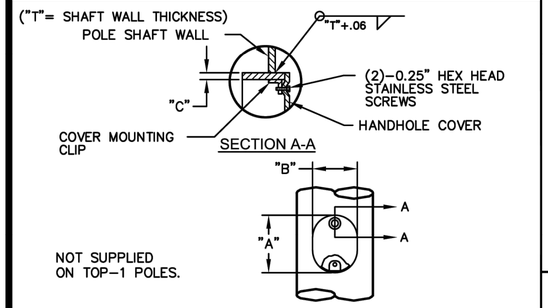
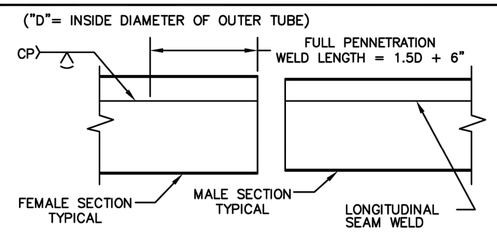


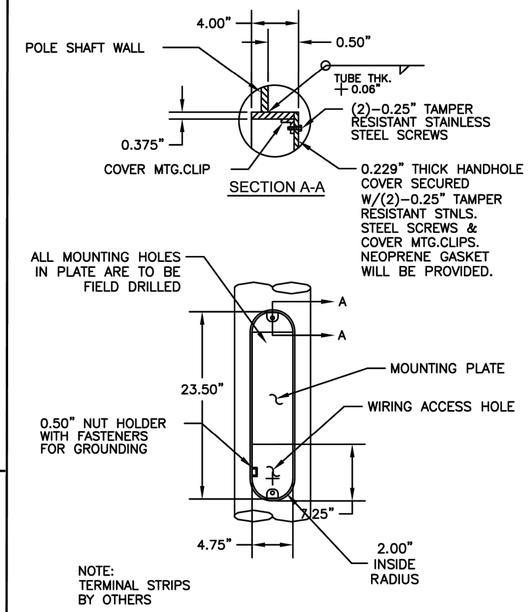
GAUGE OR THK. (IN)	A (IN)	B (IN)	C (IN)
5	7.56	5.19	0.280
0.219	7.31	5.63	0.432

DETAIL 3: HANDHOLE

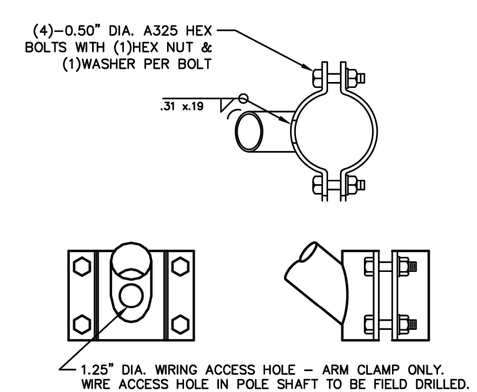


52'THRU 64'MAST ARM
WELD REINFORCEMENT

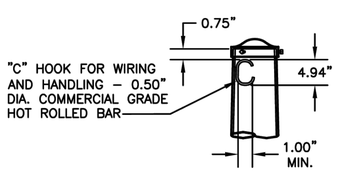
DETAIL 5: MAST ARM WELD REINFORCEMENT



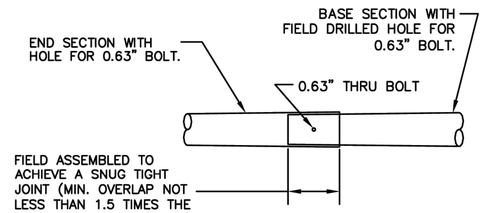
DETAIL 7: BASE HANDHOLE



DETAIL 2: LUMINAIRE ARM ATTACHMENT

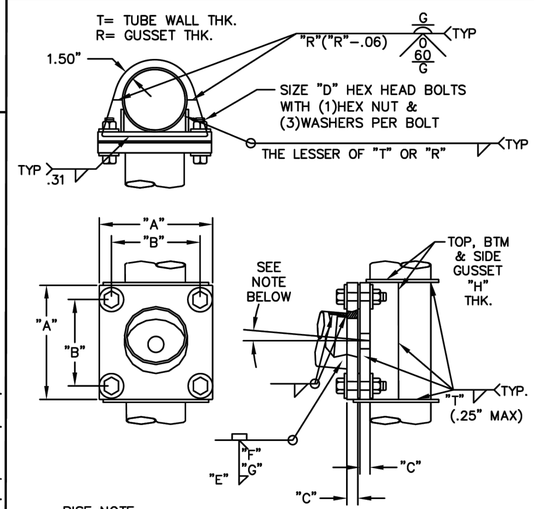


DETAIL 1: POLE TOP



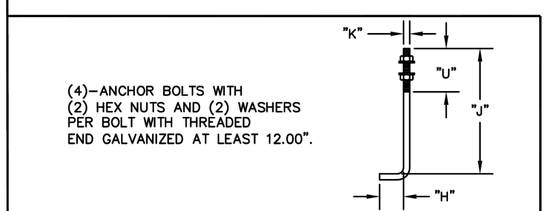
SPAN (FT)	BASE SECTION		END SECTION		
	LENGTH (FT)	GAUGE OR THK. (IN)	BASE DIA. (IN)	LENGTH (FT)	GAUGE
52.00	40.00	5	8.05	14.08	7
54.00	40.00	5	8.05	16.08	7
55.00	40.00	5	8.05	17.08	7
56.00	38.50	3	8.26	19.60	7
58.00	38.50	3	8.26	21.60	7
60.00	38.50	3	8.26	23.60	7
62.00	22.99	0.219	12.00	41.58	7
64.00	22.99	0.219	12.00	43.58	7

DETAIL 4: SIGNAL ARM SLIP JOINT

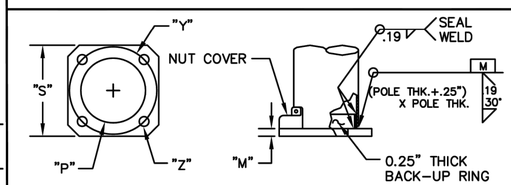


ARM SHAFT WALL THK.	ARM–TO–PLATE WELD "E"	BEVEL "F"X"G"
ALL	(ARM THK.+.25") X ARM THK.	.19" X 30°

DETAIL 6: SIGNAL ARM ATTACHMENT



DETAIL 9: ANCHOR BOLT



DETAIL 8: POLE BASE

NO.	DATE:	REVISION	BY:	APP'D
1	10/2/17	New Standard Drawing 103B (deleted 103)	DHS	TLC

EDITED BY: Doug Spaar

APP'D BY: Terry Coder

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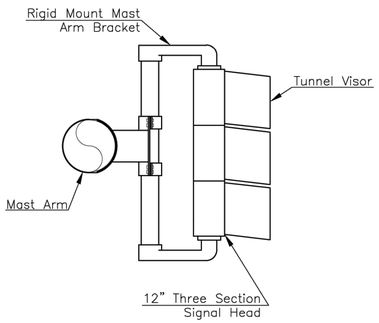
STANDARD DETAILS

TRAFFIC SIGNAL MAST ARM POLE DETAILS
(DT-103B)

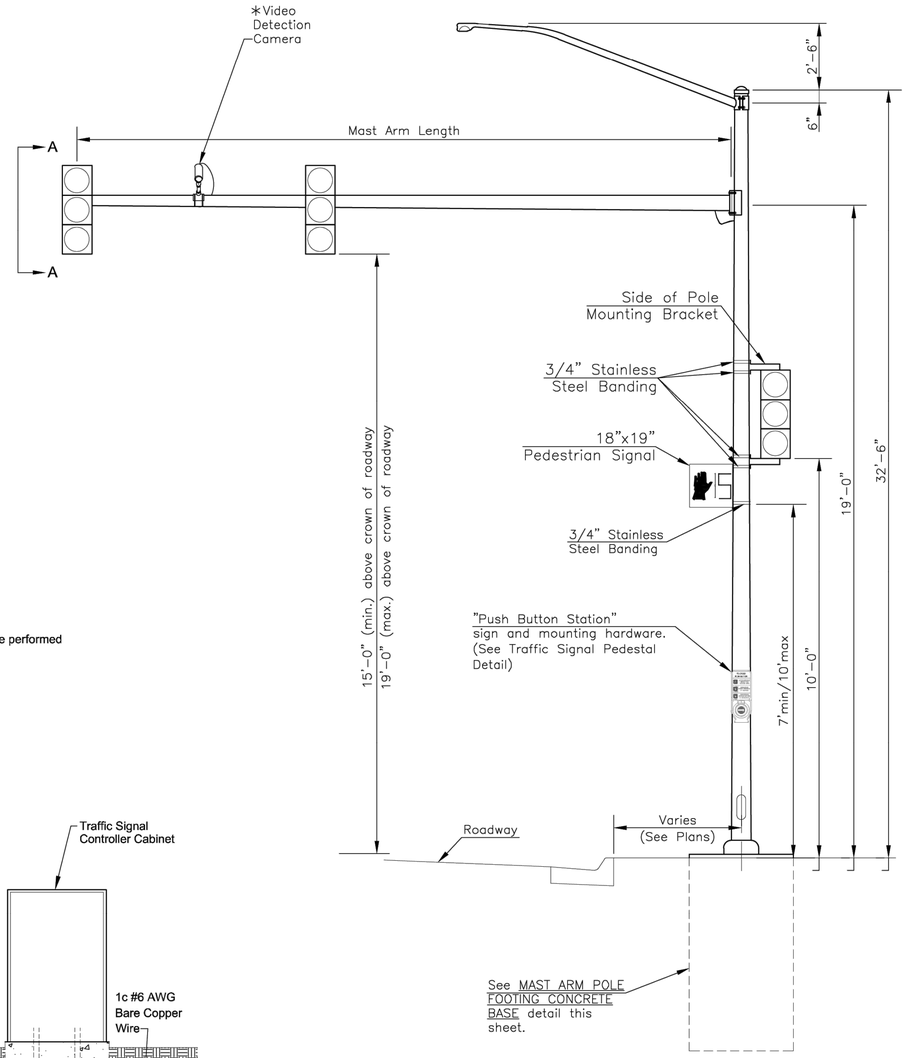
DATE: APR 2026
SHEET: 69 OF 122
PROJ.: 701038.00

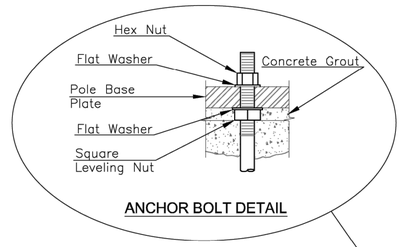
*NOTE:

Video Detection Camera locations will be as shown on plans or as directed by the Engineer.

