and Standards. For Equal Products, the manufacturer or supplier must provide certification(s) and/or test results from an independent testing laboratory addressing all existing Specifications and Standards.
- B) New Product: New Products are materials that are not addressed by current City of Tulsa Specifications and Standards. New Products must follow the procedures outlined in this specification for approval. For any New Products that are not covered by this specification, the Traffic Engineer will review the request and determine what testing is appropriate and reasonable to determine if the material is acceptable for use in the City of Tulsa.
- C) Qualification: If approved for use by the Traffic Operations Division, the material will be added to the Approved Products List as Approved. If material is listed on the Approved Products List as Approved, no additional submittals are required for that product.

If a product is approved conditionally, the material will be added to the Approved Products List as Under Evaluation and the conditions for approved use will be noted. If a material is listed on the Approved Products List as Under Evaluation, then submittals must still be provided to show that the product use falls within the restrictions stated.

Date of acceptance will be the date that Traffic Operations Division adds it to the Approved Products List as Approved or Under Evaluation.

The materials supplied from the Approved Products List must be identical to the approved materials. Submit any deviations from the approved materials for evaluation and approval before any material is fabricated or ordered.

Deviations from the approved material after shipment of any parts of the order will be cause for rejection and nonpayment of the remainder of the order. Excessive delays or noncompliance by the vendor at any point in the approval process may be cause for cancellation and nonpayment.

- D) Failure: Products not qualified under this specification will be listed on the Approved Products List as Rejected and those materials may not be furnished for Traffic Operations Division projects. A manufacturer or supplier must show evidence of correction of all deficiencies before reconsideration for qualification.

If any of the assemblies fail any of the tests, the supplier will be permitted to make one complete repair of the order on a timely basis, which will be determined by the Traffic Engineer, and the testing may be redone once before it is given Rejected status.

Minor discrepancies noted in sampling and test of this item received must be corrected within 30 days of written notice of the discrepancies or as stated in the notice. Major discrepancies that in the opinion of the Traffic Engineer will substantially delay receipt and acceptance of the item will be cause for cancellation of the purchase order. Any discrepancies found in partial shipments must be corrected before the delivery of subsequent shipments.

Unsatisfactory performance of a material or supplier, at any time, will result in a rejection of a product and removal from the Approved Products List.

627.2 PROJECT AND EQUIPMENT SUBMITTAL REQUIREMENTS

- 627.2.1 Materials on the Approved Products List: No additional submittals are required if it is listed as Approved. Materials listed as Under Evaluation must provide material specifications showing that they adhere to the conditions listed in the Approved Products List.
- 627.2.2 Materials not on the Approved Products List: Furnish three copies of the equipment list including three copies of catalog cuts. Identify proposed material on catalog cuts by a reproducible means (highlighter pen does not transfer to copies). Ensure materials lists contain material description, brand name manufacturer's address and telephone number, stock number, size, identifying trademark or symbol and other appropriate ratings. New products must follow this specification.
- 627.2.3 Approval: Approval will be given in writing. Contractor or supplier shall not fabricate or order material until receipt of the Traffic Engineer's approval.

PART 628 – SIGNAL AND LIGHTING PROJECT CONTRACTOR EXPERIENCE REQUIREMENTS

628.1.1 Pre-Qualification: Only contractors that have been pre-qualified by the Traffic Engineer or designee will be allowed to work on any Traffic Signals in the City of Tulsa.

628.1.2 Contractor Requirements: Bidders shall be experienced Contractors that have demonstrated their capabilities in executing projects that are similar in technical requirements and dollar values. In the City of Tulsa, for all work relating to the installation, maintenance, or removal of traffic signals, electrical conduit, sign flashers, or street and highway lighting, qualified Contractors or Subcontractors must be able to perform the work in conformance with the following requirements:

