

**SPECIFICATIONS FOR THE SUPPLY OF  
TS2 TYPE 1 TRAFFIC ACTUATED INTERSECTION CONTROL EQUIPMENT  
2015 SIGNAL PROGRAM**



**May 2015**

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**SPECIFICATION FOR TS2 TYPE 1  
FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

**SCOPE**

**TS2 TYPE 1 - TRAFFIC CONTROLLER**

The TS2 Type 1 controller shall include the following major components:

- LCD display
- Port 1, 2, 3 connectors
- Actuated and pre-timed control
- Minimum 12 vehicle phases with 12 concurrent pedestrian movements
- Minimum two (2) timing rings
- Minimum four (4) Overlaps
- Coordination: 16 timing plans each with independent cycle lengths, phase splits and 3 offsets
- Minimum 48 time-of-day events, commands / programs
- Minimum 6 pre-emption inputs
- Onboard diagnostics
- Real-time clock, Daylight Savings, Leap Year

**TS2 TYPE 1 - MMU**

The TS2 Type 1 MMU shall include the following major components:

- Configure as 12-channel or 16-channel
- Port 1 connector
- Downward compatible to NEMA TS1
- MSA and MSB connectors
- Onboard diagnostics

**TS2 - RACK MOUNT DETECTORS**

The TS2 rack mount detectors shall include the following major components:

- 2 channels
- LCD display
- Onboard diagnostics

**SPECIFICATION FOR TS2 TYPE 1  
FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

TS2 TYPE 1 - 42CCT M1 CABINET ASSEMBLY

The TS2 Type 1 - 42 circuit M1 cabinet assembly shall include the following major components:

- Facilities to incorporate a TS2 Type 1 fully actuated solid-state controller unit with time-based co-ordination capabilities
- Facilities to incorporate a Malfunction Management Unit for monitoring GREENS, YELLOWS, WALKS AND REDS. (NEMA (plus) Type 16)
- A Terminal Facility accommodating three (3) BIU'S, fourteen (14) NEMA LOAD SWITCHES, six (6) FLASH TRANSFER RELAYS and one (1) NEMA FLASHER providing two (2) flashing circuits
- Forty-two (42) signal outputs
- Flash Programming jumper terminal block
- MMU Programming terminal block
- SDLC communications panel
- Main Disconnect breaker housed in a "Service Entrance" panel
- Power distribution panel with breakers, over current protection for signal equipment, non-signal equipment and surge protection with line filtering
- POLICE PANEL with signal ON/OFF, AUTO/FLASH, AUTO/MANUAL switches with a manual control cord
- MAINTENANCE PANEL with signal ON/OFF, AUTO/FLASH, AUTO/MANUAL, controller ON/OFF, detector test switches and fused duplex receptacle
- Thermostatically controlled 350 watt heater assembly
- Thermostatically controlled cooling fan assembly
- Switched cabinet lamp
- Clearly labelled terminal strips
- Spare terminals for communication interface (not supplied, see 5.4.6)
- Detector Rack accommodating one (1) BIU & 8 channels of detection

**SPECIFICATION FOR TS2 TYPE 1  
FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

- Detector panel assembly accommodating eight (8) road loop field inputs, along with eight (8) vehicle and four (4) pedestrian test switches
- All Interconnect harness/wiring for above equipment
- Type 'M1' aluminium cabinet with two (2) shelves to support equipment
- Cabinet wiring diagram (double ended) (3 copies each cabinet)
- Powder coated internal panels with permanent marking system
- A additional fused equipment receptacle (5 Amps) not GFCI shall be present
- Cabinet door switch wired to Alarm 1

**SPECIFICATION FOR TS2 TYPE 1  
FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

TS2 TYPE 1 - 42CCT P2 CABINET ASSEMBLY

The TS2 Type 1 - 42 circuit P2 cabinet assembly shall include the following major components:

- Facilities to incorporate a TS2 Type 1 fully actuated solid-state controller unit with time-based co-ordination capabilities
- Facilities to incorporate a Malfunction Management Unit for monitoring GREENS, YELLOWS, WALKS AND REDS. (NEMA (plus) Type 16)
- A Terminal Facility accommodating three (3) BIU'S, fourteen (14) NEMA LOAD SWITCHES, six (6) FLASH TRANSFER RELAYS and one (1) NEMA FLASHER providing two (2) flashing circuits
- Forty-two (42) signal outputs.
- Flash Programming jumper terminal block
- MMU Programming terminal block
- SDLC communications panel
- Main Disconnect breaker housed in a "Service Entrance" panel
- Power distribution panel with breakers, over current protection for signal equipment, non-signal equipment and surge protection with line filtering
- POLICE PANEL with signal ON/OFF, AUTO/FLASH, AUTO/MANUAL switches with a manual control cord
- MAINTENANCE PANEL with signal ON/OFF, AUTO/FLASH, AUTO/MANUAL, controller ON/OFF, detector test switches and fused duplex receptacle
- Thermostatically controlled 350 watt heater assembly
- Thermostatically controlled cooling fan assembly
- Switched cabinet lamp
- Clearly labelled terminal strips
- Spare terminals for communication interface (not supplied, see 5.4.6)
- Detector Rack accommodating one (1) BIU & 16 channels of detection

