1020 - TRAFFIC SIGNAL INSTALLATION

1020.1 DESCRIPTION

a. Work

This work shall consist of furnishing all labor, materials and equipment to complete in place the traffic signal work as shown on the plans (including standard details), as specified in the following specifications, as directed by the Engineer, and in those sections of the standard specifications of the City of Overland Park, Kansas, and the Kansas Department of Transportation, that are either directly or by reference included herewith.

Whenever these specifications conflict with the plans, the General Specifications or the Kansas Department of Transportation Standard Specifications for State Road and Bridge Construction, current edition, (hereinafter referred to as "Standard Specifications") these traffic signal specifications shall govern.

b. Plans

The plans that accompany these specifications shall be considered a part thereof. Whenever any part of the plans shall be in conflict with any other part or parts of the plans, or any part of these specifications shall be in conflict with any other part or parts of these specifications or any of the items proposed to be constructed shall appear to be impracticable, or impossible to construct, then the matter shall be immediately brought to the attention of the Engineer or their agent. The Engineer's decision in the matter shall be final, and the Contractor shall follow their directions to avoid any such conflict in the plans or specifications.

All incidental parts which are not shown on the plans or specified herein and which are necessary to complete the traffic signal system shall be furnished and installed as though such parts were shown on the plans or specified herein. All systems shall be complete and in operation to the satisfaction of the Engineer at the time of acceptance of the work.

All appurtenances shall be located as shown on the plans. Any deviations must be established by the Engineer in the field. The Contractor shall have a copy of the plans and specifications at the job location at all times and accessible to the Engineer or their authorized representative.

Prior to the acceptance of the work, the Contractor shall submit an "As Built" or corrected plan showing in detail all construction changes, especially location and depth of conduit.

c. Grades

All work shall conform to line, elevation and grades as shown on the plans.

d. Regulations and Code

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to the requirement of these specifications and the plans, all material and work shall conform to the requirements of the National Electrical Code (NEC), the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances. Requirements of Underwriters' Laboratories, Incorporated shall be followed for all items installed where applicable. Pertinent requirements of the local utility company shall be followed.

Wherever reference is made in these specifications or in the standard provisions to the code, the safety orders, the general order, or the standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect at the date of advertising of these specifications.

e. Qualifications of Installers

For the actual fabrication, installation, and testing of the work of this Section, use only thoroughly trained and experienced personnel who are completely familiar with the requirements for this work and with the installation recommendations of the manufacturers of the specified items. In acceptance or rejection of installed electrical system, no allowance will be made for lack of skill on the part of installers.

f. Preliminary Schedule of Equipment and Material

Prior to commencement of construction activities, the Contractor shall submit a complete schedule of materials and equipment proposed for installation for the approval by the Engineer. This schedule shall include catalog cuts, diagrams, drawings, and other such descriptive data as may be

required by the Engineer. Any item not listed on the Approved Manufacturer's List shall also require the submittal of catalog cuts, diagrams, drawings, technical specifications, and a physical sample of the item for evaluation by the Engineer. In the event any items of material or equipment contained in the schedule fail to comply with specification requirements, such items may be rejected.

g. Rejected Materials

Rejected materials shall be immediately removed from the project site by the Contractor and shall not again be brought upon the project site. Work shall be commenced and continued at such points as may be approved by the Engineer and shall be carried on diligently and without unnecessary or unreasonable delay.

h. Coordination with Existing Utilities

All existing conduit/conductor runs and other utility information were obtained from existing office records. It shall be the Contractor's responsibility to locate all utilities, whether above, on, or below the ground, and to protect the City against any and all damages arising from work under this project.

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

i. Notification

The Contractor shall notify the Engineer before beginning work on the project. The Contractor shall keep the Engineer advised as to the progress of the project and the Contractor's proposed schedule. The Engineer may, at their option, require any work completed without their knowledge or inspection to be dismantled and inspected to their satisfaction. The contractor shall notify each property owner at least one day in advance of construction activity being started in front of the respective property.

j. Protection of Work and Cleanup

The Contractor shall care for all work until final completion and acceptance by the City. All damage done to existing improvements by the Contractor shall be repaired by the Contractor. The Contractor shall remove all surplus material and rubbish from the work as it accumulates and before the Contractor makes application for the acceptance of the work.

k. Replacing Damaged Improvements

Improvements such as sidewalks, curbs, driveways, roadway pavements and any other improvements removed, broken or damaged by the Contractor shall be replaced or reconstructed with the same kind of materials found on the work or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer. Whenever a part of a square or slab of existing concrete sidewalk, driveway or pavement is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed.

l. Traffic Signal Improvement Policies

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

The existing signal controls shall be kept in operation as long as practicable during installation of the proposed signal modifications and improvements, except for shutdowns, to allow for alterations as required for installation of the proposed improvements.

Some periods of disruption of existing signal operations can be tolerated during installation of the proposed improvements; however, the Contractor shall coordinate planned disruptions of signal operations with the Engineer, or his authorized representative, a reasonable time in advance of such disruption of operations.

All existing wiring within existing controller cabinets shall be identified by the Contractor and each conductor properly labeled prior to de-energizing the existing controller to install the proposed modifications and improvements.

Planned disruptions of signal operations shall be limited to the hours between 9:00 a.m. and 4:00 p.m., unless authorized otherwise by the Engineer. The signal controls shall be operable during all other periods

1020.2 MATERIALS

All materials used in the fabrication or assembly of the items listed below shall comply with the applicable parts of Section 1703, "Electric Lighting and Traffic Signal Equipment" of the "Standard Specifications" with the additions as stated herein. Unless specifically noted otherwise, all signalization equipment shall be new and similar to the best grade of this type of equipment, and shall be approved by the Engineer.

The Contractor shall install all of the equipment and wiring necessary for intersection signalization as indicated on the plan and in accordance with this specification. The traffic signal system shall be complete, and the Contractor shall furnish and install all equipment necessary for the satisfactory operation of electrical apparatus and for the complete operation of the traffic signal system whether specifically mentioned or not.

a. Approved Materials List

All material for traffic signal installation used by the Contractor shall be from the City's approved list of vendors. It is important that users be completely knowledgeable of all application requirements and procedures prior to product application. It is the responsibility of the installer to contact the supplier of all materials if questions regarding application procedures or conditions arise.

Manufacturers interested in pre-qualifying material under this specification shall submit a sample of the material along with a complete materials specification for each item to be considered. The sample will be reviewed for compliance with all requirements of this specification. No material shall be used unless the material has been pre-qualified. A complete list of pre-qualified materials is maintained by the Traffic Services Engineering Division of the Department of Public Works.

b. Signal Heads

Each signal head shall be a weather tight assembly of one or more signal faces of the expansible, adjustable, LED type, together with all brackets and fittings necessary for proper mounting with the type of signal support designated on the plans.