- A) For all work relating to the installation, maintenance, or removal of traffic signals, electrical conduit, sign flashers, or street and highway lighting, qualified Contractors or Subcontractors must be able to perform the work in conformance with all applicable City, State, and Federal regulations including City of Tulsa Standards and Specifications, the Project plans, the Manual on Uniform Traffic Control Devices (MUTCD), and the National Electric Code (NEC). Contractors or Subcontractors shall also have at least one employee on-site at all times with applicable International Municipal Signal Association (IMSA) certifications including, but not limited to, Level I and Level II in Traffic Signals.
- B) The Contractor shall obtain the necessary permits for electrical inspection on all signal, conduit, sign flasher and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner.
- C) The Contractor shall provide a maintenance bond that covers all of the work and materials listed in this specification for one year after the project is accepted by the City.
- D) By bidding, the Contractor is agreeing that they are capable of meeting the requirements of Part 626 of these Specifications for Traffic Signal Operation and Construction.

628.1.3 Documentation: In order to ensure that the Project work is performed by qualified and experienced Contractors, bidders must submit a qualification statement attached to their bid consisting of the following for the Contractor or Subcontractor who will be performing the signal, sign flasher, or lighting work:

- A) List of projects completed within the past four years that are similar in scope and dollar value to this project. The Contractor must have successfully completed at least five projects within this time period.

- B) For each submitted project in Item A provide the following information:
- 1) Company owner's name and telephone number,
 - 2) If applicable, the name and telephone number of any Licensed Electrical Contractors who worked on the project,
 - 3) The location of the project,
 - 4) The beginning and completion dates of the project,
 - 5) The contract amount,
 - 6) A brief description of the project work including applicable information on the type of signal, sign or lighting equipment installed, i.e. what type of signal controller, cabinet, detection, preemption system, communications equipment, lighting controllers, signal flashers, etc.
- C) Provide a list of all Sub-Contractors (if applicable) that will be utilized on the project and their experience as detailed in Items A and B above.
- D) The name and phone number of the Licensed Electrical Contractor to work on the project.
- E) The name and phone number of the Traffic Signal Field Tech on call to perform repairs as necessary for the project.

628.1.4 Changes: After the bid is accepted, if the Contractor needs to change any item already approved through the above process, the Contractor must submit those changes along with the revised documentation as listed above in items A-D to the Traffic Engineer for approval at least five business days prior to commencing work on any of the work items referenced in this specification.

PART 629 – SIGNS ASSEMBLIES WITH FLASHING BEACONS

629.1 GENERAL

- 629.1.1 This work shall consist of furnishing materials and installing poles, signs, controllers, confirmation lights and all other equipment for all types of sign assemblies with flashing beacons, including school zone flashing signs, in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer. Standard sign assemblies with flashing beacons are intended for 24/7 operations. School sign assemblies with flashing beacons are intended for intermittent operation during school hours only.

629.2 MATERIALS

- 629.2.1 General. Provide regulatory or warning sign assemblies that consist of a sheet aluminum sign with the message, traffic signal heads, signpost, foundation, wiring, and conduit as shown on the Plans or as directed by the Traffic Engineer.

All flashing beacon sign assemblies shall include the following items: aluminum pedestal pole, octagonal pedestal pole base, pole and base collar assembly for the octagonal base, signal housings and visors, two yellow ball LED indications, controller cabinet, sign as directed by the Traffic Engineer, sign mounting brackets and hardware, wiring, bonding and all other appurtenances to make the sign flasher assembly stable and functional in-place.

Power shall be supplied either via electrical service or solar panels.

All hardware shall be stainless steel. All fittings shall be aluminum with no coating.

- 629.2.2 Solar Powered Flashers. Solar powered flashers shall also include mounting hardware, battery, 55 Watt solar module (including solar panels, 1/2" Carflex electrical tubing or approved equal to protect panel wiring, and 1/2" Carflex threaded connection or approved equal) with top of pole mounting, and cabinet mounting bracket.
- 629.2.3 Electrical Service Powered Flashers. Services for electrically powered flashing signs shall be installed and paid for per City of Tulsa Specification 607.
- 629.2.4 School Flashers. School zone flashers shall include school controller cabinet either AC powered or solar powered as specified by the Traffic Engineer, with a cellular programmable time switch, antenna, and confirmation light assembly.
- 629.2.5 Standards. Materials shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs 2009 – Luminaries and Traffic Signals, ODOT Specifications – Section 836, and City of Tulsa Standards and Specifications.
- 629.2.6 Approved Products List. All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL).