**SPECIFICATION FOR TS2 TYPE 1  
FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

- Detector panel assembly accommodating 16 road loop field inputs, along with 8 vehicle and 4 pedestrian test switches
- All Interconnect harness/wiring for above equipment
- Type 'P2' aluminium cabinet with two (2) doors and two (2) shelves to support equipment
- Cabinet wiring diagram (double ended) (3 copies each cabinet)
- Powder coated internal panels with permanent marking system
- A additional fused equipment receptacle (5 Amps) not GFCI shall be present
- An additional fuse fed from the load side of the line filter shall be present
- Cabinet door switch wired to Alarm 1



# SPECIFICATION FOR TS2 TYPE 1 FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT

This base specification describes the minimum design and operating requirements for TS2 TYPE 1 Fully Actuated Traffic Controller Assemblies, and associated equipment.

## 1. GENERAL

### 1.1. APPROVALS

1.1.1. As a minimum, all electronic, electric equipment, components and workmanship shall conform to the standards of the NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) current edition NEMA Standards Publication TS2 - 2003 v02.06 for TRAFFIC CONTROLLER ASSEMBLIES, where applicable, and the Rules, Regulations governing Electrical Service for the City of Edmonton. Cabinets must be marked certifying that the device is approved for installation in Alberta and conforms to the appropriate CSA or equivalent (Canadian Standards Association) standards.

### 1.2. SAFETY

1.2.1. The Traffic Control equipment shall perform the functions described with maximum safety, reliability and efficiency while operating in the traffic control applications and environment of the City of Edmonton.

### 1.3. CONTROLLER

1.3.1. As a minimum, the Controller Unit (CU) shall meet the current NEMA Standards Publication TS2 - 2003 v02.06, Section 3. The CU shall be a NEMA TS2 Type 1.

1.3.2. The CU must be 100% compatible with the Centrac's Advanced Traffic Management System without any additional software and/or licenses.

### 1.4. CABINET ASSEMBLY

1.4.1. As a minimum, the controller assembly (CA) shall meet the current NEMA Standards Publication TS2 - 2003 v02.06.

### 1.5. TERMINAL FACILITY

1.5.1. The Terminals & Facilities (TF) shall be wired for a TS2 Type 1 interface. The TF shall be wired to meet the current NEMA Standards Publication TS2 - 2003 v02.06, Section 5.

## 2. ENVIRONMENTAL / OPERATING REQUIREMENTS

### 2.1. ENVIRONMENTAL REQUIREMENTS

2.1.1. All major components in the TS2 type1 CA, shall meet the environmental and operating standards, outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 2.

# SPECIFICATION FOR TS2 TYPE 1 FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT

## 2.2. OPERATING VOLTAGE

- 2.2.1. Circuitry shall be designed to insure proper timing and switching functions with line voltage inputs from 89 to 135 VAC.

## 2.3. TEMPERATURE RATINGS

- 2.3.1. All circuitry shall operate properly at ambient temperatures ranging from -34°C to +74°C.

## 2.4. DESIGN

- 2.4.1. The controller and signal control circuits shall utilize solid state components.
- 2.4.2. All components shall be amply de-rated so that under maximum ambient temperature and applied voltage conditions, material shortening of life or shift in values shall not occur.
- 2.4.3. Each grouping of components as a printed circuit assembly shall have a mean time to failure of three (3) years.
- 2.4.4. All printed circuit assemblies shall be of NEMA grade glass epoxy or equivalent with extra heavy cooper track.
- 2.4.5. All printed circuit assemblies shall have printed on them a reference designation for each component part.
- 2.4.6. The design life of all components shall not be less than five (5) years under 24-hours-a-day operating condition.
- 2.4.7. All logic circuit inputs and outputs shall be able to withstand transients as outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 2.1.7.

## 3. CONTROLLER UNIT (CU)

### 3.1. ENCLOSURE

- 3.1.1. An enclosure with a suitably protected finish shall enclose all electrical parts of the controller unit. The enclosure shall be designed for placement on a shelf. The height of the enclosure shall not exceed 305mm (12"). The width of the enclosure shall not exceed 380mm (15"). The depth of the enclosure including harnesses shall not exceed 368mm (14.5").

### 3.2. DESIGN

- 3.2.1. The controller will be of modular design. The main frame chassis shall be completely equipped and wired for the full complement of modules as required for

## **SPECIFICATION FOR TS2 TYPE 1 FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT**

that chassis type. The face plate of each module is to be clearly marked to identify its function. Modules of unlike functions shall be mechanically keyed to prevent insertion into wrong slot causing controller unit malfunction. Modules of same type shall be interchangeable in all controller configurations.