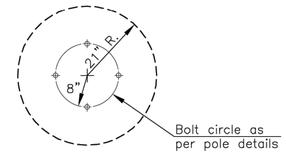


SECTION A-A

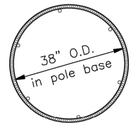




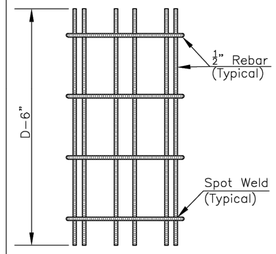
ANCHOR BOLT DETAIL



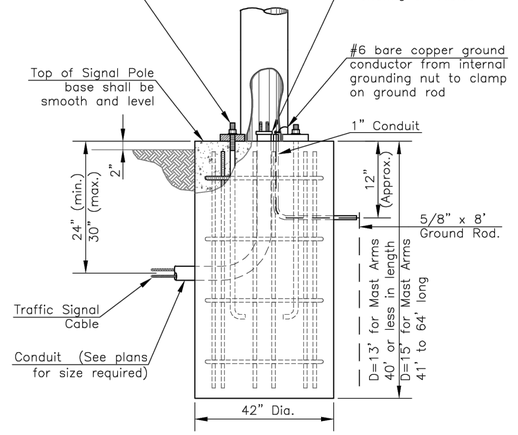
TOP VIEW



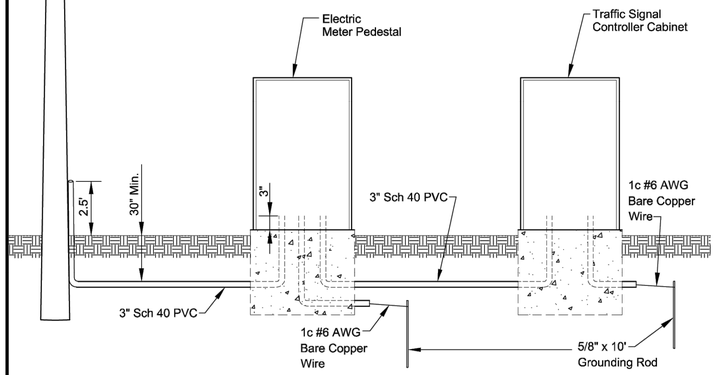
TOP VIEW



REBAR CAGE DETAIL



MAST ARM POLE FOOTING CONCRETE BASE



NOTE:

1. From Service Disconnect to Evergy Hookup, all electrical work shall be performed by licensed electricians.

ELECTRIC POWER SIGNAL SERVICE CONNECTION

NOTES:

1. See DT-103 A & B for additional pole details.
2. Directional alignment of Vehicular and Pedestrian Signal Head and bracket to be determined in the field by the Engineer.
3. Holes through in arms, poles, & pedestals shall be drilled, well reamed, and fitted with a wiring grommet to prevent the chafing of cables.
4. When Black Semi Gloss is indicated, all exposed surfaces of the traffic signal and it's appurtenances, including cabinets, brackets, banding, buckles, back-plates, sign backs, and fixtures shall have a finish color of BLACK (semi-gloss) Federal Standard 595 Color #27038 or approved equivalent.

STEEL TRAFFIC SIGNAL POLE WITH MAST ARM

NO.	DATE:	REVISION	BY:	APP'D
1	10/30/20	Revised Electrical Service Connection Added	SU	KRE
1	10/5/17	Updated Standard	DHS	TLC

EDITED BY: Shoeb Uddin

APP'D BY: Kristi Ericksen

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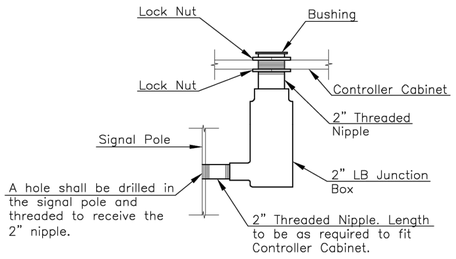
STANDARD DETAILS
DT - 104

MAST ARM AND BASE ELECTRICAL SERVICE CONNECTION

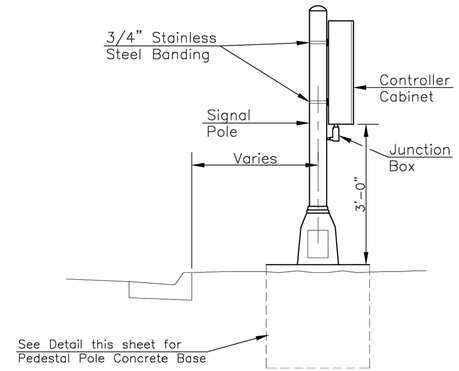
DATE: APR 2026

SHEET: 70 OF 122

PROJ.: 701038.00



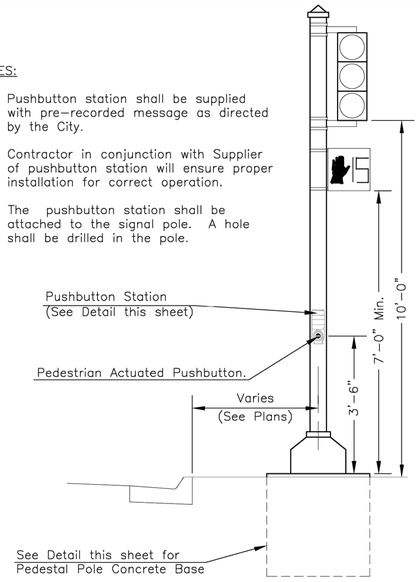
2" JUNCTION BOX CONNECTION DETAIL



PEDESTAL MOUNTED CONTROLLER

NOTES:

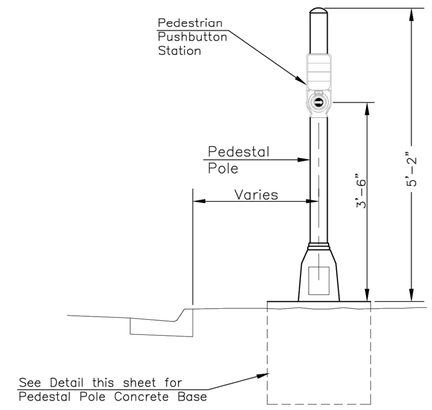
1. Pushbutton station shall be supplied with pre-recorded message as directed by the City.
2. Contractor in conjunction with Supplier of pushbutton station will ensure proper installation for correct operation.
3. The pushbutton station shall be attached to the signal pole. A hole shall be drilled in the pole.



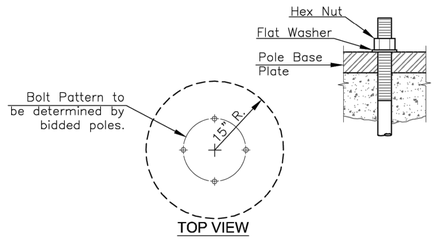
PUSHBUTTON STATION

Note: Pedestrian Pushbutton Station to be equipped with a Braille message to read as follows:
TO CROSS
PUSH BUTTON
WAIT FOR WALK SIGN

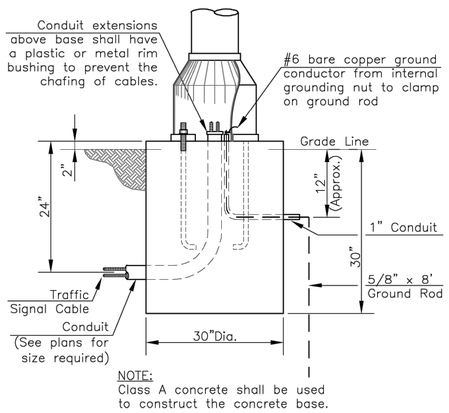
TRAFFIC SIGNAL PEDESTAL



PEDESTAL MOUNTED PUSHBUTTON STATION

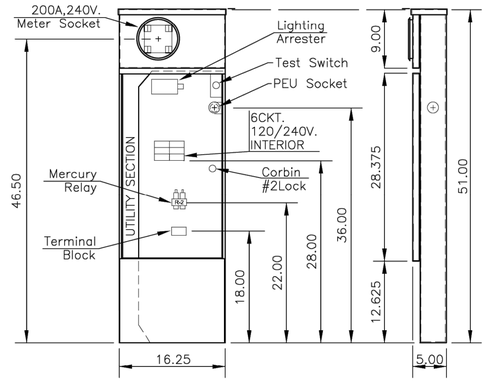


TOP VIEW

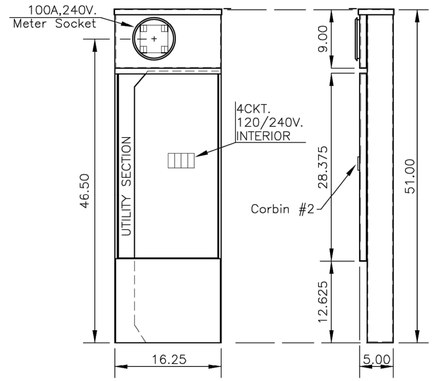


NOTE:
Class A concrete shall be used to construct the concrete base.

