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.

NO.	DATE:	REVISION	BY:	APP'D
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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STANDARD DETAILS
DT - 107

TRAFFIC SIGNAL SPECIFICATIONS

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