TENDER DOCUMENTS

SUBSECTION 6.57
INTELLIGENT TRANSPORTATION SYSTEMS
(ITS)

TABLE OF CONTENTS

PAGE

SUBSECTION 6.57 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

6.57.1 GENERAL

6.57.1.1 This subsection describes the requirements relating to the work on the intelligent transportation systems (ITS) covered by this Contract.

6.57.1.2 Any specific requirements pertaining to the work on the ITS covered by this Contract are set out on the drawings and in Section 4 *Special Technical Conditions*.

6.57.1.3 The requirements relating to the supply and installation of the conduit are described in subsection 6.51 *Conduits, Junction Boxes and Pull Boxes*.

6.57.2 MEASUREMENT UNITS

6.57.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

Measurement unit	Designation	Symbol
length	meter	m
length	millimeter	mm
mass	kilogram	kg
volume	litre	L
electric current	ampere	A
electric current	milliampere	mA
temperature	Celsius degree	°C
angle	degree	°
power	watt	W
voltage	volt	V
AC voltage	volt	Vca
DC voltage	volt	Vcc
voltage	kilovolt	kV
voltage	millivolt	mV
resistance	ohm	Ω
resistance	megohm	MΩ
luminous intensity	millicandela	mcd
luminous flux	lux	lx
luminous energy	lumen	lm
luminous efficiency	lumen per watt	lm/W
time	millisecond	ms
speed	kilometer per hour	km/h
frequency	kilohertz	kHz
frequency	gigahertz	GHz
electric inductance	microhenry	µH

6.57.3 REFERENCE STANDARDS

6.57.3.1 The **Contractor** shall carry out all work on the ITS in accordance with the requirements of the following standards and documents, to which the provisions of this Contract are added:

6.57.3.1.1 (ACNOR(CSA)) Canadian Standards Association :

- CAN/CSA-C22.2 No. 0-F10 *General Requirements – Canadian Electrical Code, Part II*;
- CAN/CSA-C22.10-18 *Building Code of Quebec,* Chapter V – *Electricity – Canadian Electrical Code, Part I and Quebec Amendments*;
- CAN/CSA-C22.2 No. 239 *Control and instrumentation cables.*

6.57.3.1.2 (NEMA) National Electrical Manufacturers Association:

- NEMA 250 *Enclosures for Electrical Equipment*;
- NEMA TS 2 *Traffic Controller Assemblies with NTCIP Requirements*.

6.57.3.1.3 (AASHTO) American Association of State Highway and Transportation Officials:

- AASHTO LTS-5 *Standard Specifications for Structural Supports for Highways Signs, Luminaires and Traffic Signals*.

6.57.3.1.4 (ITE) Institute of Transportation Engineers:

- ST-054 VTCSH (Vehicle Traffic Control Signal Heads).

6.57.3.1.5 (FCC) Federal Communications Commission:

- CSA T568.1 *Commercial Building Telecommunications Cabling Standard* – Part 1 : *General Requirements*;
- CSA T568.2 *Commercial Building Telecommunications Cabling Standard* – Part 2 *: Balanced Twisted-Pair Cabling Components*;
- CSA *T568.3 Optical Fiber Cabling Components Standard*;
- ANSI/NECA/BICSI-568 *Standard for Installing Commercial Building Telecommunications Cabling*;
- ANSI/TIA/EIA-455 *Standard Test Procedures for Fiber Optic Fibers, Cables and Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components*;

- TIA-526 *Standard Test Procedures for Fiber Optic Systems*.

6.57.3.1.6 (NTCIP) National Transportation Communications for Intelligent Transportation System Protocol:

- 1102 *Octet Encoding Rules* (OER);
- 1103 *Internet-standard Simple Network Management Protocol* (SNMP);
- 1201*Global Object Definitions*;
- 1203 *Object Definitions for Dynamic Message Signs*;
- 2001 *Class B Profile/Low Bandwidth* (NEMA TS 3.3);
- 2101 *Point to Multi-Point Protocol Using RS-232 Subnetwork Profile*;
- 2202 *Internet Transmission Control Protocol and User Datagram Protocol (TCP/IP and UDP/IP) Transport Profile*;
- 2301 *The Simple Transportation Management Framework (STMF) Application Profile*;
- 8004 *Structures & Ident. of Management Information* (SMI).

6.57.4 MATERIALS

6.57.4.1 COUNTING SYSTEM (PEDESTRIANS AND BICYCLES)

6.57.4.1.1 The counting system shall meet, without however being limited to, the following requirements:

6.57.4.1.1.1 detect the flow direction;

6.57.4.1.1.2 distinguish the type of user (pedestrian or cyclist);

6.57.4.1.1.3 provide bicycle counting data whose reliability is greater than 95%;

6.57.4.1.1.4 allow the consultation and transmission of the counting data at all times;

6.57.4.1.1.5 allow the transmission of data in XML or JSON format;

6.57.4.1.1.6 operate twenty-four (24) hours a day, seven (7) days a week.

6.57.4.1.2 Sensor

6.57.4.1.2.1 The pedestrian and cyclist counting sensor shall count pedestrians and cyclists.

6.57.4.1.3 Communication interface

6.57.4.1.3.1 The communication interface shall have the following characteristics, without however being limited thereto:

6.57.4.1.3.1.1 comply to the RS-485 standard;

6.57.4.1.3.1.2 be installed in a watertight enclosure with a minimum ingress protection rating of IP66 of the IEC 60529 standard;

6.57.4.1.3.1.3 shall have an RJ45-style IP interface;

6.57.4.1.3.1.4 allow parameterization of the IP address, subnet mask and network gateway;

6.57.4.1.3.1.5 allow access to the "Simple Network Management Protocol" (SNMP) v1/2/3;

6.57.4.1.3.1.6 ability to synchronize the date and time from the **Owner**'s server.

6.57.4.1.4 Pyroelectric detection casing.

6.57.4.1.4.1 The casing shall be NEMA 4X approved and have, minimally, the IP66 ingress protection rating of IEC 60529 standard.