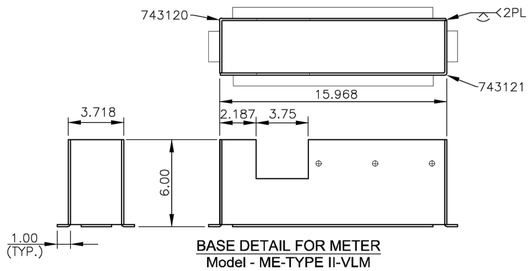
PEDESTAL POLE CONCRETE BASE DETAILS



TRAFFIC SIGNAL SECONDARY SERVICE
WITH STREET LIGHT
Model - MET2-VLM-LTS



TRAFFIC SIGNAL SECONDARY SERVICE
Model - MET2-VLM-TS



BASE DETAIL FOR METER
Model - ME-TYPE II-VLM

NO.	DATE:	REVISION	BY:	APP'D
2	10/30/20	Elec. Serv. Conn. Det. moved to DT 104	SU	KRE
1	10/5/17	Updated Standard	DHS	TLC

EDITED BY: Shoeb Uddin

APP'D BY: Kristi Ericksen

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STANDARD DETAILS
DT - 105

TRAFFIC SIGNAL PEDESTAL AND PEDESTAL CONCRETE BASE DETAILS

DATE: APR 2026
SHEET: 71 OF 122
PROJ.: 701038.00

Construction and Material Requirements for Traffic Signal Installation

General Notes:

The Standard Specifications for State Road and Bridge Construction (2015) published by the Kansas Department of Transportation is referenced throughout these Standard technical Specifications and is referred to as the "KDOT Standard Specifications". When referenced herein, "KDOT Standard Specifications" shall not include KDOT Special Provisions unless specific reference is made to a KDOT Special Provision.

Construction:

See KDOT Standard Specifications, Section 814, "Electric Lighting Systems and Traffic Signals".

The Contractor shall provide an employee with Level II certification in Traffic Signal Installation by the International Municipal Signal Association (IMSA) to be present at the job site at all times. In place of a IMSA certified employee, the supervisor on site must have 5 years of direct experience in the construction of traffic signals. Adequacy of supervisor's experience level shall be approved by the project manager or the Traffic Operations Manager for the City of Topeka, prior to bidding for the work.

The local power company shall be notified by the Contractor prior to beginning work to determine the proper type and method of hook up for the particular location. The Contractor shall be responsible for all costs associated with the power hook up, including conduit, lead-in wire, service pole, meter landing etc., regardless of whether these costs have been listed on the bill of materials.

Locations for the signal poles, pedestals, service boxes, junction boxes and loop detectors shall be staked by the contractor. Staked locations shall be approved by the Engineer prior to construction of each item.

The plan locations of existing underground utilities are approximate and have not been independently verified. The Contractor shall determine the exact location of all existing utilities before beginning work. The Contractor shall be responsible for all damages caused by contractor's failure to exactly locate and preserve all underground utilities. Companies or agencies that have identified utilities in the vicinity of the construction site are shown in the plans.

The Contractor is responsible for all field-wiring, including the power hook-up to the control cabinet. The Contractor shall be responsible for extending all field wiring into the traffic control cabinet with appropriate labels. All wiring inside the control cabinet shall be performed by the Traffic Signal Technician of the City. The Contractor shall conform to all pertinent OSHA (Occupational Safety & Health Administration) regulations.

Materials:

All materials used in the fabrication or assembly of the items listed below shall be new and shall comply with the applicable parts of Section 1703 (Electric Lighting and Traffic Signal Equipment) of the KDOT Standard Specifications.

All signs, signals and markings shall conform to the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).

See Section 1607 (Structural Steel) and Section 1608 (Structural Steel Tubing) of the KDOT Standard Specifications for the basis of acceptance of materials covered by these sections. See Section 1615 (Anchor Bolts for Structural Uses) of the KDOT Standard Specifications for the basis of acceptance of Anchor Bolts for Traffic Signal poles. If Type B certification is not provided according to Section 2601 (Materials Certification) of the KDOT Standard Specifications, the Engineer may require testing of the Anchor Bolts. Anchor Bolts for Controller Cabinets and Traffic Signal Pedestals shall meet the requirements of the latest edition of the American Society for Testing Materials (ASTM) Specifications A36 (Specification for Structural Steel) and will be visually accepted by the Engineer.

Major items of electronic equipment installed under this Contract shall be of the same type and consist of products provided by the same supplier in order to secure uniformity, single responsibility, and most satisfactory services.

Traffic Signal Specifications

I. General

A. Traffic Signal Improvement Policies:

The work included in this project may involve replacement and/or modification of traffic signal equipment for an existing Traffic Signal that is also currently in operation. The following policies are to be observed during the proposed modifications/improvements:

(1) Existing Operation - the Contractor shall provide continuous operation of the Traffic Signals during the signal modifications and improvements except for shutdowns to allow for alteration as required for installation of the proposed improvements.
(2) Periods of Disruption - some periods of disruption of existing Traffic Signal operation can be tolerated during installation of the proposed improvement; however, the Contractor shall coordinate any planned disruption of Signal operations with the Engineer a reasonable time in advance of such disruption of operations.
(3) Disruption Times - planned disruption of signal operations shall be limited to hours between 9:00 am and 4:00 pm. The Signal controls shall be operable during all other periods.
(4) Existing Wiring - all existing wiring within existing controller cabinets shall be identified by the Contractor and each conductor shall be properly labeled prior to de-energizing the existing controller to install the proposed modifications and improvements.

B. Salvaged Equipment:

(1) Reinstalled - when salvaged equipment is to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment including anchor bolts, nuts, washers, concrete etc. required to compliment the salvaged equipment in the new installation.
(2) Not Reinstalled - when salvaged equipment is not to be reinstalled, they may be stored on site temporarily. The stored equipment shall be the responsibility of the Contractor until the Contractor delivers these to the City's Traffic Operations Section located at 927 NW Harrison Street.
(3) Removal of Existing Bases - existing bases for traffic signal poles, pedestals, and controllers shall be removed a minimum of 24" below finish grade.
(4) Service Boxes and Junction Boxes in turf areas shall be completely removed. Holes are to be filled and compacted with select soil. Junction Boxes in paved areas shall have lid and wiring removed and filled with concrete or asphalt.
(5) After completion, wiring shall be removed if possible and conduit shall be abandoned in place.

C. Turn On:

(1) System Turn-on - the signal system turn-on shall not occur on Fridays, weekends, or holidays and shall be completed prior to 3:00 pm on the day of the turn-on.
(2) Supplier Representative - the supplier of control equipment shall have a representative present at the signal system turn-on.
(3) A city signal technician will be present at turn-on. Call 785-368-3913 to arrange. Should turn-on takes longer than one hour due to Contractor error, the Contractor will be billed for the additional time at $50.00 per hour.
(4) When signals are replacing Stop signs, Traffic Signal will normally flash three days or as directed by the Engineer. "Turn-on" is considered when the signal goes into normal operation.

D. Guarantee:

All equipment furnished on a project by the Contractor shall be guaranteed against any imperfections in workmanship and materials. Should any defect develop under normal and proper operating conditions during a 30 day testing period following completion of all electrical apparatus hook-ups and prior to acceptance by the city, this malfunction shall be corrected by and at the expense of the Contractor, including all labor, materials and associated costs. The customary Manufacturer;s Warranties shall be assigned to the maintaining agency.

II. 2070 Traffic Signal Control Systems

A. Vehicle Actuated Solid State Traffic Signal Controller:

(1) The Traffic Signal Controller shall be a Model 2070L Advanced Transportation Controller (ATC).
(2) The Traffic Signal Controller shall conform to the California Department of Transportation's "Transportation Electrical Equipment Specification (TEES), dated August 16, 2002, and as amended on October 27, 2003 and June 8, 2004".
(3) TEES, Chapter 1, Section 2 - 9 shall be followed for the documented controller type.
(4) The Traffic Signal Controller shall be version 2070 Lite unit. The Controller shall be physically compatible with 170E Controllers and cabinet facilities (covered in TEES, Chapter 9, Section 1).
(5) The Controller Assembly shall consist of the following modules:
(a) 2070-1B: one circuit board CPU module (TEES, Chapter 9, Section 2)
(b) 2070-2A: Field I/O module for 170 cabinets with C1S, C11S and C12S (TEES, Chapter 9, Section 3; Chapter 10, Section 3)
(c) 2070-3B: Front Panel Module - 8x40 LCD display with two keypads (TEES, Chapter 9, Section 4)
(d) 2070-4A: 10 amp power supply module (TEES, Chapter 9, Section 5).
(e) 2070-7A: Serial communications module (TEES, Chapter 10, Section 2). Each Controller assembly shall have 2 of these modules installed.
(6) Each Traffic Signal Controller shall be delivered with Local/Master Intersection Firmware installed. The Firmware shall be the latest version of Econolite's Oasis 2070 Master/Local with V-link Controller Firmware.
(7) Connections - electrical connections from the Controller to the outgoing and incoming circuits shall be made by inserting multi-terminal plugs (MS type) into the associated plug receptacles, incorporated in the mounting frame or power supply panel. The Controller shall be replaceable with a similar unit without the necessity of disconnecting and reconnecting individual wires.
(8) Voltage - the Controller System shall be designed to operate within the power range of 95 to 135 volts single phase AC at 60 Hz and in the temperature range of -30°F to +165°F.
(9) Flasher - a solid-state, two circuit, jack-mounted flasher with a rated load of 15 amp per circuit shall be supplied. Where additional load is required, more than one flasher will be provided. The flasher shall flash at the rate of 50 to 60 flashes per minute and be filtered, if required to prevent radio interference. The transfer from the controller to the flasher shall occur at the beginning of the major street green indication.
(10) Relays - when flashing relays are de-energized, the relays shall transfer signal light circuits from the controller unit to the flasher, permitting flashing yellow on the major street or highway and flashing red to be displayed on the minor street and at all left turn lane signals.