(1) Vehicle Signal Heads

Each signal face for 12" LED indications shall consist of one or more signal sections, rigidly and securely fastened together, capable of being positively positioned to control the movement of one direction of traffic. It shall meet or exceed the latest version of the equipment standard from the Institute of Transportation Engineers (ITE). Each signal section shall be a self-contained assembly consisting of an optical unit with housing, housing door, and visor. Tie rods shall not be used to fasten signal sections together to form a signal face. All signal heads on a project shall be the product of one manufacturer. Terminal blocks of suitable size shall be placed in the bottom section of the signal head, except in the case of mast arm suspended signal heads wherein the terminal block shall be placed in the top section.

The housing for each signal section shall be made of a durable, injection molded, UV stabilized, pre-colored, opaque, polycarbonate and shall be yellow in color, unless otherwise specified in the plans. It shall be clean, smooth and free from flaws, cracks, blowholes, and other imperfections. It shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together. It shall be equipped with round openings in the top and bottom to accommodate 1 ½" brackets. It shall be equipped with 72-tooth radial angular serrations to provide positive 5 degree locking increment positioning of the entire signal head so that it may be rotated at any angle in a horizontal plane between waterproof supporting brackets that lock to maintain a specific angle of direction when in place. Two integrally-cast hinge lugs and latch screws are cast in the housing both sides. The door of each housing shall be a one-piece, molded, UV and heat stabilized unit, black in color and suitably hinged and held securely to the body of the housing by simple stainless steel hinge pins. Two stainless steel "eye" bolts and wing nuts on one side of the door shall allow for opening and closing without the use of any special tools. It shall have a gasket groove on the inside of the door to accommodate a weatherproof and mildew-proof resilient gasket which, when the door is closed, seals flat against the housing, creating a positive seal. The outer face of the door shall have four metal threaded inserts, equally spaced about the circumference of the lens opening, with four screws

to accommodate the signal head visors. The door and visor shall overlap to prevent light escaping between visor and door. All other door parts, such as hinge pins, lens clips, screws, etc., shall also be of stainless steel material.

Terminal blocks of suitable size shall be composed of a sturdy polycarbonate weather resistant casing and stainless steel hardware placed in the bottom section of the signal head, for pole mounted installation and in the top section for mast arm suspended installations.

The visors for each signal section shall be durable, molded, UV and heat-stablized polycarbonate, black in color, not less than 0.05" in thickness. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be at least 9" long for 12" diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.

The optical unit and visor shall be designed as a whole so as to eliminate the return of outside rays entering the unit from above the horizontal. Nominal 12" diameter signal LED's shall be furnished, unless otherwise shown on the plans.

(2) Pedestrian Signal Heads

The housing for the 16" pedestrian signal sections shall be made of a durable, injection molded, UV stabilized, pre-colored, opaque, polycarbonate and shall be yellow in color, unless otherwise specified in the plans. It shall meet or exceed the latest version of the equipment standard from the Institute of Transportation Engineers (ITE). It shall be clean, smooth and free from flaws, cracks, blowholes, and other imperfections. Two hinge lugs shall be molded on the bottom of the door with two cotter-less locking pins that attach the door to the bottom of the housing. Two eye bolts and wing nuts on the top allow the door to be opened and closed without special tools. It shall be equipped with round openings in the top and bottom to accommodate 1 ½" brackets. It shall be equipped with 72-tooth radial angular serrations to provide positive 5 degree locking increment positioning of the entire signal head so that it may be rotated at any angle in a horizontal plane between waterproof supporting brackets that lock to maintain a specific angle of direction when in place.

The door frame shall be UV stabilized polycarbonate without the standard Z-Crate (egg crate) visor, and shall be flat black in color. It shall be designed to work with the gasket supplied by the LED manufacturer.

Terminal blocks of suitable size shall be composed of a sturdy polycarbonate weather resistant casing and stainless steel hardware placed toward the bottom of the body.

c. The mounting brackets shall be the same as those for traffic signal heads.LED Kits

The vehicular traffic signal heads shall be equipped with LED kits for all solid ball indications and single arrow indications. The pedestrian signal head shall be equipped with a LED kit for the Don't Walk "Hand Symbol", walking "Man" symbol and countdown timer indications. The LED kit (including but not limited to LED's, circuit board, lens, 16 or 18 AWG wire leads with strain relief and insulation rated at 105 C, conductors, electronic switching module, rigid housing and neoprene one-piece gasket) shall conform to the following specifications.

Electrical components shall meet all applicable codes including Institute of Transportation Engineers (ITE) and nationally recognized electrical testing laboratories. They shall meet current ITE standards for intensity and spatial distribution after 30 minute warm-up of continuous operation. All signals shall comply with ITE standards for LED signals, including color.

The number of LED's per signal head shall be sufficient to achieve intensity to meet ITE photometric test criteria in "Vehicle Traffic Control Signal Heads". The LED's shall be arranged uniformly through the signal head and in an appropriate number of parallel strings to insure no string accounts for more than 6% of the total. LED's shall be in multiple series circuits connecting no more than 6% of the total LED's in any single circuit, or the failure of any single circuit shall not result in more than a 6% reduction in total luminous intensity.

All LED's shall be "AllnGap" Technology or equal for the Red, Yellow and Portland Orange products and "InGaN" Technology or equal for Green and White products (AIGaAS Technology is not acceptable), and rated for 100,000 hours or more (@ 25 C and 30 MA). Operating voltage shall be

between 92 and 135 VAC, 60 HZ +/- 3. Operating temperatures shall be between -40 F and +165 F. Candlepower distribution shall meet ITE specifications. Brightness shall be maintained in the event of voltage fluctuations or sage, within 30% across the operating voltage and temperature range.

Control circuitry shall prevent current flow through the LED's in the off state to avoid false indication in daylight and evening hours. Beam spread shall meet all aspects of the ITE specifications. Lighting intensity shall not vary (nor flicker) by more than 30% over the allowable voltage and temperature range. Operating current measured across each LED shall not exceed an average of 30 milliamps. Transient voltage suppression of 1500 volts for 1 millisecond and fusing with a maximum rating of 2 amps are required.

Lenses shall be non-polycarbonate convex, minimum of 1/8" thick and free of flaws, bubbles, and imperfections. They shall meet the ITE color standards and 3 foot drop test. Chromaticity shall be measured in accordance with ITE standards at 44 points, meeting specifications after 30 minutes warm up.

The light output shall have a dominate wavelength of 620-635 nm for red and 596-610 nm for Portland Orange. Lens may be tinted or colored as long as the chromaticity of the lens matches that of the LED's and that luminous intensity is not reduced.