- 629.2.7 Flashing Beacon Sign Pole. Sign poles shall be 4" in diameter (4-1/2" O.D.), 13' tall, schedule 40 spun aluminum with 8 NPT taper (Pelco 5100-13 with Pelican ID or approved equal) with no coatings and an aluminum dome type pole cap (Pelco PB-5402 or approved equal). For signs taller than 48", a pole longer than 13' may be allowed with the approval of the Traffic Engineer.
- 629.2.8 Flashing Beacon Sign Pole Base. The base for the sign pole shall be an aluminum octagonal pedestal pole base assembly (Pelco PB-5349-GL or approved equal) with an aluminum pole and base collar assembly for an octagonal base (Pelco PB-5326 or approved equal).
- 629.2.9 Flashing Beacon Sign Pole Anchor Bolts. Anchor bolts for flashing beacon sign pole bases shall be stainless steel wedge anchor bolts or approved equal and shall include the following hardware:
- A) Quantity 4 of 3/4" x 8 1/2" stainless steel wedge anchors,
 - B) Quantity 4 of 2 1/2" O.D. x 1 1/16" stainless steel flat washers,
 - C) Quantity 4 of 1 7/8" O.D. x 3/4" stainless steel flat washers,
 - D) Quantity 4 of 3/4" stainless steel lock washers, and
 - E) Quantity 4 of 3/4" stainless steel hex nuts.
- 629.2.10 Flashing Beacon Sign Pole Footing. Pole footings shall be a standard F-1 pedestal footing furnished and installed in accordance with City of Tulsa Specification 603.
- 629.2.11 Flashing Beacon Sign Pole Conduit. A 2" conduit shall be installed in the footing for electrical service powered flashing beacon signs. A City of Tulsa Pull Box Size I meeting the requirements of City of Tulsa Specification 601 shall be installed within 10' of the footing for electrical service powered flashing beacon signs.
- 629.2.12 Flashing Beacon Sign Pole Bonding. There shall be #6 green THHN stranded copper connected to the bonding point of the aluminum base of each flashing beacon sign pole and the service disconnect ground buss. Bonding wire shall be connected using LA-6A Ideal Part #87-002 aluminum lug and 1/4" X 20 stainless steel bolt and nut or approved equal.
- 629.2.13 629.2.13 Signs. Provide signs in accordance with City of Tulsa Specification 608. Signs shall be attached to the pole using at least two stainless steel U-bolt clamps (Pelco SH-0209-SS or approved equal). Signs shall meet requirements of the Manual on Uniform Traffic Control Devices (MUTCD). School signs shall be 24" X 48" in size and, unless otherwise directed by the Traffic Engineer, shall read as follows: SCHOOL SPEED LIMIT 25 WHEN FLASHING. All other signs will be installed as directed by the Traffic Engineer.

629.2.14 U-Bolt Clamp Mounting Hardware. Hardware for mounting the sign and controller cabinet shall be stainless steel and shall include the following per sign or cabinet:

A) Quantity 2 of 5/16" x 1 1/2" stainless steel flat washers,

B) Quantity 2 of 5/16" stainless steel lock washers,

C) Quantity 2 of 5/16" stainless steel hex nuts.

629.2.15 Wiring. All wire shall meet the requirements of City of Tulsa Specification 611 for Electrical Conductors for Traffic Signals.

629.2.16 Flashing Beacons. Flashing beacon assemblies shall consist of two polycarbonate signal heads with amber LED indications mounted in an over sign and under sign configuration. For flashing beacon signs powered by an electrical service connect, use two 120-volt AC amber LED indications. For flashing beacon signs powered by solar panels, use two 12-volt DC amber LED indications.