B. Power:

(1) Conductor -Power Lead-in wire for intersection signalization shall be No. 6 American Wire Gauge single conductor cable for operation on a 600 volt maximum, and suitable for use at conductor temperatures not exceeding 165° F. Material, construction and tests shall be in accordance with the applicable requirements of the latest edition of the Insulated Power Cable Engineers' Association Standard S-66-524 (Cross-Linked-Thermoplastic-Polyethylene-Insualated Wire and Cable for the Transmission and Distribution of Electrical Energy)
(2) Copper Wire - Conductors shall be stranded, annealed coated copper wire. Before insulating or stranding, the copper wire shall meet the requirements of the latest edition of the American Society for Testing and Materials (ASTM) Standard B33 (Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes) for Coated Wire. Stranding shall be Class B, in accordance with the latest edition of ASTM B8 (Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard or Soft).
(3) Insulation - Insulation shall consist of cross-linked Thermosetting Polyethylene, meeting the requirements of Column A of the Insulated Power Cable Engineers' Association and listed by the Underwriters' Laboratory as Type U.S.E. RHW - 165° F.
(4) Service Circuit Breakers - the Contractor shall provide circuit breakers as shown on the plan for secondary power drop. The circuit breakers shall be single pole, molded case, of the size and trip rating as shown on the plan. The circuit breakers shall be provided in a suitable watertight enclosure provided with a hasp for a padlock. Padlock will be provided by others.
(5) Grounding - all traffic signal poles, pedestals, controller cabinets and service circuit breakers shall be grounded by means of a no. 6 American wire gauge solid bare copper wire bolted to the inside of these devices with a half inch internal ground lug. All ground wires shall be attached by means of a ground clamp to a copper-clad steel rod. The ground rod shall be 5/8 inch diameter and 8 feet long. Ground rods at pole bases shall be a minimum of 2 feet from the pole base and a minimum of 1 foot below the ground surface.
(6) Color Coding - all detector wires and cables shall be color coded according to one of the following methods: the method approved by the IMSA or method one for 2010 as approved by the insulated Power Cable engineers' association.
(7) Excess Cable - a minimum of 6 feet of excess signal and detector lead-in cable shall be coiled in each service box.
(8) Pole Wiring - each signal head shall have a separate run of signal cable from the terminal block in the pole to the signal head.

C. Multi-Conductor Cable:

(1) General - all Conductor cable for intersection signalization and interconnection shall be No. 14 American Wire Gauge multi-conductor cable for operation on a 600 volt maximum, and suitable for use at conductor temperatures not exceeding 167° F. Material, construction and tests shall be in accordance with the applicable requirements of the latest edition of the International Municipal Signal Association Specification 19-1 for Polyethelyne-insulated, Polyvinyl chloride signal cable.
(2) Alternate - as an acceptable alternate, the Contractor may use multi-conductor, stranded cable meeting the requirements of the latest edition of the Insulated Power Cable Engineers' Association, Standard S-61-402 (thermoplastic insulated wire and cable for the transmission and distribution of electrical energy), and as follows:
(a) Stranding - 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 the American Society for Testing and Materials (ASTM) B33 (Specification for Tinned soft or Annealed Copper Wire for Electrical Purposes) for coated wire or ASTM B3 (Specification for soft or Annealed Copper Wire) for uncoated wire. Stranding shall be Class B, in accordance with the latest edition of ASTM B8 (Specification for Concentric-Lay-Stranded copper conductors, hard, medium hard or soft).
(b) Insulation - Insulation for the individual conductors shall consist of a 20 mil hickness of polyethylene and an insulation covering of polyvinyl chloride compound with a 10 mil thickness.
(i) Polyethylene - the polyethylene insulation shall meet the requirements of paragraph 3.9 of the latest edition of the Insulated Power Cable Engineers' Association Standard S-61-402 (Thermoplastic Insulated Wire and Cable for Transmission and Distribution of Electrical Energy) before application to the conductor, and paragraph 3.91 after application to the conductor.
(ii) Polyvinyl Chloride - the polyvinyl chloride insulation covering shall meet the requirements of Paragraph 4.3.1 of the latest edition of the Insulated Power Cable Engineers' Association Standard S-61-402 (Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy).
(c) Jacket - 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 the latest edition of the Insulated Power Cable Engineers' Association Standard S-61-402 (Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy).
(d) Jacket Thickness - the overall Jacket thickness shall be in accordance with Table 18, Part 4 of the latest edition of the Insulated Power Cable Engineers' Association Standard S-61-402 (Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy).

D. Detector Loop Wire:

(1) General - the Conductor shall be soft drawn copper wire with Class C stranding per the latest edition of the American Society for Testing and Materials Specification B8 (Specification for Soft Annealed Copper Wire). The wires shall have Polyvinyl

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4	10/30/20	MAJOR REVIVISIONS	SU	KRE
3	3/25/09	ADDED OSHA NOTE UNDER "CONSTRUCTION"	CDR	LGV
2	2/22/08	UPDATE TRAFFIC SPECIFICATIONS	KAP	LGV
1	9/4/07	ADDED NOTE C-3 (TURN-ON)	CDR	LGV

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Chloride insulation per Underwriters' Laboratory Subject 83 for THHN at 194° F, THWN at 167° F and a Polyamide nylon armor jacket.

(2) Cable Requirements - in addition, the cable shall meet the following requirements:
- Wire Size: #14 American Wire Gauge (Stranded)
- Insulation Thickness: 0.015 inch
- Jacket Thickness: 0.004 inch
- Nominal Outside Diameter: 0.12 inch
- Conductor Color Code: Black
- Suggested Working Voltage: 600 Volts

(3) Tubing - the THHN loop wire shall be inserted into Polyvinyl Chloride or Polyethylene tubing prior to installation (One THHN wire per section of tubing). The tubing shall have a nominal inside diameter of 3/16 inch and a nominal wall thickness of 1/32 inch, and shall be continuous.

E. Shielded Detector Lead-In Cable:

(1) General - the conductor and drain wires shall be tinned copper wires. The conductors shall be shielded by a layer of aluminum bonded to polyester film. All wires shall have polyethylene insulation and a jacket of vinyl. In addition, the cable shall meet the following requirements:
- Wire Size: No. 14 (19 x 29) American Wire Gauge (Stranded)
- Drain Wire: No. 18 American Wire Gauge (Stranded)
- Insulation Thickness: 0.025 inch
- Jacket Thickness: 0.03 inch
- Nominal Outside Diameter: 0.274 inch
- Conductor Color Code: Black and Clear
- Shield Coverage: 100 percent
- Nominal Capacitance Between Conductors: 24 picofarads per foot
- Nominal Capacitance Between one Conductor and the other Conductor connected to Shield: 47 picofarads per foot
- Suggested Working Voltage: 600 Volts

(2) Alternate - as an acceptable alternate, the shielded detector shall meet the latest edition of the International Municipal Signal Association, Inc. Specification #50-2 for Lead-In cable.