The LED units shall be field replaceable requiring no special tools or sealants for replacement and shall be smooth on the outside. Lead wires shall be a minimum of 18 inches with NEMA "Spade" type terminals for connection to existing terminal block. Pedestrian signals shall have a screw-in base and shall not use transformers. Enclosure shall be dust and water resistant.

The Bi-Modal LED Green/Yellow Arrow Kit shall display alternate legends consisting of a green or yellow directional arrow. The signal shall be the appropriate model for the type of mounting as indicated on the plans. The legend shall be clearly legible under any lighting conditions without the use of a visor and shall be visible at full intensity anywhere within a 20 degree cone centered about the optical axis. Provisions shall be made to help balance the intensity between the colors by supplying approximately 50% more light to the lenses when the green arrow is being displayed than to the yellow arrow display. All parts of the LED unit shall be mounted on a 12" diameter aluminum front panel to replace the lens in the case and shall be mounted on the door of the signal head. All components shall be readily accessible when the door is open. All screws, washers, nuts and bolts shall be corrosion-resistant.

d. Signal Backplates

Where shown on plans, 5" vacuum formed backplates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Backplates shall be constructed of one piece, 0.125" thick, durable, UV stabilized, black ABS plastic capable of withstanding a 100 mph wind gust. The front side shall have a hair cell finish with a smooth finish on the back. All necessary stainless steel hardware to attach the backplate to the signal head shall be furnished. The contractor shall be responsible to provide the recommended backplate that will fit the traffic signal head body that is being supplied.

e. Signal Head Mounting Brackets

Bracket mounted signal heads, as shown on the plans, shall be supported by a one-piece mounting bracket watertight assembly made entirely of a durable polycarbonate and be yellow in color, unless otherwise specified in the plans. Each bracket shall be either plumb or level, symmetrically arranged and securely assembled. Each bracket shall have serrations for positioning traffic signals in increments of 5 degrees. Construction shall be such that all conductors are concealed within the assembly.

Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the heads are covered. The signal heads at a new signalized intersection shall be covered with an orange opaque (unless otherwise noted) signal head cover that is wind and weather resistant, and that is easily installed and removed. The color of the covering at a location where a previous traffic signal was installed shall be black.

Mast arm signal head assemblies shall be rigidly mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes.

f. Steel Traffic Signal Poles and Mast Arms

Steel poles and mast arms shall conform to Section 1608 of the "Standard Specification," the 2013 edition of the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Structural Supports for Signs, Luminaires and Traffic Signals, and the requirements on the plans. The poles and arms shall be round, tapered monotube made of one length of the best grade, structural steel sheet of not less than #7 Manufacturing Standard Gauge. Only one longitudinal weld, and no transverse welds, shall be permitted in the fabrication of the shaft or arm.

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

The tapered steel shaft shall include high strength anchor bolts and nuts, conforming to Section 1615 of the "Standard Specifications" and shall be capable of attaching mast arms as shown on the detail sheets.

All poles shall be detailed on shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate.

The type of pole shall be as specified on the plans. This pole specification is in addition to the pole detail sheet included in the plans. Refer to the pole detail sheet, which describes the pertinent design details.

(1) Steel Pole Material

The steel pole, including anchorage and arms shall be in accordance with the following material requirements:

Component	ASTM Designation	Minimum Yield Strength (ksi)
Tapered Tube	A595 GR. A or A572	55
Pole Base	A572	50
Arm Attachment	A572	50
Arm Connection Bolts	A325	NA
Anchor Bolts	F1554 GR 55	55
Galvanized Hardware	ASTM 123	NA

(2) Pole Dimensions

Pole dimensions shall be as specified in the City of Overland Park Standard Details. It is the responsibility of the fabricator to verify and attest that the material sizes proposed are structurally adequate and in full compliance with this specification and the pole detail sheet. The bolt circle and other pole and arm dimensions are provided in the table as specified in the City of Overland Park Standard Details. The base shall be cast with four (4) slotted holes to receive the anchor bolts and shall have tapped holes for attaching the two arms.

(3) Handhole Opening and Cover

The handhole cover shall attach to the frame centered 18" above the bottom of the shaft. It shall be a minimum of 6 ½" wide and 4 ½" tall and be secured with two ¼" stainless steel hex head screws. The handhole shall be reinforced with a frame. The handhole opening shall be ground smooth and free of all burrs and sharp edges. Handholes shall be located 180 degrees from the plane of the mast arms as viewed from the top.

(4) Ground Lug

Each pole shall contain an internal ground lug welded inside the pole adjacent to the handhole for the purpose of attaching a grounding connector. The ground lug shall have a ½"" diameter tapped hole.

(5) Cable Hook

Each pole shall also contain a ½" diameter hot rolled C-hook cable support welded inside the pole near the top of the pole shaft.

(6) Pole and Arm Caps

Each pole and both arms shall include end caps which shall be fastened to the shaft or arms by means of stainless steel set screws.

(7) Finish

The steel poles and arms shall be galvanized to ASTM A-123 standards..

g. Aluminum Pedestal Bases and Shaft

Aluminum pedestal bases shall consist of aluminum, die cast or sand cast base and a shaft for mounting vertical signal or standard controller cabinet capable of withstanding wind loadings of 100 mph.

The cast aluminum bases should meet the requirements of Section 1626.2(b) ASTM B26, S.G.70A-T6, S5A.F. or ASTM B108, S.G.70A-T6 of the "Standard Specifications." The base and post shall be joined by a threaded connection. Welded connections will not be accepted. The threaded post shall be easily and fully screwed into the threaded pedestal base without lubricant and be secured to the base by means of a threaded set screw and mounting collar.

The shaft shall be spun from one piece of seamless tubing, meeting the requirements of Section 1626.2(b) ASTM B210, having a minimum nominal 0.125" wall thickness. The shaft shall have no longitudinal welds, nor circumferential welds. The shaft shall have a uniform polished finish. Each shaft shall be tire-wrapped with a heavy water-resistant paper for protection during shipment and installation.

h. Loop Detectors

The term "inductive loop detector" applies to a complete installation consisting of a conductor loop or group of loops installed in the roadway, lead-in cable, and a sensor unit with power supply installed in a traffic signal controller cabinet.

(1) Sensor Unit

Sensor units mounted in the controller cabinet will be considered as part of the fully equipped cabinet. Sensor units which will be remote to the controller cabinet shall be solid state digital, providing two or four detection channels as indicated in the plans, with an inductance range of 0 to 2000 microhenries. Power failure shall result in a continuous call indication.

i. Electrical Cable

All electrical cable as called out for in the plans shall be new and shall meet the following specifications.