Heads shall be wired so they will bounce flash using 4#14 Traffic Signal Electrical Cable as specified in City of Tulsa Standard 629 between the signal heads and the cabinet. A 2#14 shielded electrical conductor shall be used between the two amber LED indications and run through a shoe.

Flashing beacons shall be mounted using a gusseted tube (Pelco AB-0300-18 inch or approved equal), two-way upper arm assembly (Pelco AB-0296-SS or approved equal), two-way lower arm assembly (Pelco AB-0297-SS or approved equal), and neoprene gaskets (Pelco SE-0354 or approved equal) as shown in City of Tulsa Standard Drawing 629.

The flashing beacon assembly shall be mounted to the pole using a 62" cable mount clamp kit (Pelco Astro-Brac Stellar Series Clamp Kit, AS-3009-62-SS, or approved equal).

The signal housing, visor, and 12" amber LED indications shall meet the requirements of City of Tulsa Specification 614 except that they shall be considered part of the assembly and shall not be paid for separately.

629.2.17 Confirmation Light Assembly. Confirmation light assemblies shall be LED with stainless steel, clear globe, on-way hub assembly and 29" band mount (Pelco SM-0286-CL-29-SS or approved equal). A 2#14 shielded electrical cable shall be used for the confirmation light.

629.2.18 School Controller Cabinet. Cabinet shall be an RTC Model #502608-T model or approved equal. The cabinet shall use NEMA flasher and transfer relay. Cabinet dimensions shall be 15" high, 15" wide and 12" deep. The cabinet shall not be pre-drilled for conduit connection. The cabinet shall come with an RTC AP22 programmable time switch with Guardian Board and cellular modem, or approved equal, with the latest software and hardware.

If a solar powered flashing beacon assembly is being used along with a school zone controller cabinet, then the cabinet shall be an RTC Model #502598SW cabinet or approved equal. The cabinet shall contain one DCF2, two circuit 12-volt DC battery. Cabinet dimensions shall be 17" high, 18" wide and 14" deep. The cabinet shall come with an RTC AP22 cellular programmable time switch with Guardian Board, or approved equal, with the latest software and hardware.

If cabinet is mounted on the flashing beacon sign pole, cabinet shall be mounted using two stainless steel U-bolt clamps (Pelco SH-0209-SS or approved equal) or using two stainless steel 4" mounting kits (Pelco SE-1100-SS or approved equal). If U-bolt clamps are used, the connection from the base of the cabinet to the pole shall consist of one 1-1/2" case nipple, one 1-1/2" aluminum L.B. gasket and cover, one 1-1/2" X 2" aluminum all thread nipple (Pelco SE-0309-2 or approved equal) and one stainless steel 1-way hub assembly for a 4-1/2" O.D. pole (Pelco SE-3093-SS or approved equal).

If cabinet is mounted to wooden service pole, cabinet shall be mounted using stainless steel banding. Conduit shall be 1-1/2" galvanized steel electrical conduit as specified in City of Tulsa Specification 602 and shall be strapped to the pole using 2-hole straps. From the cabinet to the disconnect, 1" Sealtight, or approved equal, shall be used.

Cabinet door shall lock with a 3-point locking system, similar to the 3-point locking system used on a McCain 332 traffic signal cabinet.

629.2.19 Flasher Controller Cabinet. If a school controller cabinet is not used, flasher controller cabinet assembly shall be the same as for the school controller cabinet but shall not include a time clock.

629.2.20 School Controller Cellular Programmable Time Switch. Programmable time switch shall be fully compatible with existing school flasher hardware used by the City of Tulsa, as outlined in this specification (RTC AP22 programmable time switch with Guardian Board and cellular modem, or approved equal, with the latest software and hardware). In addition, the system shall meet the following requirements:

- A) 10-year prepaid cellular service plan,
- B) Monitoring software must be included at no additional charge,
- C) Software may be cloud-based and have the ability to define secure logins with variable access levels for users,
- D) Software must have the ability to schedule a full calendar year,
- E) Software must include real time monitoring of the voltage/battery status, beacon status, clock drift, and loss of communications,
- F) Front-panel status indication (Including time of day and schedule),

- G) Programmable directly from the front panel with no extra hardware, laptop or programming devices,
- H) Easily retrofitted into existing cabinets as described in this specification without modifications,
- I) Must be able to remotely program and monitor, schedule and give manual commands,
- J) All hardware including modem, mounting brackets, antennas, and other incidentals shall be included,
- K) Licensing shall include a minimum of 250 school flashers.