III. Traffic Detection System

A. Detector Unit Specifications:

1. Detector Units shall be in compliance with the Environmental, Transient, and size requirements of NEMA Standards TS-1 Sec. 15, TS-2 Sec. 6.5, plus California/ New York Type 2070 specifications and meet the design, operation, electrical and functional performance requirements of this specification.
2. Detector Units shall be available in both two and four channel versions. The four channel Detector Unit shall occupy the space of the two adjacent two channel detector units. Both two and four channel versions shall be capable of Timing Delay and/or Extension Functions for each channel independently.
3. Detector Units shall be microprocessor controlled, fully digital and self-tuning, and shall be configured as a rack mounted, printed circuit board for insertion into a California/New York type 170 input file.
4. Detector Units shall have two serial ports, an Ethernet RJ 45 port on the front panel and a send/receive port on the Card Edge Connector.
5. Detector Units shall employ a constant L threshold that will respond to vehicle generated changes in inductance and provide a relatively constant, predictable response to small licensed motor vehicles without having to change sensitivity settings despite series added inductance, i.e. multiple loops connected in series with Lead-in/Homerun from 50' to over 1000'.
6. Detector Units shall include a 60 Hz filter for accurate detection thresholds in noisy power line environments.
7. Detector Units shall be designed to operate over a voltage range from 10.8 VDC to 37 VDC.
8. Detector Units shall draw less than 50 MA per channel from the DC power source over the input voltage range.
9. The front panel of the Detector Units shall be provided with a Hand Pull to facilitate insertion and removal of the unit from the input file.
10. Detector Units shall include optically isolated and solid state outputs, designed to provide a continuous "Failsafe" (Fail-Call) output in the event of power loss to the unit.
11. Detector Units shall contain a common, switched Loop Oscillator to eliminate mutual interference/magnetic coupling (cross-talk) from multiple loops in adjacent lanes and/or allow the use of overlapped loops for directional control and/or use of multi-conductor Home-run cable when connected to the same detector unit.
12. Detector Units shall contain a frequency switch which will provide three frequency selections per unit to reduce interaction with loops connected to another unit. The unit shall maintain the same sensitivity threshold in nano-henries in any of the three frequencies selected.
13. Detector Units shall contain a Toggle switch with a spring-load position which will reset all channels and stable positions to allow selection of "normal" or "fast recovery" mode to enhance performance in the Left-Turn lanes or other queue situations.
14. Within two seconds after application/interruption of supply voltage, Detector Units shall automatically self-tune. Channel outputs shall display calls for a period of less than two seconds after which detection shall be normal.
15. Detector Units shall contain a remote reset input which will allow an external reset of all channels. When the input voltage of Pin C falls below 8 VDC for over 15 microseconds, the detector unit shall reset all active channels and establish a new reference for each "on" loop within 2 seconds.
16. Detector Units shall a front panel mounted RJ 45 Ethernet port to interface with PCs, or other devices. The design of the unit shall provide for a number of user selectable changes in operating characteristics to allow for modifications of performance for unique or special applications that can be obtained by invoking the options from a computer or other device connected to one of the RJ 45 Ethernet ports.
17. Detector Units shall record the occurrence of an open loop, shorted loop or excess inductance change (>25%). The type of error and time of error shall be made available through the serial interface.
18. Detector Units shall use a Windows (TM) based user interface software for the PC or other devices connected to the RJ 45 Ethernet port.
19. The front panel of the detector unit shall include erasable write-on pads adjacent to each detection indicator to aid in the identification of associated lane, function or phase activity.

B. Detector Channel Specifications:

1. Each channel shall tune to an external load of 20 to 2500 micro-henries.
2. Each channel shall provide a continuous, non-resettable (Fail-Safe) output and indication in response to an open loop and/or open lead-in system, except in the off position.
3. Each channel shall continue to operate with poor quality loop systems (Q>2) including those that have a single point short to the ground
4. Each channel shall have a DIP switch that will invoke a special micro-loop (TM) mode Setting this switch shall change the operating mode of the detector to be specific to micro-loop (TM) probes.
5. Each channel shall include two wide angle, high visibility LED indicators.
   (a) Each channel shall have a green LED to display channel detect output status (output state and the status of delay and extension timers) plus a red LED to display loop fault monitor diagnostics (open loop, shorted loop, >25% inductance change).
   (b) The green channel detect LED indicator shall flash at a rate of 4 Hz during delay timing, and at a rate of 16 Hz during extension timing.
   (c) During fault indication, the green channel detect LED shall provide a steady output indication in either the presence or pulse mode.
   (d) The red channel fault LED shall provide a coded flashing sequence to indicate loop system fault type.
   (e) The red channel fault LED shall flash at a rate of 1 second on and 1 second off to indicate >25% change of inductance.
   (f) The red channel fault LED shall flash at a rate of 1 second on and 1 second off, followed by 0.25 second on and 0.25 second off (2 times) for an open loop indication.
   (g) The red channel fault LED shall flash at a rate of 1 second on and 1 second off, followed by 0.25 second on and 0.25 second off for a shorted loop indication.
6. Each channel shall be controlled by a direct reading 16 position Push-wheel switch to select a minimum of 8 pulse mode sensitivities - 7 presence mode sensitivities channel reset and an off mode.
   (a) Push-wheel switches shall include 8 sensitivity threshold settings in a 2:1 steps over a range of 128:1 to enable precise predictable selection of the proper sensitivity to detect all licensed motor vehicles. Each numerical sensitivity setting shall be equated to nano-henries of inductance as follows:

Sensitivity Level	Nanohenries
C	1024
1	512
2	256
3	128
4	64
5	32
6	16
7	8

   (b) Pulse mode shall be indicated on the Push-wheel by a pulse symbol over the channel sensitivity numeral.
   (c) Pulse mode settings shall provide a single118 ± 2 MS output pulse in response to vehicles being detected.
   (d) Presence hold times shall be at least 4 minutes for small 70 CC motorcycles and a minimum of 60 minutes for automobiles over 1 to 8, 6'x6', 3-turn loops connected in series.
   (e) The off position shall be selected by selecting an "X" on the switch. Selecting the off position shall disable channel output and indicators including the fault indications.
7. Each channel shall be capable of independently timing programmable delay and/or extension times.
   (a) When delay and/or extension timing is specified, each channel shall include a 7 position DIP switch on the printed circuit board to select delay, extension, or off , if no timing is desired. Delay time shall be selectable from 0 to 31 seconds in 1.0 second increments and extension timing shall be selectable from 0 to 7.5 seconds in 0.25 second increments. Selection of "off" shall disable timing in both pulse and presence modes.
   (b) When delay and/or extension timing is specified, each channel shall include an external input to control the timing. A true condition on the external input shall exist when the voltage falls below 8 VDC for longer than 17 milliseconds. Extension shall occur only if the external input to the detector channel is true (low/active). Delay shall occur only if the detector channel is false (high/active).
8. If a vehicle remains in the sensing zone, the channel shall re-phase after 1.9 seconds to enable detecting additional vehicles on unoccupied portions of the loop after 2 seconds.
9. Each channel shall have special circuitry to prevent tuning out continuous peak hour traffic, long or multiple small loops as there is vehicle movement into the sensing zone at least every 10 minutes.
10. For each channel, the maximum response time to an instantaneous beginning or end of a simulating inductance change of twice the magnitude required to detect in sensitivity 1, 2 and 3, when connected to typical 3 or 4 turn, 6'x6' loops with 50' to 1000' of Lead-in/Homerun cable attached, shall be less than 3 milliseconds for 2 channel units, and less than 6 milliseconds for 4 channel units. This shall provide a constant and accurate output duration for speed or occupancy measurement applications.

C. Video Vehicle Detection System:

This work shall consist of furnishing a vehicle detection system which detects vehicles by processing video images and provides detection outputs to a traffic signal controller. This equipment shall meet the NEMA environmental, power and surge ratings as set forth in NEMA TS1 and TS2 170 and 2070 specifications.

(1) System Hardware:

The machine vision sensors shall be four integrated imaging CCD arrays with optics, high speed, color/monochrome, image processing hardware and a CPU bundled into a sealed enclosure. The environmental enclosure shall be waterproof and dust-tight per NEMA-4 specifications. The enclosure shall allow the machine vision sensor to operate satisfactorily over an ambient temperature range from -34°C to +74°C while exposed to precipitation as well as direct sunlight. The enclosure shall allow the image sensor horizon to be rotated during field installation. The enclosure shall include a provision at the rear of the enclosure for connection of the factory fabricated power, communications and video signal cable.

Input power to the environmental enclosure shall be 24 V AC/DC and either 50 or 60 Hz. A heater shall be at the front of the enclosure to prevent the formation of ice and condensation in cold weather, as well as to assure proper operation of the lens IRIS mechanism. The heater shall not interfere with the operation of the image sensor electronics, and it shall not cause interference with the video signal. The enclosure shall be light colored and shall include a Sunshield to minimize solar heating and glares. The front edge of the sunshield shall protrude beyond the front edge of the enclosure and shall include a provision to divert water flow to the sides of the Sunshield. The amount of overhang of the sunshield shall be adjustable to prevent direct sunlight from entering the lens or hitting the faceplate. When operating in the environmental enclosure with the power, communication and video signal cable connected, the image sensor shall meet FCC class B and CE requirements for electromagnetic interference emissions.

The CCD arrays shall be directly controlled by the CPU, thus providing high video quality for detection that has virtually no noise to degrade detection performance. The optics and camera electronics shall be directly controlled for optimal illumination. For traffic detection, the lens shall be pre-focused at the factory, as required for operation. It shall be possible for the user to focus the lens, as required for operation. The machine vision sensor shall operate ata minimum rate of 30 frames per second when configured for the NTSC (US) color video standard. The machine vision sensor shall process a minimum of 20 detector zones placed anywhere in the filed of view of the sensor. The video output shall have the ability to selectively show overlaid graphics indicating the current real-time detection state of each individual detector defined in the video. The sensor output NTSC color video shall be viewed with any compatible video device.

(2) System Software:

The system shall include software resident to each video detection module (VDM) that detects vehicles in multiple lanes using only the video image. Detection zones shall be defined using only a video menu and a pointing device to place the zones on a video image without using a computer. Up to 26 detection zones per camera shall be available per VDM and shall be logically assignable to 4 outputs per card assembly. The VDM shall also have an embedded Help system and complete operation manual available integrally with the menu driven interface.