6.57.4.1.4.2 The casing cover shall be secured with captive screws.

6.57.4.1.4.3 The **Contractor** shall supply all the hardware needed for the assembly and installation of the casing.

6.57.4.2 INDUCTIVE LOOP VEHICLE DETECTOR (COUNTING) SYSTEM

6.57.4.2.1 Inductive loop detector

6.57.4.2.1.1 The detection loop shall meet, but not be limited to, the following requirements:

6.57.4.2.1.1.1 be located in the roadway and be composed of one or more inductive loops of rectangular shape;

6.57.4.2.1.1.2 consist of several turns of multi-stranded tinned copper wire with a cross-section of 1 to 2 mm². The wire used shall have a highly insulating polyvinyl chloride (PVC) coating;

6.57.4.2.1.1.3 be embedded in the roadway at 7 cm deep, below the asphalt pavement;

6.57.4.2.1.1.4 have a loop end (portion of the wire pair located between the end of the loop and the detection unit) consisting of a pair of twisted and shielded wires at the rate of ten (10) turns per meter to avoid disturbing magnetic fields;

6.57.4.2.1.1.5 operate with a sinusoidal electrical signal of a few tens of mV applied across the electromagnetic loop terminals at a frequency between 50 and 150 kHz. This voltage shall induce a magnetic field radiating around the loop and above the pavement;

6.57.4.2.1.1.6 be of "prefabricated" type, with four (4) turns of continuous wire. The wire shall consist of a 14 AWG stranded copper conductor insulated and covered with a polyethylene sheath;

6.57.4.2.1.1.7 have a continuous and spliceless cable between the detection loop and the pull box or junction box. In the box, the cables shall form a loop of 1 m;

6.57.4.2.1.1.8 be factory-built in 19 mm diameter PVC conduits, forming a rectangle measuring 1.8 m x 1.8 m with a tolerance of ± 2 cm. The inside of the conduit forming the loop shall be injected under pressure with a malleable urethane and shall be the product *Syntcaptor 9002*, or equivalent authorized by the Engineer, in the full internal volume and without any air pockets;

6.57.4.2.1.1.9 have the corners of the conduit formed with the hot-bent process, without serious deformation, with a radius of curvature of 100 mm and without the use of coupling sleeves. A "T" shaped fitting shall complete the geometric shape of the loop and allow the coupling of a supply conduit to the pull box or junction box.

6.57.4.2.2 Splices

6.57.4.2.2.1 The splices shall be made using Thomas & Betts STA-KON series isolated compression lugs, or equivalent authorized by the Engineer, which are then embedded in an epoxy block. The product shall be the *Encapsulation Kit* for *SCOTCHCAST n 82-A1* or *n°3832 buried* cables manufactured by 3M, or equivalent authorized by the Engineer.

6.57.4.3 RADAR VEHICLE DETECTION SYSTEM

6.57.4.3.1 The radar vehicle detection system (RVDS) shall meet, but not be limited to, the following requirements:

6.57.4.3.1.1 operates by radio frequency to collect and provide statistics on traffic;

6.57.4.3.1.2 enable to collects information using a radio operating frequency;

6.57.4.3.1.3 enable measure the volume and speed of vehicles and classify vehicles according to the average speed and length of the vehicles;

6.57.4.3.1.4 use a frequency-modulated continuous wave (FMCW) radar capable of simultaneously detecting and reporting the traffic conditions on multiple traffic lanes;

6.57.4.3.1.5 require very little on-site maintenance and allow remote reconfiguration for optimal performance;

6.57.4.3.1.6 have an internal processor that performs the auto-configuration of the lanes on the basis of the vehicle traffic in its field of view, without user intervention. The process shall run without requiring the use of a computer or external processor. The auto-configuration shall be manually adjustable by a user through its user-friendly Windows™ interface providing a graphical visual representation of the detection area, captured vehicles and traffic lanes, for visual confirmation of the proper functioning of the radar;

6.57.4.3.1.7 be robust in design and all outdoor parts shall be weatherproof, UV resistant and corrosion resistant and shall be protected against mold growth and humidity deterioration, due to relative humidity conditions between 5% and 95%. The RVDS unit shall maintain its performance in all weather conditions including, without being limited to, rain, freezing rain, snow, wind, dust, dirt, fog, as well as changes in temperature and lighting conditions. It shall operate at an ambient temperature ranging between -40°C and 74°C;

6.57.4.3.1.8 have a RS-485 communication port and a RS-232 port and an Ethernet port;

6.57.4.3.1.9 allow a custom parameterization of the IP address, the subnet mask and the network gateway;

6.57.4.3.1.10 allow access to the Simple Network Management Protocol (SNMP) v1/2/3 and NTCIP;

6.57.4.3.1.11 have the ability to synchronize the date and time from the **Owner**'s server.

6.57.4.3.2 The equipment and accessories of the RVDS for power supply and communication with the detection unit shall be installed in a separate pole-mounted enclosure. The enclosure shall house the power supply, protection and communication modules, as well as the pre-identified connection terminals and other accessories that facilitate the access for modifications and additions to the RVDS without the need for lane closures.

6.57.4.3.2.1 The modules shall be DIN rail mounted, allowing power supply and communication therein between without the need for additional wiring.

6.57.4.3.3 Pre-assembled control cabinets and control panels

6.57.4.3.3.1 The control cabinets and control panels shall be pre-assembled prior to installation on the site and functional as soon as they are connected. They shall contain all the equipment required for proper functioning such as the main circuit breaker, wiring, modules, fittings, connections, mounts, etc.

6.57.4.3.3.2 The pre-assembled control cabinets and control panels shall be CSA approved.

6.57.4.3.4 Communication cable

6.57.4.3.4.1 The communication and power supply cable between the control cabinet or control panel and detection radar shall have the following characteristics, without however being limited to:

6.57.4.3.4.1.1 be of sufficient length for their connection;

6.57.4.3.4.1.2 be robust and weatherproof;

6.57.4.3.4.1.3 have six (6) 18 AWG gauge conductors;

6.57.4.3.4.1.4 provide power and RS-485 communication between the sensor and the cabinet;

6.57.4.3.4.1.5 have twisted tinned copper pairs with markers to identify the pairs;

6.57.4.3.4.1.6 be shielded with polypropylene/aluminum foil and tinned copper drain cable;

6.57.4.3.4.1.7 have a PVC sheath.