(1) Detector Loop Wire

The detector loop wire shall be #14 A.W.G., stranded, type THHN/THWN, 1-conductor cable with 15 mil wall black polyvinyl chloride / 4 mill wall of clear nylon insulation housed in black polyvinyl chloride tubing meeting IMSA specification 51-5. The polyvinyl chloride tubing shall be ULFR-1 rated 105 degrees C with a 0.030" wall thickness plus or minus 0.005".

(2) Detector Lead-In Cable

The 600 volt detector lead-in cable shall be composed of 2c #14 AWG stranded, tinned copper conductors insulated with 30 mil wall of low density color coded (one black and one clear) polyethylene. The conductors shall be wrapped with an aluminum bonded to polyester film with the foil facing out along with a #16 AWG tinned copper drain wire. The cable shall be in provided in a jacket of 30 mil wall black low density polyethylene and constructed per IMSA 50-2 in a 3" left hand lay. The cable shall have identifying markings showing the manufacturer's name, IMSA 50-2, 600V and the year of manufacture.

(3) Multi-Conductor Cable

All conductor cable for intersection signalization and intersection interconnection shall be multi-conductor cable for operation on a 600 volt maximum, and suitable for use at conductor temperatures not exceeding 75 degrees C. Material, construction, and tests shall be in accordance with the applicable requirements of the Insulated Power Cable Engineers Association standard S-61-402 "Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy."

Conductors shall be stranded, annealed uncoated copper or annealed coated copper. Copper wire before insulating or stranding shall meet the requirements of the latest edition of ASTM B-33 (for coated wire) or ASTM B-3 (for uncoated wire). Stranding shall be Class B in accordance with the latest edition of ASTM B-8.

Insulation for the individual conductors shall consist of a 20 mil thickness of polyethylene, and an insulation covering a polyvinyl chloride compound with a 10 mil thickness. The polyethylene insulation shall meet the requirements of paragraph 3.9 of I.P.C.E.A. standard S-61-402 before application to the conductor, and paragraph 3.9.1 after application to the conductor. The polyvinyl chloride insulation covering shall meet the requirements of paragraph 4.3.1 of I.P.C.E.A. standard S-61-402, and shall be color coded in accordance with method 1 or 3, part 5 of I.P.C.E.A. standard S-61-402.

The overall cable jacket shall consist of a polyvinyl chloride compound which will provide a tough, heat, moisture, ozone, and flame resistant covering meeting the requirements of paragraph 4.3.1 of I.P.C.E.A. standard S-61-402. The overall jacket thickness shall be in accordance with Table 18, part 4, I.P.C.E.A. standard S-61-402. As an acceptable alternate, the Contractor may use multi-conductor, stranded, cable meeting the requirements of International Municipal Signal Association, Inc. Specification 19-1 (1967) for Polyethylene-Insulated, Polyvinyl Chloride Jacketed Signal Cable.

(4) Electrical Service Cable

All wire and cable shall be type USE-2, soft drawn, stranded annealed copper, single conductor of 7 strands with 60 mil thick cross linked polyethylene insulation suitable for operation at 600 volts or less in wet or dry locations, including direct burial in the earth. It shall meet ASTM B8, UL 44, UL 854, ICEA S-95-658/NEMA WC70 and other applicable standards. Power distribution cable shall be #4 AWG with black insulation. Electrical service cable shall be #2 AWG and be supplied with black, white and green insulation for hot, neutral and ground, respectively. Parallel conductors on the same cable reel is permitted as long as the cables are not twisted or braded together.

(5) Equipment Ground Wire

Equipment ground wire shall be annealed, soft drawn, solid, bare, copper #6 AWG meeting ASTM B3.

j. Service Circuit Breakers

The contractor shall provide circuit breakers as shown on the plans for secondary power drop. The circuit breakers shall be single pole, molded case breakers of the size and trip rating shown on the plans. The circuit breakers shall be provided in a combination meter can/breaker box, rain-tight enclosure provided with a hasp for a padlock to be provided by others.

k. Conduit

Conduit shall be of the material type and size as specified in the plans or standard details.

(1) HDPE Traffic Signal Conduit

The conduit shall exhibit good workmanship and be free from holes, blisters, inclusions, cracks, and homogenous throughout. There should not be any foreign particles embedded in the plastic as a result of the extrusion process. There should not be any surface distortions that penetrate either internally or externally into the conduit wall greater than 10% of the minimum wall thickness. The conduit shall be constructed of polymeric materials which are lightweight, flexible, corrosion resistant and nonconductive. The base material shall be clean, virgin grade high-density polyethylene (HDPE) which conforms to ASTM D3350, most recent edition, Type III. Any regrind material shall be non-wide specification, reworked from the same virgin material from the same manufacturer as the original conduit. The conduit shall have a controlled outside diameter with the cross-sectional dimensions meeting SDR 13.5 manufactured to ASTM D3035 specifications and having a minimum ASTM cell classification 334480E. The conduit shall be smooth walled inside and out with a minimum coefficient of friction of 0.35. The conduit shall meet the following minimum requirements:

Density	> 0.940 g/cc	ASTM D-1505

Melt Index	< 0.4 gm/10 min.	ASTM D-1238(E)
Flexural Modulus	> 80,000 psi	ASTMD-790
Tensile Strength	> 3,000 psi	ASTM D-638
Slow Crack Growth		
ESCR (Bell Test)	10% Igepal	ASTM D-1693
Test Duration	192 hours min	ASTM D-1693
Failure	10% max	ASTM D-1693
Molded Plaque	3	ASTM D-1693
Hydrostatic Strength Class	NPR	ASTM D-2837
Color and UV Stabilizer	E > 2%	ASTM D-3350
Ultimate Elongation	>400 %	ASTM D-638

Minimum wall thickness shall be in accordance with the following table:

Diameter	Wall Thickness
1 ½" SDR 13.5	0.141"
2" SDR 13.5	0.176"
3" SDR 13.5	0.259"
4" SDR 13.5	0.333"

Traffic Signal conduit shall be sized according to the plans for 1 ½", 2", 3" and/or 4" in diameter. The conduit shall be pigmented throughout the entire cross-section so as to produce a uniform black color, forming an integral part of the product. It shall be extruded with three longitudinal white identifying stripes along its entire length. All colors shall be produced from light stabilized pigments, which are further protected from ultra-violet (UV) degradation by the incorporation of Hindered Amine Light Stabilizers (HALS) allowing protection for up to two years of outside storage. The conduit shall be sequentially marked and identified along its outer length in contrasting color and with a print of at least 0.125" height. The print interval shall not exceed five feet and shall include: 1) Manufacturer's name, 2) Product name/number, 3) Production code, 4) Length of Conduit (in feet), and 5) "City Traffic".