(3) Sensor Hardware / Camera:

The machine vision sensor shall use medium resolution color/monochrome image sensors as the video source for real-time vehicle detection using either NTSC or PAL formats. As a minimum, each image sensor shall produce images with a CCD sensing element with horizontal resolution of at least 500 lines and vertical resolution of at least 350 lines. Images shall be output as video conforming to NTSC or PAL specifications and provide software JPEG video compression with a usable video and resolvable features in the video image when those features have luminance levels as low as 0.1 Lux at night. Usable video and resolvable features in the video image shall also be produced when those features have luminance levels as high as 10,000 Lux during the day. Usable video and resolvable features in the video image shall be produced when the ratio of the luminance of the resolved features in any single video frame is 300:1. The sensor shall provide direct real-time IRIS and shutter speed control, be usable for video surveillance, provide an optical filter and appropriate electronic circuitry in the sensor to suppress "Blooming" effects at night, and have Gamma for the image sensor preset at the factory to a value of 1.0.

(4) Sensor Optics:

The machine vision sensor shall be equipped with an integrated zoom lens with zoom and focus capabilities that can be changed using either configuration computer software or a hand-held controller.

(5) Functional Requirements of Machine Vision Sensor:

The machine vision sensor shall be programmable with a variety of detector types that perform specific functions selectable by software. Detector types shall include stopline detectors capable of providing presence of moving vehicle detection base on phase status, presence detectors, directional presence and input detectors. In addition, phase green or red shall be displayed. The unit shall monitor a programmable contrast detector and apply video loss timing parameters to output by implementing minimum, maximum or user defined fixed time recall of the assigned phases. The detector shall be capable of having Boolean logic applied to multiple detectors or a minimum number of detectors out of a total present, prior to placing a call.

(6) Required Features of Detector Units:

1. Count Detection - generates traffic counts, occupancy and traffic volume statistics.
2. Presence Detection - indicates presence of a vehicle, stopped vehicle, or vehicles traveling in the wrong direction.
3. Speed Detection - provides vehicle count, speed, length and classification.
4. Combination - combines outputs of multiple detectors via Boolean logic functions.

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3	10/30/20	MAJOR REVIVISIONS	SU	KRE
2	07-06-10	ADD CONTROLLER SPEC UNDER IX	KAP	LGV
1	01-14-08	ADD 333SD-ITS CONTROLLER DETAIL	KAP	LGV

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5. Display - displays information on the machine video output and passes input information to other detectors.
6. Detector Station - collects and reports traffic data for specified time intervals.
7. Incident Detection - monitors traffic parameters for conditions that indicate an incident has occurred, such as an accident or a stalled vehicle that results in a sudden reduction in roadway capacity or throughput.
8. Schedulers - define plans that can be used by other detectors to specify different parameters for each time of day plan.
9. Contrast Loss Detection - monitor quality of video images.
10. Speed Alarm - generates alarm outputs based on user-defined algorithm using speed.

(7) External Interfaces:
The external interfaces to the machine vision sensor shall include a detector port specifically to exchange detector state data with the cabinet interface devices, different color video output and 24 V AC/DC power to operate the sensor.

(8) Sensor Field Interface Equipment:
A communications panel shall be provided with each machine vision sensor.

(9) Power:
The machine vision sensor shall operate on 24 V AC/DC, 50 / 60 Hz, and maximum 25 watts (10 watts for the camera and the processor and 15 watts for the heater).

(10) Cable:
Video detection cables shall conform to the requirements of the Video detection system. Surplus cable shall be returned to the City.

(11) Sensor Operation Log:
The machine vision sensor shall maintain a non-volatile operation log, which must contain the following as a minimum:
(a) Revision number for the current machine vision sensor hardware and software components in operation.
(b) Title and comments for the detector configuration.
(c) Date and time the last detector configuration was downloaded to the machine vision sensor.
(d) Date and time the operation log was last cleared.
(e) Date and time communications were opened/closed with the machine vision sensor.
(f) Date and time of last power-up.
(g) Time-stamped, self-diagnosed hardware and software errors that shall aid in system maintenance and troubleshooting.

(12) Sensor Vehicle Detection Performance:
The real time detection performance of the machine vision sensor shall be optimized by following the guidelines for traffic applications including machine vision sensor mounting location, number of traffic lanes to monitor, sizing, placement, and orientation of vehicle detectors, traffic approaching and/or departing the sensor's filed of view, and minimizing the effects of lane changing field of maneuvers.

(13) Detection Zone Placement:
The video detection system shall provide flexible detection zone placement anywhere and at any orientation within the field of view of the machine vision sensor. Preferred detector configuration shall be detection zones placed across lanes of traffic for optimal count accuracy, detection zones placed parallel to lanes of traffic for optimal presence detection accuracy of moving or stopped vehicles. A single detection zone shall be able to replace one or more conventional detector loops connected in series. Detection zones shall be able to be overlapped for optimal road coverage. In addition, selective group of detectors shall be able to be logically combined into a single output by using optimal delay and extend timing and signal state information. Optimal detection shall be achieved when the machine vision sensor placement provides an unobstructed view of each traffic lane where vehicle detection is required. Obstructions are not limited to fixed objects. Obstruction of the view can also occur when vehicles from a lane nearer to the sensor obscure the view of a lane further away from the sensor.

(14) Detection Zone Programming:
Placement of Detection zones shall be by means of a portable or desktop computer using Windows 10/11, a keyboard and a mouse. The VGA monitor shall be able to show the detection zones superimposed on images of traffic scenes. The mouse and keyboard shall be used to place, size, and orient detection zones to provide optimal road coverage for vehicle detection, modify detector parameters for site geometry to optimize performance, edit previously defined detector configurations, adjust detector zone size and placement, add detectors for additional traffic applications, reprogram sensors for different traffic applications, changes in site geometry, or traffic re-routing. It shall be possible to download detector configurations from the computer to the machine vision sensor, upload current detector configuration that is running in the machine vision sensor, back up detector configuration by saving them to the computer's fixed/removable disks, perform the above upload, store, and retrieve functions for video snapshots of the machine vision sensor.

(15) Optimal Detection:
The video detection system shall provide optimal detection of vehicle passage and presence when the machine vision sensor is mounted 30 feet or higher above the roadway, the image sensor is adjacent to the desired coverage area and the distance to the farthest detection zone location is not greater than 10 times the mounting height of the machine vision sensor. The machine vision sensor shall be able to view either approaching or departing traffic or both in the same field of view. The machine vision sensor, when placed at a mounting height that minimizes vehicle image occlusion and equipped with a lens to match the width of the road shall be able to monitor up to 8 lanes of traffic simultaneously.

(16) Detection Zone Preparation:
The machine vision sensor's real-time detection operation shall be verifiable by viewing the video output of the sensor with any standard video display device/monitor.

(17) Count Detection Performance:
Using a machine vision sensor installed within the optical viewing specifications described above for the count station traffic applications, the system shall be able to accurately count vehicles with at least 96% accuracy under normal operating conditions (day and night) and at least 93% accuracy under adverse conditions. Adverse conditions are combination of weather and lighting conditions that result from shadows, fog, rain and snow etc.

(18) Demand Presence Detection Performance:
Using a machine vision sensor installed within the optimal viewing specifications described above for intersection control applications, the system shall be able to accurately provide demand presence detection. The demand presence accuracy shall be based on the ability to enable a protected turning movement on an intersection stop line, when a demand exists. The probability of not detecting a vehicle for demand presence shall be less than 1% under all operating conditions. In the presence of adverse conditions, the machine vision sensor shall minimize extraneous (false) protected movement calls to less than 7%.

(19) Speed Detection Performance:
The machine vision sensor shall accurately measure average (arithmetic mean) speed of multiple vehicles with more than 98% accuracy under all operating conditions for approaching and departing traffic. The average speed measurement shall include more than 10 vehicles in the sample to ensure statistical significance. Optimal speed detection performance requires the sensor location to follow the specifications described above for count station traffic applications with the exception that the sensor must be higher than 40 feet. The machine vision sensor shall accurately measure individual vehicle speeds with more than 95% accuracy under all operating conditions for vehicles approaching the sensor (viewing the front end of the vehicles), 90% accuracy for vehicles departing the sensor (viewing the rear end of the vehicles). These specifications shall apply to vehicles that travel through both the count and speed detector pair and shall not include partial etection situations created by lane changing maneuvers.

(20) Sensor Electrical:
The video output of the machine vision sensor shall be isolated from earth ground. All video connections from the sensor to the interface panel shall also be isolated from earth ground. The video output, communication, and power stages of the sensor shall include transient protection to prevent damage to the sensor due to voltage transients occurring on the cable leading from the machine vision sensor to other field terminations. The machine vision sensor shall have passed requirements for and received the CE mark. The power to the sensor shall be fused in the control cabinet.

(21) Video Camera Cable:
(a) Video Cable Option 1 shall be #16 AWG 3/c - 1000 foot roll. All surplus wire shall be returned returned to the City
(b) Video Cable Option 2 shall be Ethernet cable. Any Ethernet cable run outside the Traffic Controller cabinet shall be environmentally hardened, shielded, outdoor rated 350 MHz Category 5E cable. The Cable shall be riser rated, 24 AWG solid copper with Polyolefin insulation, UV and Oil resistant PVC jacket. Pair 1 shall be blue, white/blue; Pair 2 shall be orange, white/orange; Pair 3 shall be green, white/green and Pair 4 shall be brown, white/brown. The operating temperature shall be from -40° C to +70° C. The cable shall conform to the following Standards:
- ISO/IEC 11801 Category 5E
- NEMA WC 63
- ANSI/TIA/EIA 568-B.2 Category 5E

The cable shall be without splicing or joints for any single run. The Contractor shall obtain instructions from the manufacturer about alternate architecture when length of a single run of Category 5E cable exceeds 320 feet. Contractor shall provide 1000 foot roll. All surplus cable shall be returned to the City.