6.57.4.3.4.2 The communication cables between the control cabinets or control panels and the transmission antennas shall be equipped with one (1) surge protector installed between the two (2) cables.

6.57.4.4 VARIABLE MESSAGE SIGNS (VMS)

6.57.4.4.1 The VMS shall be able to be programmed using a compatible computer. The VMS communication protocol shall comply with the NTCIP standard. The **Contractor** shall provide the software for communication between the computer and the VMS.

6.57.4.4.2 A corrosion protection shall be applied between all metal surfaces of different types.

6.57.4.4.3 The VMS installed above the roadway, on overhead structures, shall have a minimum clearance height of 6.5 m, measured from the roadway level to the lowest point of the VMS unit including accessories, conduits, fasteners and supports.

6.57.4.4.4 All electronic circuits, including the controllers and their connections, shall be moisture-protected by means of a sealant in accordance with the acceptability of electronic assemblies IPC A-610, and a certification shall be provided by the manufacturer. The light emitting diode (LED) base shall also be coated with a sealant to protect them against mould, moisture and corrosion in accordance with standard NEMA TS-4. The equipment inside the cabinet shall be protected against mold, dust, salt and corrosion by using a sealant, paints and other means.

6.57.4.4.5 The controllers shall be industrial and compliant with standard NEMA TS-4. The controller shall carry the application software. The controller memories shall be large enough to allow for future expansions.

6.57.4.4.6 The controllers' application software shall be downloadable remotely via the communication port connected to a control center. The version of both the "firmware" software and the VMS controller application shall be the same for all VMS.

6.57.4.4.7 The VMS shall be designed to prevent the display of incorrect information in the event of a malfunction. It shall comprise an automatic deletion function, which immediately erases the message displayed on the panel in the event of internal or external failures such as a communication failure with the central control system, an invalid transmission of the control system or a power failure.

6.57.4.4.8 The cabinet shall be equipped with a heating or ventilation system to ensure that the legibility of the messages is not impaired by the formation of mist, frost, droplets and snow accumulation on the front panel.

6.57.4.4.9 The ventilation systems shall be equipped with filters with adequate frame and skeleton. All air intakes shall be fitted with filters and held in a semi-rigid frame. The air outlets shall be equipped with mosquito nets. These shall be provided with deflectors on the outside and shall be completely waterproof and weatherproof, such as rain and snow. The air intakes shall be equipped with baffles in order to block the projection of particles or dust.

6.57.4.4.10 The use of a forced ventilation system shall be controlled by a thermostat.

6.57.4.4.11 Supports

6.57.4.4.11.1 The VMS supports shall be rigid enough to withstand vibration, wind and air movement caused particularly by passing vehicles.

6.57.4.4.11.2 The loads to be used to calculate the stresses are those of standard CAN/CSA S6-14 "*Canadian Highway Bridge Design Code"*.

6.57.4.4.11.3 The design criteria are, without however being limited to, the following:

6.57.4.4.11.3.1 permanent loads, weight of structure and equipment;

6.57.4.4.11.3.2 wind load;

6.57.4.4.11.3.3 ice load;

6.57.4.4.11.3.4 live load;

6.57.4.4.11.3.5 strength of the steel or aluminium structure;

6.57.4.4.11.3.6 materials used;

6.57.4.4.11.3.7 weather conditions.

6.57.4.4.12 Location

6.57.4.4.12.1 The VMS can be installed above the roadway (overhead VMS) or along the edge of the roadway (lateral VMS and mobile VMS). The lateral VMS shall, as much as possible, be installed on the right side of the roadway. However, they may, on an exceptional basis, be placed on the left side of the roadway in the cases where there is a lack of space or visibility, to make it possible for all roadway users to read the message.

6.57.4.4.13 Power supply

6.57.4.4.13.1 All power supply cables shall enter the sign enclosure through sealed and tight inlet holes. No drilling is allowed on the upper surfaces of the VMS.

6.57.4.4.13.2 The lightning conductor cable shall not touch structures directly. It shall be routed in a suitable conduit as indicated on the drawings.

6.57.4.4.13.3 All display equipment shall be protected from, without however being limited to, the following damages:

6.57.4.4.13.3.1 lightning near the VMS, the structure or roadside cabinet;

6.57.4.4.13.3.2 electric transitions on the electrical wiring;

6.57.4.4.13.3.3 electric transitions on the internal and external signal wiring;

6.57.4.4.13.3.4 electromechanical interference and electrical shocks.

6.57.4.4.13.4 The cabinet shall be equipped with a heating or ventilation system to ensure that the legibility of the messages is not impaired by the formation of mist, frost, droplets and snow accumulation on the front panel.

6.57.4.4.14 Communication

6.57.4.4.14.1 All control and communication cables shall enter the sign enclosure through sealed and tight inlet holes.

6.57.4.4.14.2 A control device located on each site shall be capable of operating the panel both in local control mode, namely without external communication, and in remote control mode, namely by communicating with an external central control system.

6.57.4.4.14.3 The controller shall support all TCP/IP and NTCIP communications for dynamic message signs and support, at a minimum, the defined elements.

6.57.4.4.14.4 The communication shall make it possible to receive and transmit commands to and from the central control system using commands via data transfer protocols, Ethernet/IP and TCP/IP and shall be capable of controlling the display of messages on the VMS panel.

6.57.4.5 LANE CONTROL SIGNAL SYSTEM

6.57.4.5.1 General

6.57.4.5.1.1 The lane control signal shall consist of an aluminum housing with a LED matrix capable of displaying luminous messages.

6.57.4.5.1.2 Each lane control signal shall be equipped with a sun visor and have four (4) superimposed messages, not visible when switched off. The messages shall be legible from a minimum distance of 400 m.

6.57.4.5.1.3 The outer dimensions of the enclosure shall be 710 mm × 710 mm and a maximum depth of 450 mm.

6.57.4.5.1.4 The lane control signal shall operate within an ambient temperature range of -40°C to +74°C.

6.57.4.5.1.5 The LED display matrix shall be completely sealed so as to prevent any infiltration of dust and moisture penetration in accordance with standard NEMA 250 for Type 4 enclosure. The matrix shall further meet NEMA TS-2 environmental requirements.