The conduit coming off the reel shall return to a circular shape upon the release of tension when it is unreeled. The conduit ovality as defined in ASTM D-2122 shall not exceed the percentage listed in the following table per ASTM F-2160:

Diameter	% Ovality
1 ½"	7%
2"	7%
3"	10%
4"	15%

When conduit 3" or above in diameter exceeds 10% ovality, it may be used if the contractor uses re-rounding equipment until 10% ovality or less is achieved. The mean elongation defined as the change in length divided by the original length, multiplied by 100 at a given load shall not be more than 10%. The conduit shall recover to a minimum of 95% of its original outer diameter upon release of a 200 pound load or shall not deflect to more than 5% of its original inside diameter within 10 minutes after removal of the compressive load.

(2) HDPE Conduit Fittings:

An approved factory coupling as listed in the Overland Park Approved Equipment List shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit.

l. Concrete for Foundations

All concrete construction shall meet the requirements of Section 401 of these specifications, including any special provisions, except as otherwise noted herein.

(1) Mix Designs

The mix designs shall be approved by the Kansas City Metro Materials Board as meeting the designation "KCMMB 4K".

(2) Ready-Mixed Concrete

Ready-mixed concrete shall be mixed and placed in accordance with the requirements of the Standard Specifications, except that ready-mixed concrete shall be transported with agitation. All concrete shall meet the slump requirements specified. Any addition of water shall be in accordance with the KCMMB specification and prior approval of the Engineer.

m. Anchor Bolts

All signal poles that are mounted on concrete foundations shall have anchor bolts conforming to the following specifications.

(1) Anchor Bolts for Mast Arm Poles

A set of four steel anchor bolts, sized according to the standard details with a 6" hook shall be supplied with each signal pole. Anchor bolts shall meet ASTM F1554, Grade 55 or AASHTO M314-90, Grade 55 with a minimum yield strength of 55,000 psi and tensile strength from 75,000 to 95,000 psi. They shall have Unified National Coarse (UNC) rolled threads, per ANSI B1.1, Class 2A. A minimum of the last 12" of the threaded end shall be hot dipped galvanized per ASTM A153. No welding is allowed on anchor bolts. Hardware shall include two ASTM A563, ANSI B18.2.2 heavy hex head nuts, and two ASTM F436 flat washers. All hardware shall be galvanized per ASTM A153.

(2) Anchor Bolts for Pedestal Poles

A set of four ¾"-10NC x 18" long steel anchor bolts with a minimum 4" hook shall be supplied with each lighting pole when mounted on a concrete foundation. Anchor bolts shall meet ASTM A36 Gr 50 steel with a minimum yield strength of 36,000 psi. They shall have Unified National Coarse (UNC) cut threads and be hot dipped galvanized the entire length per ASTM A153. Hardware shall include one 2 ¾" O.D. x 1-1/16" ID x 5/16" thick flat washer meeting ASTM F436 and one ASTM A563 heavy hex head nut per anchor bolt. All hardware shall be galvanized per ASTM A153.

n. Concrete Pier Reinforcing Spacers and Supports

All reinforcing cages for mast arm signal pole foundations shall be constructed with reinforcing spacers and supports to maintain clearance from pier walls and floor.

(1) Pier Wheels

Pier wheels or drill shaft wheels shall be fabricated of non-corrosive plastic and capable of firmly snapping into place.

(2) Pier Boots

Pier boots shall be fabricated from non-corrosive plastic

o. Conduit Couplings, Elbows and Fittings

Couplings for conduit shall be used to connect two runs of conduit, whether PVC to PVC, PVC to HDPE, HDPE to HDPE, PVC to RGC or HDPE to RGC as appropriate for field conditions and as outlined in the standard details and Approved Equipment List.

(1) PVC Conduit Couplings, Elbows and Fittings

Polyvinyl chloride (PVC) couplings, elbows and fittings shall be schedule 40 or schedule 80 for use with schedule 40 and 80 PVC conduit, respectively and shall be listed to UL-651 (latest revision). Standard PVC to PVC couplings shall have a center stop. Standard and special radius elbows shall either have a plain end or bell end.

(2) HDPE Conduit Fittings

An approved factory coupling or adhesive, as listed in the Overland Park Approved Equipment List shall be used for connection of the HDPE conduit to PVC conduit or between two HDPE conduits.

(a) Conduit Adhesive

The adhesive shall be capable of joining HDPE conduit to PVC, fiberglass and metal conduit using standard PVC couplings. It shall be a rapid cure, two-part resin adhesive supplied in a side-by-side mixing cartridge to form a durable, strong and watertight joint. The adhesive shall have the following minimum properties:

Color	Grey	
Peak Exotherm @ 70º F	< 200º F	
Hardness	70-80	Shore D Durometer
Flexibility	>2%	ASTM D-790
Dielectric Strength	450 Volts/Mil (Nonconductive)	ASTM D-149
Airtight (continuous)	120 psi	
Specific Gravity Part A	1.2	
Specific Gravity Part B	1.2	
VOC	0 g/L	ASTM D-1693
Operating Temperature	-60º F to 250º F	ASTM D-2837

(b) Mechanical Coupling

Couplings shall be able to join HDPE conduit to HDPE or PVC conduit. Couplings can be fabricated from either aluminum or high-density polyethylene and shall be able to mechanically connect to the conduits.

Aluminum body couplings for use on HDPE conduit shall contain a center stop and reverse threads to draw two conduits together and shall be able to be installed by hand. The sharp threads shall be able to withstand high pulling loads that meet or exceed the Bellcore tensile standard of 1,000 lbs. The coupling shall be machined with one degree of taper and have a long chamfered lead-in for straight, easy starting. They shall incorporate a wide, six pitch thread angle which greatly reduces the number of revolutions necessary to install the coupling.

Aluminum body couplings for use between HDPE and PVC conduit shall contain left hand threads on the HDPE end of the coupling that will cause, when installing the female pipe thread, them to tighten further on the conduit. The other end of the conduit shall be machined with regular IPS female pipe threads to accept a male to female PVC pipe adapter while gluing the PVC pipe into the female end of the adapter.

Polyethylene body couplings for use between HDPE conduits or between HDPE and PVC conduits shall have locking rings and external band clamps and 5/16” hex head tightening bolts that are all made from corrosion-resistant stainless steel. They shall be able to be re-entered without any special tools and shall be air and water tight by use of internal O-rings on each end. They shall meet UL-514B standards.

(c) Fusion Couplings

Electrofusion couplings shall be manufactured in accordance with ASTM F-1055 for use with pipe conforming to ASTM D2513/3035, F-714 and with Butt fittings conforming to ASTM D3261 as applicable. They shall be produced from a pre-blended virgin resin that has a PPI listing of PE3408 rating and Hydrostatic Design Basis of 1600 psi @ 73º F. The resin shall have a cell classification of 445574C which complies with ASTM D3350. The heating wire shall be copper, or nickel alloy. The terminal pins shall be machined or die swaged 70/30 brass or nickel-plated carbon steel.