(c) RJ-45 Connector: RJ-45 plug connectors shall be used at both the camera and the cabinet ends. The supplier of the video detection system shall approve the category 5E cable, RJ-45 connector and crimping tool. Manufacturer's instructions must be followed to ensure proper connection.

D. Radar Detection System:

This work shall consist of furnishing a vehicle detection system which detects vehicles by processing radio waves and provides detection outputs to a traffic signal controller. The radar detection system shall meet the NEMA environmental, power and surge ratings as set forth in NEMA TS1 and TS2 170 and 2070 specifications.

(1) Functional Requirements:
(a) Detects up to 10 traffic lanes
(b) Tracks vehicles through a 90 degree field of view that extends out 140 feet
(c) Detects and tracks vehicles in two dimensions
(d) Reports real-time presence of both moving and stopped vehicles
(e) Supports curved and angled traffic lanes, including islands and medians
(f) Remotely accessible for traffic monitoring and sensor management
(g) Accurate performance in ambient temperatures (-30°F to +165°F), relative humidity up to 95% (non-condensing), rain up to 1 inch per hour, freezing rain, snow, wind, dust, fog and direct light on sensor during dawn and dusk.

(2) System Hardware:
The system hardware shall include a matrix of radar sensors for each approach of the intersection, and shall be connected to the radar processing unit in the traffic control cabinet. In addition, the system hardware shall meet the following requirements.
(a) Provides sensor detection data directly to the controller through SDLC port
(b) Provides up to 64 detector channels
(c) Provides an Ethernet port for network connectivity
(d) Provides DC power for up to 4 sensors.
(e) Protects the sensor from surges
(f) Equipped with a power switch for each sensor
(g) Equipped with multiple configuration connections for communication:
- USB
- Rj 11 Jacks for RS-485
- DB-9 connector for RS-232
- T-bus port
(h) Suitable for placing on a shelf or affixed to the cabinet wall

(3) Radar Features
(a) Operating Frequency: 24.0 - 24.5 GHz (K-band)
(b) Matrix of 16 radars
(c) No manual tuning to circuitry
(d) No temperature-based compensation
(e) Bandwidth stability: 1%
(f) Printed circuit board antennas
(g) Antenna vertical 6 dB beam width (two way pattern): 65°
(h) Horizontal field of view: 90°
(i) Antenna two way sidelobes: -40 dB
(j) Transmit bandwidth: 245 MHz
(k) Un-windowed resolution: 2 ft
(l) RF channels: 8
(m) Self-test for verifying hardware functionality
(n) Diagnostic mode for verifying system functionality

(4) Sensor Outputs
(a) Real time presence data in up to 10 lanes
(b) Maximum number of detection zones: 16
(c) Maximum number of channels: 16
(d) User selectable zone to channel mapping
(e) AND logic triggers the channel when all selected zones are active
(f) OR logic used to combine multiple zones to a channel output
(g) Channel output extend and delay functionality
(h) Algorithms mitigate detection from wrong way or cross traffic
(i) Fail safe mode for contact closure outputs if communication is lost.

(5) Communication Ports
(a) Two half-duplex RS-485 communication ports shall support the following functions:
(i) Dedicated detection communication
(ii) Configuration, verification or traffic display without disrupting detector communications.
(b) Firmware upgradability over any communication port
(c) User configurable:
(i) Response Delay
(ii) Push port

(6) Configuration
The Radar detection system shall allow the user to configure the system to meet the following features/requirements.
(a) Automatic and manual configuration of traffic lanes, stop bars and detection zones
(b) Lane Positioning increment: 1 foot
(c) Four sided zones of any shape and size
(d) Overlapping zones to be supported
(e) Sensor reconfiguration without disrupting detection functions
(f) Graphic user interface with traffic pattern display
(g) Counting and Pulsed channels to be supported
(h) Windows Mobile compatible software
(i) The system shall support any of the following operating systems:
(i) Windows Mobile 5.0 or greater (Socket Mobile 650-M)
(ii) Windows XP
(iii) Windows Vista
(iv) Windows 7 or higher
(j) Software-supported functionality:
(i) TCP/IP connectivity
(ii) Sensor Configuration back-up and restore
(iii) View and edit backed-up sensor configuration
(iv) Real time traffic visualization for performance verification and traffic display
(v) Zone and channel actuation display
(vi) Virtual sensor connection for demonstration and training
(vii) Local or remote sensor firmware upgradability

(7) Physical Properties
(a) Resistant to corrosion, fungus, moisture deterioration and ultraviolet rays
(b) Enclosure shall be made of Lexan EXL polycarbonate
(c) Compliant to NEMA 250 with respect to the following properties:
(i) Watertight
(ii) Hose down
(iii) 4X corrosion protection
(d) Rotational backplate for 360° of roll

(8) Electrical Properties
(a) Power consumption: 9 Watts
(b) Supply voltage: 9 - 28 VDC
(c) Onboard surge protection

(9) Conductor Cable
The conductor cable shall be heavy duty weather resistant 6-conductor cable to provide power and RS-485 communications between the sensor and the traffic control cabinet and shall conform to the following specifications.
(a) The cable shall be Orion Wire Combo-2204-2002-PVCGY or approved equal.

NO.	DATE:	REVISION	BY:	APP'D
2	10/30/20	MAJOR REVISIONS	SU	KRE
1	01/05/10	REFORMAT TEXT VIEW	KAP	LGV

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STANDARD DETAILS
DT - 108

TRAFFIC SIGNAL SPECIFICATIONS

DATE: APR 2026

PROJECT 701038.00

(b) It shall attach to an 8-pin connector.
(c) The cable shall be color coded for quick and easy wiring to terminal blocks and Click modules.
(e) RS-485 conductor shall be 2 twisted pairs. The power conductor shall be a twisted pair.
(f) The entire cable assembly shall be shielded with aluminum/polyester shield with drain wire.
(g) The cable shall be RoHS compliant
(h) The cable shall be environmentally sealed to ensure excellent immersion capability, and also be capable of withstanding extreme weather conditions.
(i) The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 40 pF/ft at 1 kHz.
(j) The RS-485 conductors and the power conductors shall have nominal conductor DC resistance of less than 16.7 ohms/1000 ft and 11 ohms/1000 ft at 20°C respectively.
(k) The cable shall have a diameter of 0.41 inch.
(l) The cable jacket shall be made of gray PVC that is 0.053 inch thick.
(m) The power wires and the communication wires shall be 20 AWG and 22 AWG respectively.
(n) The cable shall be capable of operating at temperatures up to 221°F when dry and 167°F when wet.
(o) The cable shall have an FT4 flammability rating.

(10) Connector Cable:
The cable end connector shall meet MIL-C-26482 specifications and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of the jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells.

(11) Testing Requirements
The radar traffic detection system shall meet the following testing and certification requirements.
(a) Tested under FCC CFR 47, part 15, section 15.249
(b) FCC certification on product label.
(c) FCC regulation compliant for life of the sensor.
(d) Tested under IEC 6100-4-5 class 4
(e) Tested under NEMA TS2-2003:
- Shock pulses of 10 g, 11 ms half sine wave
- Vibration of 0.5 g up to 30 Hz
- 300 V positive/negative pulses
- Stored at -49°F for 24 hours
- Stored at +185°F for 24 hours
- Operation at 10.8 VDC between -29.2°F and +165.2°F

All test results and certification shall be made available to the City.

E. Training, Warranty and Instructions:

For all traffic signal components and equipment including video detection and radar detection systems, the vendor shall provide adequate training, minimum warranty and detailed instructions as described below.

(1) Training:
A one-day training seminar will be provided by the vendor and shall provide instruction in the proper installation and programming of the radar detection system.

(2) Warranty:
All traffic signal equipment shall be warranted to be free of defects in material and workmanship for a period of minimum two years from the date of acceptance by the City. During the warranty period, the supplier shall repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect. All materials returned for warranty repairs shall be made through the product distributor at no added charge to the City. Warranty repairs/replacement shall be completed within two weeks from the date of return to distributors.

During the warranty period, updates to all software shall be available from the supplier without charge.

(3) Instructions:
Wiring diagram of the system including detailed instructions and installation manual for all equipment and system shall be provided as necessary. Changes/substitutions in these requirements will not be accepted unless authorized in writing.

The company agrees, upon the request of the engineer, to deliver a sample of the equipment or system to be supplied in compliance with these specifications for test before acceptance. After completion of the test, the sample shall be returned.

IV. Traffic Signal Heads:

A. General:
(1) Signal Head Mounting
(a) Installation - Signal Heads shall not be installed at any intersection until all other signal equipment, including the controller, are in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are completely covered. In no case, shall the heads be installed more than 10 days prior to the signal turn-on. The Engineer shall direct the final positioning of the signal heads for optimum visibility. Vertical bracket and pedestal mounted traffic signal heads shall installed at a height of 10 feet from the base of the pole to the bottom of the signal head unless otherwise specified in the Plans. Mast arm mounted signal heads shall be installed at a height of 15 to 19 feet from the pavement to the bottom of the signal head.
(b) Bracket Mounting - Bracket-mounted signal heads, as shown on the Plan, shall be supported by mounting brackets consisting of watertight assemblies of 1.5 inch durable Polycarbonate. Mounting brackets shall be yellow. The dimensions of the mounting brackets shall be as required to provide proper signal head alignment. Each bracket shall have 72 tooth serrations to assure a positive lock with the signal head and allow positioning of the traffic signal heads in increments of 5 degrees. Al members shall be plumb or level, symmetrically arranged and securely assembled. Mounting brackets shall be attached to the pole with a stainless steel banding. Construction shall be such that all conductors are concealed within the assembly.
(c) Mast Arm Mounting - Mast Arm Signal Head Assemblies shall be rigid mounted. The assembly shall consist of both top and bottom brackets and be easily and completely adjustable in both horizontal and vertical planes. The top and bottom brackets shall have 72 tooth serrations cast into the arm to assure a positive lock with the signal housing. The mast arm signal bracket shall be constructed of high strength aluminum. It shall have a minimum of 1.5 inch opening to completely enclose the signal wiring. The bracket shall accommodate the number and size of signal heads as shown on the Plan. It shall be attached to the size and shape of the mast arm supplied by means of stainless steel bands.
(2) Back Plates - where shown on the Plan, 5 inch back plates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Back plates shall be constructed of durable plastic capable of withstanding a 100 miles per hour wind.