6.57.4.5.1.6 The housing shall open to a minimum of 180° when the lane control signal is installed in its final position.

6.57.4.5.1.7 The front door shall be secured to the cabinet using stainless steel retractable hinges and locked with two (2) ¼ turn stainless steel latches.

6.57.4.5.1.8 A restraint bar shall keep the front door in the open position at an angle of at least 90 °.

6.57.4.5.2 Characteristics of the lane control signal

6.57.4.5.2.1 The lane control signal shall be completely modular, and consist of LED display modules. The aluminum enclosure shall be equipped with a visor and contrast screen.

6.57.4.5.2.2 The display panels shall be fully compatible with the existing controllers.

6.57.4.5.2.3 The lane control signals shall be connected to the controllers.

6.57.4.5.2.4 All modules shall be easily removable.

6.57.4.5.2.5 The assembly of the lane control signal shall be carried out so that all internal components are adequately secured to withstand the mechanical shocks and vibrations caused particularly by wind and in accordance with standard AASHTO for winds of 120 km/h with a gust factor of 30%.

6.57.4.5.2.6 The self-tapping fastener is prohibited.

6.57.4.5.2.7 All mechanical fasteners shall be stainless steel.

6.57.4.5.3 LED display

6.57.4.5.3.1 The display shall consist of a LED matrix mounted on a black printed circuit board.

6.57.4.5.3.2 The matrix shall include the following messages:

6.57.4.5.3.2.1 X in red;

6.57.4.5.3.2.2 ↓ in green;

6.57.4.5.3.2.3 → in yellow;

6.57.4.5.3.2.4 ← in yellow.

6.57.4.5.3.3 The chromaticity coordinates of the luminous messages shall comply with section 8.04 and Table 1 of standard VTCSH.

6.57.4.5.3.4 The messages shall have a minimum height of 585 mm.

6.57.4.5.3.5 The messages shall be composed of three (3) rows of LEDs evenly distributed. The distance between the LEDs shall not exceed 13 mm and shall not vary by more than 10%.

6.57.4.5.3.6 The display printed circuit board shall have a minimum thickness of 2.35 mm.

6.57.4.5.3.7 The red LEDs shall be the product *AlInGaP* using aluminum, indium, gallium and phosphorus and the green LEDs shall be the product *InGaN* using indium, gallium and nitrogen.

6.57.4.5.3.8 The minimum nominal brightness level of the LEDs shall be 6,000 mcd at 20 mA.

6.57.4.5.3.9 The LED printed circuit board shall be designed so that the loss of a single LED results in a maximum loss of five (5) LEDs.

6.57.4.5.3.10 No components other than the LEDs shall be fixed on the front of the display.

6.57.4.5.3.11 The back of the display shall be protected with a thermoformed polystyrene protective panel.

6.57.4.5.3.12 The display printed circuit board shall be fixed and sealed in the front door, which consists of an aluminum frame, a lens and a thermoformed polystyrene protective panel fixed with a gasket.

6.57.4.5.3.13 The protective lens shall be made of non-reflective polycarbonate with a minimum thickness of 4.75 mm with UV protection. The lens shall allow at least 82% of the light to pass.

6.57.4.5.3.14 The entire display module shall be removable from the enclosure in less than fifteen (15) minutes.

6.57.4.5.3.15 The display module shall be equipped with a multicore connecting cable with ferrule connectors attached at the ends.

6.57.4.5.4 Lane control signal power supply module

6.57.4.5.4.1 The power supply module shall be CSA/UL approved.

6.57.4.5.4.2 The power supply module shall be a plug-in product of standard dimensions of 165 mm × 115 mm.

6.57.4.5.4.3 The power supply module shall be mounted on a printed circuit board with an aluminum front plate and a handle for handling.

6.57.4.5.4.4 The plug-in contacts shall be gold plated.

6.57.4.5.4.5 The power supply module shall be calibrated to power the LEDs in DC power supply current not exceeding 20 mA.

6.57.4.5.4.6 The module shall regulate the power supply current to compensate for fluctuations in input voltage ranging from 95 Vca to 135 Vca. The display brightness shall not vary by more than 5% and shall not be perceptible to the human eye.

6.57.4.5.4.7 In accordance with the ITE standard for lane control signal with LED lights, the LEDs shall comply with the intensity, colour and uniformity standards. The total harmonic distortion shall be less than 20% and the activation and stop time shall be less than 75 ms.

6.57.4.5.4.8 The module shall be equipped with fuses and overvoltage protection capable of withstanding high-energy high pulse and low pulse repetition, in accordance with Article 2.1.6 of standard NEMA TS-2.

6.57.4.5.4.9 The power supply module shall comply with section 15 of standard FCC, concerning the emission of electronic noise.

6.57.4.5.4.10 The power supply module shall have a minimum capacity of 25 W.

6.57.4.5.4.11 The power supply module shall be equipped with a temperature control device to maintain the stability of the power supply current of the LEDs regardless of the outside temperature ranging from -34°C to +74°C.

6.57.4.5.4.12 The power supply module shall be equipped with an auto-dimming circuit to reduce the light intensity in function of the ambient light level.

6.57.4.5.4.13 The power supply module shall be configurable to receive an attenuation control from an internal or external 120V or 24V photocell.

6.57.4.5.4.14 The dimming circuit shall be calibrated to reduce the feed current by 60%.

6.57.4.5.4.15 The auto-dimming circuit shall be equipped with a thirty-second delay to prevent interference caused by headlights and shadows.

6.57.4.5.4.16 The power supply module shall be designed to monitor the display and it shall be configurable to emit either an alarm signal when the message is switched off or a confirmation signal when it is lit. The signal shall be configurable for 120V or 24V.

6.57.4.5.4.17 The power supply module shall be equipped with three (3) indicator lights displaying the following status:

6.57.4.5.4.17.1 on;

6.57.4.5.4.17.2 alarm;

6.57.4.5.4.17.3 dimmed.

6.57.4.5.5 Lane control signal modular chassis

6.57.4.5.5.1 The modular chassis for lane control signals shall be one piece, consisting of an anodized aluminum chassis and an interconnect printed circuit board equipped with connectors and terminals.