(d) Conduit Expansion Fittings

Conduit expansion fittings shall be two-piece PVC. One piece shall telescope the other to accommodate thermal expansion and contraction along the conduit run. The spigot part of the joint shall slide through an internal O-ring to keep moisture and debris out of the fitting. Couplings for conduits

sized through 2” in diameter shall expand up to 4”. Couplings for conduits sized 2” through 6” shall expand up to 8”.

p. Junction and Service Boxes

Material for junction and service boxes shall be a polymer concrete of select-grade aggregate consisting of sand and gravel bound together with a polymer resin system and reinforced with continuous woven glass strands. It shall have the following minimum properties:

Compressive Strength: 11,000 psi per ASTM C-109/D-3410
Tensile Strength: 1,700 psi per ASTM C-496/D-638/D-2343
Flexural Strength: 7,500 psi per ASTM C-580/D-790

All junction boxes, service boxes, and covers shall be rated at no less than 22,500 lbs. test load (Tier 15) per ANSI/SCTE-77. All boxes shall be stackable for extra depth. The box shall consist of straight sides and open on the bottom. The various types of junction and service boxes shall be sized according to the standard details.

The cover shall have a non-skid textured surface having a minimum coefficient of friction of 0.50 under wet or dry conditions. It shall have a slot with a lift pin for inserting a lift hook. There shall be two stainless steel hex head bolts and washers in opposite corners for bolting down the cover to the box. There shall be a cleanout hole in the box below the bolt to aid cleaning out debris. A logo with the words “Traffic Signal” shall be either embossed or molded into the cover or on a name plate that can be permanently affixed to the recessed area in the box lid.

q. Ground Rods and Clamps

Ground rods shall be fabricated from a rigid, high carbon steel core and tip with a heavy, 99.95% pure, 10 mil minimum uniform coating of copper, metallurgically bonded to the core. They shall be UL-467 rated. The name, length, diameter, part number and UL logo shall be roll-stamped onto the ground rod.

Ground rod clamps shall be fabricated from high strength copper or bronze alloy meeting UL-467 standards with a hex head clamping bolt. It shall be able to accommodate a bare, solid #6 AWG copper ground cable or #10 AWG stranded locating/ground cable.

1020.3 CONSTRUCTION REQUIREMENTS

The contractor shall only use qualified laborers who are well trained to perform functions related to traffic signals, including familiarity with applicable sections of the National Electric Code. The "Standard Specifications" shall be amended by the addition of the following:

a. Concrete Foundations

Refer to section 401 of these specifications for information regarding placement and curing, admixtures, forms, special weather conditions, and strength acceptance requirements. The bottom of the concrete foundations shall rest on firm ground. The exposed portions shall be formed to present a neat appearance. Forms shall be true to line and grade. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position, to proper heights, and held in place by means of a template until the concrete sets. All reinforcing steel shall be ASTM A615 GR60 and sized and arranged according to the standard details. All reinforcing steel shall be spot welded or securely wired to adjacent bars to keep it in place. If at any time, in the inspector’s opinion that the cage is not sufficiently supported by wire ties, they can require spot welding instead. The contractor shall use drill shaft wheels (pier wheels) and rebar support boots (pier boots) on the reinforcing cages for mast arm pole foundations to maintain 3’ clearance to the shaft wall and shaft bottom, respectively. The drill shaft wheels shall be spaced at 90 degrees around the rebar cage, beginning on the second hoop bar up from the bottom of the cage and on the second hoop bar down from the top of the cage. For foundations deeper than 12’, an additional set of pier wheels shall be placed in the middle of the reinforcing cage. Support boots shall be placed at the bottom of every vertical bar. Both forms and ground which will contact the concrete shall be thoroughly moistened before placing concrete. Concrete shall not be placed until forms

and reinforcing steel have been checked and approved by the Engineer. Placement of concrete shall be witnessed by the Engineer.

Concrete foundations shall be consolidated by an internal type vibrator. The vibrator shall operate at frequencies of vibration not less than 8,000 cycles per minute under load. The amplitude of vibration shall be adequate to consolidate concrete properly. The concrete shall be cured with an approved moisture barrier such as wet burlap, polyethylene, etc., for a period of seventy-two (72) hours. Cold weather curing shall be such that the concrete temperature shall be maintained above freezing for the entire curing period. Forms shall not be removed until the concrete is thoroughly set.

(1) Concrete Pole Foundations

All concrete used for traffic signal mast arm pole foundations shall have a 6" to 9" slump. High-range water reducers may be used to achieve the higher slumps. Concrete for pedestal pole foundations shall have a 4" slump. Foundations for all traffic signal poles shall have a 6-inch square cap poured after pole is erected and plumbed and arms (if applicable) are attached. Top of footing shall be finished to curb, sidewalk grade, finished ground surface or as directed by the Engineer. Traffic signal poles shall not be erected until concrete has reached 3,400 psi.

(2) Concrete Controller Foundations

All concrete used for controller foundations shall have a 4" slump. The top slab of the landing pad shall be finished to curb, sidewalk grade, finished ground surface or as directed by the Engineer. Control center foundations shall have the appropriate number of conduits as indicated in the plans and standard details. All exposed corners shall be constructed with chamfer strips to provide a neat appearance. All concrete surfaces shall be brushed and sealed with an approved curing compound.

b. Service and Junction Boxes

Service boxes and junction boxes shall be installed at the locations shown on the plans and at such additional points as the Contractor, at his own expense, may desire to facilitate the work. The Contractor may install, at their own expense, such additional boxes as may be desired to facilitate the work upon approval of the Engineer. Service and junction boxes shall be installed on eighteen (18) and eight (8) inches of crushed rock, respectively, as shown on the plans or as directed by the Engineer. Additional rock shall be installed around the base of the box such that the rock extends 2" above the bottom of the box. Boxes shall be installed so that the covers are level with the curb or sidewalk grade or level with the surrounding ground when no grade is established. Junction or service boxes placed in a paver median or island shall have a concrete border placed around them as indicated in the standard details.

c. HDPE Conduit

The location of conduit runs shown on the plans are for bidding purposes only and may be changed with permission of the Engineer in charge of construction to avoid underground obstructions. Installation shall conform to the appropriate articles of the National Electrical Safety Code. The conduit shall be installed continuous from outlet (service box, or junction box) to outlet or as otherwise shown on the plans. No couplings or joints will be allowed at intermediate points unless approved by the Engineer in charge of construction. The conduit may be directional bored to minimize disruption to the existing improvements, or trenched. When trenching multiple conduits, a minimum of 12" horizontal or vertical separation shall be maintained between nearest edges of conduits. When directional boring, only one conduit shall be pulled back at a time. Multiple conduits shall not be pulled through the same bore hole. As much as physically possible, a minimum of 12" separation shall be maintained between bored conduits.

