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:
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