6.57.4.5.5.2 The chassis shall have a capacity of at least twenty-four (24) power supply modules.

6.57.4.5.5.3 The chassis shall be ventilated and equipped with locking devices to prevent modules from being disconnected by vibration.

6.57.4.5.5.4 The chassis shall be equipped with four (4) spring captive bolts to secure it to the housing. The chassis shall be demountable without the need for tools in less than five (5) minutes.

6.57.4.5.5.5 The chassis interconnect circuit shall comprise terminals for twenty-four (24) messages, one (1) photocell input and twenty-four (24) alarm outputs.

6.57.4.5.5.6 The connection terminals shall be “anti-vibration” with integrated springs.

6.57.4.5.5.7 All connections shall be done via the interconnect circuit. No internal wiring is permitted with the exception of the display connecting cable.

6.57.4.5.5.8 All terminals shall be permanently identified by means of print.

6.57.4.5.5.9 All printed circuit boards shall be fixed vertically to facilitate ventilation and prevent accumulation of dust and moisture on the surface.

6.57.4.5.6 Lane control signal enclosure

6.57.4.5.6.1 The lane control signal housing shall be a one-direction aluminum enclosure, with a minimal thickness of 3.175 mm and a depth of 200 mm.

6.57.4.5.6.2 All corners shall be welded by means of the Tungsten Inert Gas (TIG) process over the entire length.

6.57.4.5.6.3 The enclosure shall be equipped with a gutter around the perimeter of the front opening, to prevent water leakage inside the enclosure.

6.57.4.5.6.4 The enclosure shall be equipped with an aluminum visor of a minimum length of 254 mm to improve the visibility of the display.

6.57.4.5.6.5 The rear enclosure and the visor shall be painted with a black-colored matte polyester powder and the interior frame shall be painted black.

6.57.4.5.6.6 The enclosure shall be equipped with a 150 mm wide aluminum contrast screen, painted with yellow PS211A190 polyester powder.

6.57.4.5.6.7 The enclosure shall comprise two (2) 63.5 mm x 63.5 mm x 6.35 mm aluminum angles adequately welded to support the weight of the head not exceeding 30 kg.

6.57.4.5.7 Lane control signal brackets

6.57.4.5.7.1 The drawings of the brackets that hold the lane control signal heads to the structure do not contain a complete and detailed description of all accessories necessary to carry out the work. The **Contractor** shall provide a complete support system in accordance with best practices and in compliance with all standards in force. In addition, the brackets shall not reduce the free height or the clearance allowed.

6.57.4.5.7.2 The brackets proposed by the **Contractor** shall use the anchor holes and lane control signal head geometry indicated on the drawings. It is forbidden to modify the lane control signal head housings to fix the brackets thereon. Each lane control signal shall have its own mounting bracket.

6.57.4.5.7.3 The **Contractor** shall use a support system that does not cause metal corrosion.

6.57.4.5.7.4 A protective neoprene strip shall be placed between any aluminum element and a steel element, so as to avoid direct contact. A horizontally placed neoprene strip shall be interrupted in three (3) locations over a length of 25 mm so as to facilitate the drainage of water.

6.57.4.5.7.5 The bolts connecting the lane control signal head aluminum housing to the brackets shall be made of stainless steel.

6.57.4.5.7.6 The bolts connecting any aluminum element to a steel element shall be made of stainless steel.

6.57.4.5.7.7 The steel elements of the support system shall be galvanized.

6.57.4.5.7.8 Prior to ordering the lane control signal brackets, the **Contractor** shall submit to the Engineer, for review, the shop drawings.

6.57.4.5.8 Maintenance for lane control signals

6.57.4.5.8.1 In case of breakdown, the defective module shall be easily and quickly identifiable for immediate replacement.

6.57.4.5.8.2 All lane control signals components shall be an electronic product. Any electromechanical part, such as relay or transformer, is prohibited.

6.57.4.5.8.3 The manufacturer shall use identical lane control signals components for all structures.

6.57.4.5.9 Lane control signal power supply cables

6.57.4.5.9.1 The power supply cables between the lane control signals and the lane control signal local control cabinets shall be the insulated type *Armoured Control and Instrumentation Cable* (ACIC), with a nominal voltage of 600V and have ten (10) copper conductors with a minimum size of 18 AWG.

6.57.4.5.9.2 The power supply cables between the lane control signal junction boxes and the lane control signal local control cabinets shall be equipped with tight PVC coated aluminum *Seal Tight* connectors at each end.

6.57.4.5.9.3 The power supply cables between the lane control signals and the junction boxes shall be flexible and tight, with a nominal voltage of 600V and have ten (10) copper conductors with a minimum size of 18 AWG.

6.57.4.5.9.4 The power supply cables between the junction boxes and the lane control signal local control cabinets shall be VNTC type, flexible and tight, insulated, with a nominal voltage of 600V and have ten (10) copper conductors with a minimum size of 18 AWG.

6.57.4.5.9.5 The power supply cables between the lane control signals and the junction boxes shall have appropriate tight fittings.

6.57.4.5.10 Junction boxes for lane control signal structures

6.57.4.5.10.1 The **Contractor** shall supply and install the complete junction boxes, including the angles and fasteners, and identified, to link the lane control signal to the control cabinet, namely one (1) junction box per lane per structure.

6.57.4.5.10.2 The boxes shall be NEMA 4X fiberglass-reinforced polyester.

6.57.4.5.10.3 The boxes shall have eight (8) spring-loaded connection terminals for the connection of the lane control signals.

6.57.4.5.10.4 The **Contractor** shall supply all the hardware necessary to secure the junction boxes.

6.57.4.6 VIDEO SURVEILLANCE SYSTEM

6.57.4.6.1 The **Owner** uses fixed and mobile cameras.

6.57.4.6.2 All cameras shall be of the type manufactured for outdoor environment; they shall hold, at a minimum, the IP68 certification, and shall be capable of operating at temperatures ranging from -40°C to +60°C.

6.57.4.6.3 The cameras shall have a washer kit comprising the washer pump drive card, washer blade nozzle and mounting brackets.