Boring pits shall be kept two (2) feet clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined, or subgrade softened, will not be permitted. The number of bends in any run of conduit shall not exceed 360 degrees.

Conduit entering equipment shall be continuous into the service box, junction box, and control center. A factory 90° PVC conduit elbow shall be used for installation into concrete control center foundations or signal foundations.

It shall be the privilege of the Contractor at their own expense to use larger size conduit if desired; and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

The conduit installed under all roadway surfaces shall be placed a minimum of forty-eight (48) inches below the bottom of pavement elevation to the top of conduit; under drives at a depth of between twenty-four (24) and thirty-six (36) inches below top of pavement; and within park areas at a depth of between twenty-four (24) and thirty-six (36) inches below finished grade. Electrical service conduit shall be installed 30" below grade. Any conduit installed in a trench that will be below any paved surface shall be backfilled with AB-3 or crushed rock to a depth of 6" above the top of the conduit and then low strength flowable fill to below the proposed paved surface.

The location of all conduits installed or used in this project shall be marked by aluminum markers placed in the top of curb, gutter, or wall, directly above the conduit. The markers shall either be embedded in fresh conduit or they shall be drilled with a recess such that the top of the marker is flush with the finished surface. When markers are installed in a drilled hole, they shall be set with epoxy. The City will provide the markers.

Conduit installed in foundations, shall extend above the foundation vertically to a height as specified in the standard details. Conduit entering through the bottom of a junction box or service box shall extend above the crushed rock base as specified in the standard details. At all outlets, conduit shall enter from the direction of the run. Existing underground conduit to be incorporated into a new system or newly installed conduit which will be left empty shall be cleaned with a mandrel and blown out with compressed air. A locating wire shall be placed in any conduit that would otherwise be empty. Duct seal shall be installed in the end of all conduits in junction and service boxes and at the control center.

(1) PVC Conduit

If PVC conduit is installed or used between the signal control center and the Evergy service point, it shall be continuous without junction boxes. All joints in PVC conduit shall be glued. A factory 90° PVC large 36" radius conduit elbow shall be used for installation into a control center and at the Evergy power source. All PVC conduits shall be installed by the trenching method. Directional boring of PVC conduit will not be permitted.

(2) HDPE Conduit

It is desirable that the conduit be directional bored to minimize disruption to the existing improvements. Conduit shall be placed under existing pavement by approved boring methods. Pavement shall not be disturbed without the written permission of the Engineer and then only in the event insurmountable obstructions are encountered. Boring pits shall be kept twenty-four (24) inches clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined, or subgrade softened, will not be permitted.

The conduit entering equipment shall be continuous from appurtenance to appurtenance (junction box, light pole or control center) or as otherwise shown on the plans. At signal poles, control centers, and Evergy power sources, HDPE conduit shall be transitioned to PVC conduit with approved couplings and PVC pipe nipples prior to the PVC radius as indicated in the standard details. At junction boxes and service boxes, it is desirable to sweep the HDPE conduit directly into the junction box. If approved by the Engineer, HDPE conduit may be transitioned to PVC according to standard details. Conduit bends or sweeps shall have a radius of not less than six (6) times the inside diameter of the conduit. Conduit bends shall be made without crimping or flattening, using the longest radius practicable. The ends of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof.

d. Conduit Couplings

Conduit couplings between appurtenances, except immediately at the pole foundation or junction box, as indicated in the standard details, shall not be allowed unless fusion couplings or other fusion methods are used. No matter what coupling is used for the specific application, the end(s) of the conduit shall be round and shall be cut square using an appropriate tube cutters. The contractor shall measure the "stab" depth of the coupler and transfer this measurement on each conduit end with a permanent marker

to ensure both conduit ends are fully inserted into the coupling when complete. The coupling shall be centered over the contact points of the two conduits.

(1) Fusion Couplings

Fusion couplings shall require installation by a skilled and certified installer. Proof of certification shall be made prior to installing the coupling. Installation of one test coupling shall be required before this method of coupling HDPE conduit is approved. The certified installer shall be present for every coupling. All heat fusion joining methods require that there is no water flowing or standing in or below the conduit that can reach the fusion surfaces. Conduit surfaces shall be dry prior to and during fusion and should be protected from moisture during rain or snow events. Electrofusion couplings can be installed at ambient temperatures ranging from -10 degrees F to 120 degrees F. Follow the recommendations of the manufacturer. The fusion surface of the coupling shall be clean and free from body oils or other substances that will prevent proper fusing. The ends of the conduit shall be cleaned with 90% or greater concentration of isopropyl alcohol, wiping in only one direction. The area to be cleaned shall be at least two times the full length of the coupling on each end of the conduit. Measure and mark the conduit slightly longer than ½ the length of the coupling to indicate the scrape/peel length needed. Scribe "witness marks" on the conduit surface. Each end of the conduits shall be scraped or peeled to remove the oxidation and contamination layer with a "peeler" type tool that removes a continuous and measureable ribbon of conduit surface. A minimum of 0.007" of material (thickness of two sheets of paper) shall be removed from each end. None of the "witness marks" shall be visible after scraping. Sandpaper, utility/emery cloth, wood rasps, metal files and abrasives/grinders shall never be used to scrape the conduit ends. Insert the conduit ends into the coupling to the stab depth (½ the length of the coupling). After the conduit has been inserted into the coupling, assembly clamps shall be used to align the ends. The electrical source shall be connected to the electrofusion control box. The contractor shall verify the control box inputs based on the model used. The control box shall acclimate to the jobsite weather conditions for a minimum period of 15 minutes prior to using. The power should be of sufficient output for the size and type of fitting being used. See the power requirements of the manufacturer of the coupling. If an extension cord is used, it should be of sufficient gauge and not more than the specified maximum length according to manufacturer's instructions. Connect the control box leads to the fitting and verify proper fusion time and voltage. Fusion time is different depending on the size of the coupling. After the fusion process is complete, allow proper cooling time while the conduit is still being held by clamps and additional cooling time before rough handling of conduit according to the manufacturer's instructions.