629.2.21 School Controller Antenna. Antennas shall be installed according to City of Tulsa Standard 629 unless otherwise specified by the Traffic Engineer.

Antennas shall include any cabling, mounting equipment, or other appurtenances to make them operational. All cabling shall be secured with UV rated tie wraps.

629.2.22 Inspection. All materials shall be inspected by an authorized agent of the City of Tulsa Traffic Operations Division (TOD) to ensure compliance with the specifications.

629.3 CONSTRUCTION METHODS

629.3.1 All hardware and fittings shall be installed wrench tight.

629.3.2 Controller cabinets for electrical service powered flashers shall be mounted to the wooden service pole. If a pedestal service is being used, the controller cabinet may be mounted on the flashing beacon pole.

629.3.3 Poles shall be installed plumb in two perpendicular directions. The pole must be wrench tight before the collar is installed. Pins must be installed.

629.3.4 Flashing beacons and signs shall be aimed and leveled properly to insure maximum visibility prior to acceptance of the sign assembly.

629.3.5 Excess cable must be tied down using UV rated tie wraps.

629.3.6 All unused, drilled holes in the poles shall be resealed by non-ferrous rain-tight materials and methods as approved by the Traffic Engineer.

629.3.7 All holes in the top of the signal heads shall be permanently sealed with aluminum, stainless or nylon hardware or approved equal. No silicone shall be allowed.

629.3.8 Antenna for cellular programmable time switch shall be mounted per manufacturer's instructions. For antennas installed on the pole cap, a 7/8" hole shall be drilled into the

pole cap and filed smooth for antenna installation. For antennas installed on a wooden service pole, the antenna riser shall be strapped to the pole using 3/4" straps and 3/4" EMT.

629.3.9 Antenna for cellular programmable time switch shall be mounted to the top end of the solar panel frame with self-tapping screws if solar flashing beacon is used. For antennas installed on a solar panel, drill a 7/8" hole for a 1/2" case nipple and locknut to prevent coaxial cable from chafing. Coaxial cable for the antenna shall be installed to limit exposure to sunlight.

629.3.10 Antennas shall be installed plumb.

629.3.11 A 1-3/8" hole for cable access for the confirmation light assembly shall be drilled through the pole and filed smooth, located 26" from the top of the pole as shown on City of Tulsa Standard 629.

629.3.12 A 1-3/8" hole shall be drilled for cable access for the controller cabinet and filed smooth as shown on City of Tulsa Standard 629.

629.3.13 For solar powered flashing beacon sign assemblies, no splices shall be allowed between the panel junction box and the control cabinet.

629.4 METHOD OF MEASUREMENT

629.4.1 Sign assemblies with flashing beacons will be measured by each assembled unit installed.

629.5 BASIS OF PAYMENT

The accepted sign assemblies with flashing beacons, measured as provided above, will be paid for at the contract unit price as follows:

- A) Sign Assembly with Flashing Beacon, Electric.....EACH
- B) Sign Assembly with Flashing Beacon, Solar.....EACH
- C) School Sign Assembly with Flashing Beacon, Electric.....EACH
- D) School Sign Assembly with Flashing Beacon, Solar.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as shown on the Plans and these Specifications.

PART 630 – RECTANGULAR RAPID FLASHING BEACONS

630.1 GENERAL

- 630.1.1 This work shall consist of furnishing and installing solar powered rectangular rapid flashing beacons (RRFB) at the locations indicated on the plans or where directed by the Traffic Engineer.