6.57.4.6.4 The mobile cameras shall be in a black solid cast aluminum housing and shall operate in the most demanding conditions. The housing shall be both impact- and weather-resistant. A long-lasting silicone wiper shall be integrated onto the housing. The housing shall have an internal heating unit and the glass shall be tempered.

6.57.4.6.5 The mobile camera shall operate day and night and have a x36 optical zoom with progressive scan. The image control and quality shall provide a minimum horizontal resolution of 550 lines with a minimum illumination sensitivity of 1 lx, so as to obtain clear and usable video images. In addition, the camera shall be the autofocus type with horizontal and vertical aperture correction.

6.57.4.6.6 The camera shall have one (1) sabotage alarm input, two (2) relay outputs and one (1) washer output. The camera shall have a minimum of fifty (50) pre-programmable positions.

6.57.4.6.7 The "Pan and Tilt" brushless motor technology shall be quiet and extremely reliable, with 360° continuous orientation and 270° tilt. Guard tours with preset and return to the original position shall be programmable.

6.57.4.6.8 The camera shall be the *IP* type, with Multicast capacity.

6.57.4.6.9 The camera shall have a minimum illumination sensitivity of 0.9 lx in color mode and 0.2 lx in black and white mode. The communication protocol of the camera shall be carried out by means of a converter and shall be compatible with that of the **Owner**.

6.57.4.6.10 The housing shall be vandal-resistant and have built-in heating with anti-handling contact. The housing screws shall be made of stainless steel and tamper-proof. The **Contractor** shall provide the brackets for mounting either on a wall, on a mast or under a canopy, depending on the environment and location.

6.57.4.6.11 All cameras shall be identified and numbered in accordance with the **Owner**'s numbering code. The codification and inscription to appear on the cameras will be provided to the **Contractor** after award of this Contract. The material (lamicoid, metal photo or sticker) used as well as the dimensions for the identification of the

6.57.4.6.12 Camera bracket

6.57.4.6.12.1 The **Contractor** shall provide a mounting compatible with the chosen camera model. The mounting system shall include, without however being limited to the following:

6.57.4.6.12.1.1 mounting bracket;

6.57.4.6.12.1.2 thin base with cable passage adapted to the camera model;

6.57.4.6.12.1.3 appropriate attachment according to the diameter of the pole.

6.57.4.7 WASHER TANK AND PUMP

6.57.4.7.1 The washer pump shall have, without however being limited to, the following characteristics:

6.57.4.7.1.1 have a washer nozzle attached to the base of the camera;

6.57.4.7.1.2 be corrosion resistant;

6.57.4.7.1.3 offer the possibility of adjusting the jet;

6.57.4.7.1.4 have an ultraviolet-resistant washer fluid reservoir with a minimum capacity of 23 L with support and a level detection mechanism.

6.57.4.7.2 The washer pump system shall have, without however being limited to, the following characteristics:

6.57.4.7.2.1 allow top filling with a surplus outlet;

6.57.4.7.2.2 have a shut-off valve to prevent leakage during filling;

6.57.4.7.2.3 be equipped with a relay to open the shut-off valve before activation of the pump.

6.57.4.7.3 The washer fluid reservoir with pump and integrated control receiver shall be installed in an insulated NEMA 4X enclosure with heating system, having a stainless steel lockable device.

6.57.4.7.4 In order to have a complete and functional washer system, the **Contractor** shall supply and install all the following components, without however being limited thereto:

6.57.4.7.4.1 one (1) washer fluid reservoir for each camera having an enclosure with a wiper;

6.57.4.7.4.2 one (1) washer nozzle;

6.57.4.7.4.3 one (1) composite cable with grommet and be connected to the camera housing;

6.57.4.7.4.4 one (1) flexible three (3) 18 AWG gauge conductor power cable from 120V power box;

6.57.4.7.4.5 one (1) 0.3175 mm diameter conduit from the washer fluid reservoir to the camera;

6.57.4.7.4.6 one (1) 0.4 mm diameter conduit from the washer fluid reservoir to the bottom of the pole;

6.57.4.7.4.7 all the necessary mounting brackets and accessories;

6.57.4.7.4.8 one (1) fill of the washer fluid reservoir with winter washer fluid of -40 C.

6.57.4.7.5 The **Contractor** shall submit a shop drawing of the connection diagram and assembly of the camera and washer system to the Engineer for review.

6.57.4.8 Identification

6.57.4.8.1 The identification of the conductors shall be made with a polyolefin heat-shrinkable tube, white color with black lettering. The product for the identification of conductors shall be the *LS8E-H000X034H1C* of the manufacturer Panduit printed mechanically or equivalent authorized by the Engineer. The diameter of the tube shall allow it to adjust properly to each conductor as well as to the number of conductors to identify.

6.57.4.8.2 The cable identification shall be made with a *SMK* label manufactured by Thomas & Betts or equivalent authorized by the Engineer and shall be of a diameter appropriate to the cable to be identified.

6.57.4.8.3 All other materials shall be identified using lamicoid type identification plates. The identification plates shall be UV resistant and black with white cores. Text and images shall be engraved on the front side of the plates. The reverse side shall have a self-adhesive tape on 100% of the surface of the plate.

6.57.5 EXECUTION OF WORK

6.57.5.1 INSTALLATION OF THE INDUCTIVE LOOP DETECTORS

6.57.5.1.1 For each site of inductive loop detectors to be installed, the **Contractor** shall install markers to make it possible to locate each loop, by lane and in geometry, by marking line projection and by positioning.

6.57.5.1.2 The **Contractor** shall prepare the on-site implementation of each inductive loop detector in order to allow the Engineer to validate the site configuration.

6.57.5.1.3 The **Contractor** shall ensure that there is a minimum distance of 50 mm from any metal element, all around a loop.

6.57.5.1.4 The **Contractor** shall ensure, for each loop and supply conduit, a minimum depth of 100 mm between the roadway surface and the top of the loop conduit.

6.57.5.1.5 The **Contractor** shall install each inductive loop detector perpendicular to the roadway lane, in accordance with the drawings. The use of a precise measurement template is required in order to obtain the appropriate degree of precision during installation and during the verification by the Engineer. Each inductive loop detector and supply conduit shall be fixed laterally by means of staples at every corner and every 300 mm of their route.