(2) Butt Fusion Plates

Commercial fusion plate machines shall be used in this process. All points on both heating tool surfaces, where the heating tool surfaces will contact the conduit ends, shall be within the prescribed minimum and maximum temperatures. The temperature differentials between any two points on the heating tool fusion surfaces shall not exceed 20 degree F. Clean the inside and outside of the conduit ends by wiping with a clean, dry, lint free cloth or paper towel. Remove all foreign matter. Align the conduits in the machine by placing them in the clamps and tightening. Conduit ends should protrude past the clamps enough so that facing will be complete. Bring the ends together and check high-low alignment. Adjust the alignment as necessary by tightening the high side down. Place the facing tool between the component ends, and face them to establish smooth, clean, parallel mating surfaces. A complete facing will produce continuous circumferential shavings from both ends. Face until there is minimal distance between the fixed and moveable clamps. Stop the facer before moving the pipe ends away from the facer. Remove the facing tool, and clear all shavings and pipe chips from the component ends. Do not touch the component ends with your hands after facing. Bring the component ends together, check alignment and check for slippage. Look for complete contact all around both ends with no detectable gaps. Verify that the contact surface of the heating tool is maintaining the correct temperature. Place the heating tool between the conduit ends, and move the ends against the heating tool. Bring the conduit ends together under pressure to ensure full contact. The initial contact pressure should be held very briefly and released without breaking contact. Pressure should be reduced when evidence of melt appears on the

circumference of the conduit. Hold the ends against the heating tool without force. Beads of melted conduit will form against the heating tool at the component ends. When the proper melt bead size is formed, quickly separate the ends and remove the heating tool. The proper bead size is dependent upon the size of the conduit. During heating, the melt bead will expand out flush to the heating tool surface, or may curl slightly away from the surface. Immediately after the heating tool is removed, quickly inspect the melted ends, which should be flat, smooth and completely melted. If the melt surfaces are acceptable, immediately and in a continuous motion, bring the ends together and apply the correct joining force (or fusion pressure). The correct fusion pressure will form a double bead that is rolled over and contacts the conduit surface. Maintain fusion pressure until the joint is cool to the touch.

(3) Glued Couplings

Install glued couplings within the working temperature as specified by the manufacturer. For conduit over 3" in diameter, taper the end at 45 degrees with a rasp or knife. Abrade and clean both adhesion surfaces and wipe with a clean rag to remove dirt and grime. Sand the outside of the conduit ½" beyond the depth of insertion into the coupling with 80-grit sandpaper as well as the inside of the coupling. All polish shall be removed. Clean the adhesion surfaces with recommended cleaner. Dispense the adhesive material through the mixing tubes in a 1/8" to ¼" bead using a zigzag pattern the depth of the coupling insert. Squeeze out a small sample prior to applying to the conduit to ensure the product is properly mixed in the mixing tube. The pattern should be about 3/8" in width and extend to the outer edge of the conduit. The coupling shall immediately be twisted onto the conduit and held in place. The joint shall not be moved until the recommended working time is achieved based on the ambient air temperature according to the manufacturer's instructions.

e. Wiring

Cable shall be carefully pulled through conduit without chafing the insulation jacket on the edge of the conduit or cable entries within the pole.

Color codes, as listed in the standard details, shall be followed so that the red insulated conductor connects to the red indication terminal, orange to yellow, green to green, etc. Cables shall be labeled at the controller with permanent plastic identification tags appropriately attached to the cables by an approved method. Metal identification tags are not allowed. Information on the tags shall identify equipment served by the conductor cable in accordance with designations used on the plans.

f. Concrete

All concrete for mast arm pole foundations shall be placed with a tremie chute at least six foot in length to prevent concrete from striking the wall of the augured hole.

g. Bonding and Grounding

All steel poles and pedestals shall be bonded to form a continuous system, and effectively grounded. Bonding jumpers shall be No. 6 A.W.G. bare, solid copper wire or equal connected by approved clamps. Grounding of conduit and neutral at service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 A.W.G. or equal. Ground electrodes shall be provided at each signal pole and pedestal and at the controller as detailed on the plans. If a single ground rod is used and its resistance exceeds 25 Ohms, it must be augmented by one additional ground rod located no less than 6 feet from the original ground rod.

A 5/8" x 8' ground rod and ground rod clamp shall be installed in each type FO service box and traffic signal service box for attachment of the #10 AWG THHN stranded copper locating/ground cable. See the standard details for additional information.

h. Detector Loops

Installation shall conform to the details and notes shown on the plans. Loop wire shall be one continuous wire with each partial loop to be in the configuration detailed on the plans. All loop conductors shall be wound in the same direction with the start and end clearly marked on the conductors at the junction or service box. Conductors of all loops to be operated shall be run continuous to the nearest junction or service box. The loop conductors for each loop shall be spliced in the junction or service box to a detector lead-in cable running from the box to a sensor unit mounted in the controller cabinet

Saw cuts for loop wires shall be made with a self-propelled, water cooled power saw. The water is used to cool and lubricate the blade and eliminate blowing saw dust. All jagged edges or sharp corners and protrusions shall be removed using a small chisel and hammer. The saw cut shall be cleaned of cutting dust, grit, oil and other contaminates. The saw cut shall be flushed clean with water and dried with compressed dry air immediately after cutting. Care shall be taken during the cutting and cleaning operation to avoid blowing debris at passing pedestrians and vehicles or onto private property.

After conductors are installed in the slots cut in the pavement, the slots shall be neatly filled with epoxy sealant for concrete, or an approved asphalt sealer for a bituminous surface, to within 1/8" of the pavement surface. The sealant shall be between 2" and 3" thick above the top conductor in the saw cut as determined by the saw cut depth and as indicated in the plans. Before setting, surplus sealant shall be removed from the adjacent road surfaces without the use of solvents. Sand or other absorbent material shall be spread over the sealant if traffic is allowed over the loop before the sealant is completely set.

i. Plugging Holes in Signal Poles

Holes in existing signal poles left due to removal of existing equipment shall be repaired with steel, zinc plated knockout plug. Silicon sealant shall be applied to the back side of the plug prior to installation to seal moisture from entering the pole. Duct butter or conduit sealant shall not be allowed.

1020.4 MEASUREMENT AND PAYMENT

a. Lump Sum

The Engineer will measure the traffic signal installation as indicated on the plans, complete-in-place and accepted, as a unit lump sum quantity for all work necessary.

Payment for “Traffic Signal Installation (Location)” at the contract lump sum price bid is full compensation for the specified work.

b. Unit Bid Prices

The traffic signal installation, repair, maintenance or modification as indicated on the plans or as directed by the Engineer will be measured by the units indicated herein, and shall include all items necessary to complete the work of a fully functional traffic signal system.

(1) The Engineer will measure all work related to furnishing and installing conduit of specified type and size by the linear foot.

(2) The Engineer will measure all work related to furnishing and installing cable of specified type by the linear foot.

(3) The Engineer will measure all work related to furnishing and installing each junction box or service box of specified size and type.

(4) The Engineer will measure all work related to furnishing and installing each detector loop of specified type, based on the number of individual diamonds.

Payment for “Conduit (Size) (Type)”, “Cable (Type)”, “Junction Box (Type)”, “Service Box (Type)” and “Detector Loop (Type)” at the contract unit prices bid is full compensation for the specified work.