630.2 MATERIALS

- 630.2.1 Approved Products List. All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL) or by approved submittals.
- 630.2.2 Each RRFB should meet the specifications of Interim Approval for Optional Use of Pedestrian Actuated Rectangular Rapid Flashing Beacons at Uncontrolled Marked Crosswalks (IA-21) (FHWA) and Interpretation Letter 4(09)-5(I) – RRFB.
- 630.2.3 Use with W11-2 (FYG) sign for crosswalks, S1-1 (FYG) sign for school crosswalks and W11-15 (FYG) sign for shared use paths or other locations where bikes are permitted to cross. All diamond shaped signs shall be 30" x 30" for single lane roads and 36" x 36" for multi-lane roads and shall meet the requirements of City of Tulsa Specification 608 for Traffic Signs.
- 630.2.4 Each RRFB full assembly shall be a complete assembly, consisting of supporting structure (pole, all mounting brackets for all components of the assembly, and foundation), indications, signage, and electrical components (wiring, solid-state circuit boards, solar panels, etc.).
- 630.2.5 The supporting structure of the RRFB shall consist of a 2" minimum perforated square-tube post, meeting the requirements of the latest version of the City of Tulsa Specification 608 for Traffic Signs. If the manufacturer recommends that the sign be placed into a concrete or other footing, and/or a larger pole, then that shall also be included as a part of the full assembly. Posts shall not be attached to the top of concrete slabs by bracketed anchor assemblies.
- 630.2.6 Each RRFB shall be powered by solar panels.
- 630.2.7 Each RRFB to be supplied with all required hardware to install assembly. Hardware for mounting the sign to the pole shall meet the requirements of City of Tulsa Specification 608 for Traffic Signs.
- 630.2.8 Single Sided RRFB Full Assemblies shall typically only be used at one-way streets or divided streets. All other RRFB Full Assemblies shall be double sided, unless directed otherwise by the Traffic Engineer.

630.3 CONSTRUCTION METHODS

- 630.3.1 Each RRFB shall be activated by a push button unless otherwise specified. Supplemental RRFB signs used in coordination with other push button activated RRFBs at a crosswalk may not have push buttons, as determined by the Traffic Engineer. All RRFB assemblies including supplemental RRFB assemblies for a crosswalk shall actuate at the same time when a push button is pushed.
- 630.3.2 The push buttons shall be PROWAG, ADA and MUTCD compliant and shall meet the applicable requirements of City of Tulsa Specification 613 for Pedestrian Push Buttons.
- 630.3.3 The push buttons shall be Accessible Pedestrian Signals (APS) push buttons to allow for both factory and manually programmed speech-walk messages. If an APS system is utilized, the standard verbal message will be "Warning Lights are Flashing". This message shall be repeated twice.
- 630.3.4 Construct the pedestrian push button so that it is tamper proof. Design it to prevent an electrical shock under any weather conditions.
- 630.3.5 RRFB's that have pedestrian push buttons shall also have an R10-25 sign, PUSH BUTTON TO TURN ON WARNING LIGHTS / AWAIT GAP IN TRAFFIC.

630.4 METHOD OF MEASUREMENT

- 630.4.1 For the pay items that require installation, the Contractor shall provide all installation services, equipment, and materials as necessary to install a fully operational RRFB assembly in the locations indicated by the plans or as directed by the Traffic Engineer. This is to include all set-up and installation equipment, pole mounts, brackets, hardware, and any other appurtenances necessary to make the RRFB operational.

630.5 BASIS OF PAYMENT

The accepted RRFB system, measured as provided above, will be paid for at the contract unit prices as follows:

- A) Single Sided RRFB with APBS, Installed.....EACH
- B) Single Sided RRFB with APBS, Materials Only.....EACH
- C) Single Sided RRFB without Push Buttons, Installed.....EACH
- D) Single Sided RRFB without Push Buttons, Materials Only.....EACH
- E) Double Sided RRFB with APBS, Installed.....EACH
- F) Double Sided RRFB with APBS, Materials Only.....EACH
- G) Double Sided RRFB without Push Buttons, Installed.....EACH
- H) Double Sided RRFB without Push Buttons, Materials Only.....EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

SECTION END