6.57.5.1.6 The **Contractor** shall fill all trenches with rapid-setting grout up to the level of the roadway. The product shall be *SikaSet 45* manufactured by Sika Canada Inc., or equivalent authorized by the Engineer. The **Contractor** shall plan the grout setting time before reopening the lanes to traffic.

6.57.5.1.7 All twisted loop wires, starting at the end of the loop, shall be inserted into a PVC conduit of the appropriate diameter buried inside the paved roadway up to the junction box or pull box.

6.57.5.1.8 The loops shall be numbered in the direction of traffic, sequentially and across the entire roadway. The loops shall have an identification marker and shall not have linked nodes because of the risk of damaging the loop cable.

6.57.5.2 TESTING OF THE INDUCTIVE LOOP DETECTORS

6.57.5.2.1 The **Contractor** shall conduct the inductance, resistance and insulation tests of each inductive loop detector.

6.57.5.2.2 The inductance value of a 1.8 m by 1.8 m inductive loop detector consisting of four turns of wire ranges between 125 and 300 µH, including the supply cable. The measurements shall not vary by more than 15% from the theoretical value for an inductive loop detector.

6.57.5.2.3 The circuit of the loop and supply cable shall, after installation, have a resistivity of 5 Ω or less.

6.57.5.2.4 The inductive loop detector cables are verified using a voltage of 2.5kVcc. A minimum reading of 10,000 MΩ shall be obtained for each loop. The verification is carried out directly on the RWU cables. The loop circuit comprises the supply cable.

6.57.5.3 COMMISSIONING AND PROGRAMMING OF THE RVDS

6.57.5.3.1 Following the commissioning and initial configuration of each station in accordance with the manufacturer's recommendations, the **Contractor** shall provide for testing of the Radar Vehicle Detection System (RVDS) equipment including the radar, the data collection and radio transmission between the stations and via fibre optic. The tests shall be carried out on data collected during a period of at least one (1) week. The data shall be validated and compared to other data to assess the accuracy thereof.

6.57.5.3.2 The **Contractor** shall plan and coordinate the configuration and commissioning of the equipment with the RVDS manufacturer so that everything is perfectly functional and the adjustment is done properly.

6.57.5.4 TESTING AND APPROVAL OF THE VMS

6.57.5.4.1 All tests on the VMS described in this subsection shall be conducted both in accordance with the instructions that follow the inspection and testing plan submitted by the manufacturer and in the presence of the Engineer.

6.57.5.4.2 The factory pre-installation tests such as software and command operations testing, archiving (actions, alarms, users), displays, programming, communication, vibration and temperature, shall be performed.

6.57.5.4.3 Worksite start-up tests such as message display, daytime and nighttime intensity, operation, functioning, response time, photocell adjustments, as well as tests to verify all pixels, shall be performed.

6.57.5.5 FACTORY-TESTING OF THE LANE CONTROL SIGNALS PRIOR TO THE EXECUTION OF THE WORK

6.57.5.5.1 The **Contractor** undertakes to have the manufacturer demonstrate to the Engineer, during testing, that the equipment supplied performs as intended. The **Owner** may require additional tests thereby deemed necessary to validate the proper functioning of the equipment.

6.57.5.5.2 No later than fourteen (14) days before the start of the manufacturing of the lane control signals, the **Contractor** shall provide the Engineer, for review, with a test plan prepared by the manufacturer of the lane control signals.

6.57.5.5.3 The Engineer shall be notified at least five (5) days before the start of the tests.

6.57.5.5.4 The Engineer may attend the tests.

6.57.5.5.5 The tests shall be planned in function of a batch of equipment prior to their shipping in order to minimize the Engineer's travels.

6.57.5.5.6 In the event that a test demonstrates any defect, the test shall be interrupted. The cause of the defect shall be determined and the **Contractor** shall make all necessary repairs to the satisfaction of the Engineer.

6.57.5.5.7 All equipment shall be verified by the manufacturer once installed to demonstrate that the entire system is operating in accordance with the requirements of the Contract.

6.57.5.5.8 At least five (5) days prior to the delivery of the equipment on which the tests were conducted, the **Contractor** shall provide the Engineer, for review, with a report prepared by the manufacturer indicating the results of the tests.

6.57.5.6 MAINTAINING THE LANE CONTROL SIGNAL SERVICES

6.57.5.6.1 The **Contractor** shall maintain all existing lane control signals in operation. The **Contractor** shall provide for the phasing of its work in function of this constraint and in function of a list of priorities thereby given by the **Owner**.

6.57.5.6.2 The lane control signal service interruptions shall be coordinated and authorized by the **Owner** at least five (5) working days prior to any interruption.

6.57.5.6.3 The work shall be carried out sequentially so as to maintain one out of two lane control signal structures in operation. In addition, the structures may not remain out of service for more than one hundred and twenty (120) consecutive hours. The **Contractor** shall provide for the phasing of the work in function of these constraints.

6.57.5.7 SEQUENCE OF WORK FOR THE INSTALLATION OF THE LANE CONTROL SIGNALS

6.57.5.7.1 The **Contractor** shall submit to the **Owner**, for approval, the sequence in which the modifications of the structures will be carried out, in order to guarantee the safety of users and to allow the **Owner** to plan the programming and testing sequence in order for the signage of the structures to be returned in operation as quickly as possible.

6.57.5.7.2 The work shall be planned in such a way as to complete the work on a lane control signal structure as quickly as possible.

6.57.5.7.3 The **Contractor** shall prepare and submit to the Engineer, for review, the test procedures for each component of the system such as the communication network, inputs/outputs and power supply. These test procedures shall be drafted in accordance with the **Owner**'s *Guide de rédaction et d'exécution d'un Rapport d'essais de système automatisé*. All tests shall be documented in a test notebook filled with all corresponding test results and submitted to the Engineer, for review. The Engineer shall authorize the test procedures prior to the conduct of any test. However, the **Contractor** is not responsible for the programming that will be performed by a third party.

6.57.5.8 MOUNTING OF THE LANE CONTROL SIGNALS

6.57.5.8.1 The **Contractor** shall supply, install and connect the lane control signal mounting brackets to the structures.