B. Vehicle Traffic Signal Heads:
(1) General - all 2 and 3 section Signal Heads shall have "1-5/c #4 AWG" pulled to each from the base. All 4 section Signal Heads shall have "1-7/c #14 AWG" pulled to each from the base. All Push Buttons shall have "1-2/c #14 AWG" pulled to each from the base.
(2) Assembly - each Signal Head shall be a watertight assembly of 3 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 Plan. Each signal face shall consist of 3 or more signal sections, rigidly and securely fastened together, positively positioned to control the movement of one direction of traffic. Each signal section shall be self-contained assembly consisting of an optical unit with housing, housing door, and visor. The rods shall not be used to fasten signal section together to form a signal face. All Signal Heads on a project shall be the product of one manufacturer, except for programmed heads. Terminal blocks of suitable size shall be placed in the middle section of the Signal Head.
(3) Housing - the housing for each signal section shall be made of durable polycarbonate. It shall be clean, smooth and free from flaws, cracks, blowholes and other imperfections. The housing shall be yellow with black doors. It shall be designed as a self-contained unit for separate mounting or inclusion in a signal face containing 3 or more signal sections rigidly and securely fastened together. It shall be equipped with round openings in the top and bottom and shall have 72 tooth serrations to assure a positive lock between signal heads and brackets and allow positioning of the traffic signal heads in increments of 5 degrees. The doors shall be suitably hinged and held securely to the body of the housing by simple stainless steel locking devices. All other door parts such as hinge pins, lens clips, screws etc. shall also be of stainless steel. A neoprene or silicone gasket shall be used between the lens and the reflectors to exclude dust and moisture.
(4) Visors - the visors for each signal section shall be a durable polycarbonate not less than 0.05 inch (No. 18 US Gauge) in thickness. It shall be designed to fit tightly against the door by means of 4 fastening screws and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be at least 9.5 inches long for 12 inch diameter signals, shall angle slightly downward and shall be of the tunnel type. The optical unit and visor shall be designed as a whole as to eliminate outside rays from entering the unit from above the horizontal. All visors shall be black.
(5) Wiring - wiring for each lamp receptacle shall be provided by color coded No. 18 Gauge lead wires with polyvinyl chloride insulation and a nylon jacket. Wires shall be of sufficient length to extend to the terminal block with the door fully open without splicing.

C. One Section Pedestrian Traffic Signal Head with Countdown Display:
(1) It shall meet or exceed current ITE standards and the 2009 MUTCD.
(2) The housing shall be polycarbonate and shall be a "clamshell type" housing. The housing shall be yellow in color. two equally spaced mounting lugs shall be internally cast into the top and bottom, permitting it to be hinged from either direction. the housing shall have a 72 tooth serrated bushing for use with standard signal hardware. each base shall have reinforcing ribs projecting the load bearing stress to the mounting point.
(3) The door shall be cast from aluminum alloy. The door shall be polycarbonate black.
(4) The visor shall be a one piece injection molded from ultraviolet stabilized, flame retardant, permanently colored, black polycarbonate.
(5) The pedestrian signal head shall be capable of displaying, brightly and uniformly, the alternate message symbol full "hand" in portland orange and the full "person" in white while being subject to strong ambient light conditions; the message shall "blankout" when not energized.
(6) The hand and person shall be nine (9) inches high.
(7) The overall dimensions of the signal head shall be approximately 18-inches wide, 19-inches high, and 9-inches deep, including hinges, and all components shall be readily accessible from the front.
(8) The countdown timer shall countdown the don't walk phase only; the walk phase countdown timer (if present) shall be disabled at the factory.
(9) The light source for each indication of the pedestrian head shall be a light emitting diode array meeting etl certification. the light output shall be comparable to that of a standard pedestrian signal illuminated by a 90-watt incandescent lamp. The module shall operate over a voltage range of 89 to 135 volts AC and consume less than 12 watts of power. the module shall have an operating temperature range of at least -34° C to +74° C.
(10) The manufacture shall warrant the pedestrian assembly against defects in workmanship and material for a period of 15 years. the manufacture shall warrant the pedestrian signal assembly (except the led lamps) against defects in material and workmanship for a period of 5 years. all warranties shall be assigned to the City of Topeka.

D. LED Signal Lamps:
(1) The red, green and yellow indication lamps shall almost perfectly approximate, to the motorist, the appearance of an incandescent Traffic Signal.
(2) The lens shall be made of UV stabilized plastic. The rear cover shall be of non-flammable material, and the entire unit shall be totally sealed to preclude the entrance of water, dust or other contaminants.
(3) The self-contained, regulated power supply shall allow the unit to operate over an input voltage range between 89 and 135 volts AC, and shall be configured in at east 3 parallel circuits for reliability. Light output shall be comparable to that provided by a standard, 12 inch Traffic Signal lens illuminated by a 150 watt incandescent lamp. The red wave length shall be 630 to 660 NM.
(4) The manufacturer shall warrant the unit against defects in workmanship and materials for a period of at least 15 years after the date of shipment. This warranty shall be assigned to the City of Topeka.

E. Programmed Visibility Traffic Signal Heads:
(1) General - programmed visibility traffic signal heads and the installation thereof shall conform to the provisions above, except the provisions on optical units and visors shall not apply. the programmed visibility traffic signal heads shall be constructed of die cast aluminum.
(2) Visibility - the visibility of the signal indication shall be adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled. During daylight, the signal indications shall be visible only in those areas or lanes designated. During dusk or darkness, a faint glow visible to the side will be permissible. External illumination shall not cause a signal indication, nor shall a signal indication in one signal section cause a signal indication in another signal section. Each section of a signal face shall provide a nominal 12 diameter round indication or arrow indication meeting the Institute of Transportation Engineers' dimensions as required.
(3) Visor - each section shall be provided with a sheet aluminum Sun visor.
(4) Programming - the indication of each signal head, when not programmed, shall be visible from anywhere within 15 degrees of the optical axis. The signal head shall be able to be preset at angles between 10 degrees above and 10 degrees below the horizontal, and shall be preset at 4 degrees (post top) or 8 degrees (overhead) below the horizontal.
(5) Color Scheme - programmed signal heads shall have the stated color scheme.
(6) Candle Power - the signal section with the yellow indication, prior to programming, when directed downward 5 degrees from the horizontal, shall provide a minimum candlepower of 2500 candelas in the direction of the axis and a maximum candlepower of 100 candelas at 15 degrees horizontally in each direction from the axis. The signal head with yellow indication shall be programmed so that a minimum candle power of 2500 candelas can be directed along the optical axis and a candle power of less than 100 candelas directed at 1/2 degree horizontal from the axis and no measurable light is directed from 1 to 15 degrees horizontal from the axis. Under the same conditions, the candle power of the red indication shall be at least 19 percent of the yellow indication, and the candle power of the green indication shall be at least 38 percent of the yellow indication.
(7) Lamps - all traffic signal lamps shall meet the requirements of the latest edition of the equipment and materials standards of the Institute of Transportation Engineers (ITE) - traffic signal lamps. A nominal 130 watt, 120 volt, A21 clear traffic signal lamp shall be used in all 12 inch vehicle traffic signal indications.
(8) Dimming Devices - dimming devices shall be provided to gradually reduce the candle power as a function of the individual background illumination of each signal head for nighttime operation to approximately 15 percent of that for daytime operation.

V. Traffic Signal Poles, Pedestals and Conduits:

A. General:
(1) Load - all traffic signal poles shall conform to the 2013 Edition of the American Association of State Highway and Transportation Officials' "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" Handbook and all interims. The poles shall also accommodate wind loads which may cause deflections of the Mast Arm in the vertical. These deflections shall not be such that there is less than 15 feet clearance between the roadway and the lowest point of the signal assembly.
(2) Shop Drawings - all traffic signal poles shall be detailed on Shop Drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas and type of mounting that is designed to accommodate. All new traffic signal poles or poles not previously approved will require submission of design calculations along with the Shop Drawings. Shop drawings and all design calculations shall be submitted to the Traffic Engineer for review and approval.
(3) Shaft - the shaft shall include high strength anchor bolts, washers and nuts, conforming to section 1615 of KDOT Standard Specifications. Also to be included are cover leaves, a hand-hole and cover, cast pole top, a J-hook, wire support and a suitable device for attaching the mast arm to the shaft. The shaft shall include 1 inch rubber grommets at all outlets for signal wiring. The Contractor shall provide type "B" certification for anchor bolts, in accordance to Section 2601 of KDOT Standard Specifications.

NO.	DATE:	REVISION	BY:	APP'D
3	10/30/20	Major Revisions	SU	KRE
2	01/22/18	Add Warranty Note under Sec. III – C	DHS	TLC
1	9/1/17	Updated Standard	DHS	TLC

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