6.57.5.8.2 When the work is to be carried out on an existing structure, the **Contractor** shall verify both the dimensions and the condition of the structure before undertaking the lane control signal installation work. The **Contractor** shall notify the Engineer of any deviation or problem detected and await his instructions.

6.57.5.8.3 When installing equipment such as lane control signals or electrical conduit on a lane control signal structure, the **Contractor** shall in no case drill or screw into the structure.

6.57.5.8.4 All accessories, brackets and hardware supplied shall be new.

6.57.5.8.5 The **Contractor**'s assembly drawing shall include a safe handling method to be used for attaching the lane control signals during handling and until installation on the structure and include a description of the operations at the various stages of assembly.

6.57.5.8.6 The **Contractor** is responsible for carrying out and completing the work and shall ensure that its workers are informed in order to carry out the work in accordance with the drawings and according to best practices.

6.57.5.8.7 The installation of the traffic signage panels shall be independent from the installation of the lane control signals. The accessories used for attaching the traffic signage panels on the lane control signal structure stringers shall in no way rest on or be fixed to the lane control signal heads themselves or brackets thereof.

6.57.5.9 TESTING OF THE LANE CONTROL SIGNAL SYSTEM

6.57.5.9.1 The **Contractor** shall verify all equipment thereby installed and ensure that the entire system operates to the satisfaction of the **Owner**.

6.57.5.9.2 All communications links shall be verified and documented by the **Contractor**.

6.57.5.9.3 From the main control station, each circuit associated with the different signals for each lane shall be activated to verify that lane control signal system is working as intended.

6.57.5.9.4 Once the cables connected, each signal shall be switched on to verify that the confirmation devices are working as intended.

6.57.5.9.5 Within five (5) working days following the execution of the tests, the **Contractor** shall submit to the Engineer, for review, the reports of the detailed test results for each element tested.

6.57.5.9.6 The **Contractor** shall perform all tests before re-commissioning a lane control signal structure.

6.57.5.10 MAINTAINING THE VIDEO SURVEILLANCE SERVICES

6.57.5.10.1 The **Contractor** shall maintain all existing cameras in function at all times during the work. The **Contractor** shall provide for the phasing of its work in function of this constraint and in function of a list of priorities thereby given by the **Owner** following award of this Contract.

6.57.5.10.2 The camera service interruptions shall be coordinated and approved by the **Owner** at least five (5) working days prior to any interruption.

6.57.5.11 SEQUENCE OF WORK FOR THE INSTALLATION OF THE VIDEO SURVEILLANCE EQUIPMENT

6.57.5.11.1 The **Contractor** shall prepare the sequence of execution of the installation work of the video surveillance equipment. The sequence of work shall aim at limiting the operational impacts. It shall further clearly identify the work requiring a service interruption.

6.57.5.11.2 At least fourteen (14) days prior to the commencement of the work, the **Contractor** shall submit the sequence of work to the Engineer, for review.

6.57.5.12 IDENTIFICATION OF EQUIPMENT, CABLES AND CONDUCTORS

6.57.5.12.1 The **Contractor** shall supply and install all the identifications necessary for the operation and maintenance of the executed work. This identification shall be written in French and in English.

6.57.5.12.2 All equipment shall be identified with waterproof and indelible labels.

6.57.5.12.3 The identification shall correspond to the information as well as the nomenclature of the equipment indicated in the drawings. The **Contractor** shall allow the Engineer at least fifteen (15) working days to validate the proposed nomenclature. The **Contractor** is not authorized to install identifications that have not been validated. The **Contractor** shall submit all identifications to the Engineer for review.

6.57.5.12.4 All equipment cabinets shall be identified.

6.57.5.12.5 The **Contractor** shall ensure that all conductors are identified at their ends with permanent marking. The identification shall remain legible according to the connection of the conductor.

6.57.5.12.6 The **Contractor** shall also label the cables at each end, as well as in the pull boxes, fusion boxes, junction boxes, access manholes, work cages as well as any other location requiring identification for operation and maintenance purposes. Labels must be secured with "tie-rap" type fasteners.

6.57.5.12.7 All materials shall be identified by means of an identification plate in accordance with paragraph 6.57.4.8.3. The label shall be affixed directly to the materials. In addition, plates installed on outdoor materials shall be securely fastened with a minimum of two (2) stainless steel fasteners to maintain integrity and watertightness.

6.57.6 QUALITY CONTROL

6.57.6.1 LANE CONTROL SIGNAL SYSTEM

6.57.6.1.1 The **Contractor** shall provide the Engineer with documents demonstrating the perfect compatibility of the lane control signal with the control panels currently in operation. The components proposed by the **Contractor** shall be of compatible and equivalent technology for all structures.

6.57.6.2 QUALIFICATIONS OF THE VIDEO SURVEILLANCE CONTRACTOR

6.57.6.2.1 The personnel performing the installation of the video surveillance equipment shall have at least three (3) years of relevant experience in the installation and configuration of the type of remote video surveillance equipment required by this Contract.

6.57.6.2.2 The personnel carrying out the installation work of the video surveillance equipment shall have successfully completed a training program for the installation and configuration of video surveillance equipment and hold a training certificate.

6.57.6.2.3 The **Contractor**, or its subcontractor, if applicable, shall submit an attestation or certificate demonstrating that it is an integrator recognized and authorized by the equipment manufacturer.

6.57.7 WARRANTY

6.57.7.1 WARRANTY AND MAINTENANCE SERVICE

6.57.7.1.1 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to the *Lane Control Signal System*.

6.57.7.1.2 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to *Video Surveillance System*.

6.57.7.1.3 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to the *Counting System (pedestrians and bicycles)*.

6.57.7.1.4 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to the *Inductive Loop Vehicle Detector System*.

6.57.7.1.5 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to the *Radar Vehicle Detection System*.

6.57.7.1.6 Notwithstanding the General Conditions, a warranty of twenty-four (24) months from the date of issuance of the Interim Certificate of Completion of the work concerned applies to all equipment mentioned in this subsection that is related to the *Variable Message Signs (VMS)*.

END OF SUBSECTION