- 3.2.2. All controller input/output connectors, fuse holders, indications, displays, switches and control devices required for the operation and adjustments of the controller shall be mounted on the front panel. The front panel of the controller shall be permanently marked to identify I/O connections, fuse holders, indicators, etc.
- 3.2.3. All displays/indicators shall have a minimum design life of 20,000 hours at rated conditions. A means of extinguishing displays shall be provided to extend the lifetime of the displays.
- 3.2.4. All components, parts and terminal shall be readily accessible for adjustments, testing or service. If circuit board extender cards or cables are employed to facilitate testing, extender cards and/or cables are to be supplied with every ten (10) control units or less.
- 3.2.5. The controller unit shall use EEPROM (Electrically Erasable Programmable Read Only Memory) or Flash Memory to store all user programmable data. Flash Memory will be used to store controller unit operating software to allow for software upgrades via Port 2 (ref 3.3.2 below) or similar port. EPROM's or Proms are not acceptable.

### **3.3. CONTROLLER INTERFACE**

#### **3.3.1. PORT 1**

- 3.3.1.1. The Port 1 connector shall be mounted on the front of the CU and shall be a 15 pin metal shell D sub miniature connector. Port 1 shall be used for communications with in the Controller Assembly. As a minimum, Port 1 shall meet the requirements outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.3.1.

#### **3.3.2. PORT 2**

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3.3.2.1. The Port 2 connector shall be a 25 pin metal shell D sub miniature connector. Port 2 connector shall be an RS232 DTE interface for connecting to a printer or personal computer. As a minimum, Port 2 shall meet the requirements outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.3.2. Complete and/or optional portions of controller data and status reports shall be available to be transmitted to the printer.

3.3.2.2. The Controller software shall be 100% compatible with the Centrac's local addition software (Windows based) without any additional software and/or licenses on the PC or in Centrac's Local Edition.

3.3.2.3. This software must be Windows based and able to run on the City of Edmonton's Certified PC. The software shall come complete on a CD and the license shall be a site license, allowing the City to run this software package on as many PCs as required to support these controllers.

3.3.2.4. At minimum, it shall offer facilities to:

- upload to the PC all or selected portions of data from the controller
- edit all or portions of the data
- incorporate data entry error checking
- print reports on all or selected portions of the data
- download data from PC to controller
- compare on-file data to controller data and report
- maintain a filing system for various controller databases
- monitor and display in real-time the current operating status of the controller
- monitor and display in real-time the current status of inputs/outputs

### 3.3.3. PORT 3

3.3.3.1. The Port 3 connector shall be used for the future system interface, connecting to the interconnect lines. As a minimum, Port 3 shall meet the requirements outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.3.3.

### 3.3.4. TYPE 1 INTERFACE STANDARDS

3.3.4.1. The Type 1 CU interface shall meet the requirements outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.3.4 providing a connector on the front of the CU, which mates with MS3106-18-1S.

3.3.4.2. The CU should provide for re-assigning input or output functions to unused input or output BIU pins (input/output re-mapping). At a minimum, the following functions shall be capable of re-assignment:

- Phase Vehicle Red/Amber/Green
- Phase Pedestrian (Walk, PCL, Don't Walk)
- Phase Check, Next, ON

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- Vehicle and Pedestrian Overlaps
- Unused Phase Inputs to serve as coordination / pre-emption I/Ps

**3.4. ACTUATED CONTROL FUNCTIONS**

3.4.1. The controllers shall, as a minimum, meet the functional standards outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.5.

3.4.2. As a minimum, the CU shall provide all inputs/outputs and functional capabilities for twelve (12) vehicle phases, each with twelve (12) concurrent pedestrian movements and two timing rings. Phases shall be optionally assigned to the timing rings and barriers shall be optionally defined within the rings. The controller shall, at minimum, be able to be optionally configured to run in the following modes:

- NEMA Dual Quad
- 12-phase sequential
- Lead/Lag
- Split Ring (Dual 6-Phase)

3.4.3. Each traffic signal phase shall be capable of timing the following intervals: (These represent minimum timings and maximum increments.)

<u>INTERVAL</u>	<u>RANGE (Seconds)</u>	<u>INCREMENT</u>
MINIMUM GREEN (Initial)	0 - 255	1
PASSAGE (Preset Gap)	0 - 25	0.1
MAX GREEN I	0 - 255	1
MAX GREEN II	0 - 255	1
YELLOW CLEARANCE	3.0 - 9.9	0.1
RED CLEARANCE	0 - 25	0.1
WALK	0 - 255	1
PED CLEARANCE	0 - 255	1

3.4.4. Timing for the controller functions shall be accomplished by digital methods and relate directly to the 60Hz input line frequency. Timing intervals shall not deviate more than  $\pm 0.1$  sec. from their set values.

3.4.5. Each phase shall have identical control capability, options and features. Options and features for each phase may be exercised independently of options and features selected on other phases.

3.4.6. The sequence of intervals for each phase shall be: GREEN, YELLOW, RED and ALL RED for vehicle movements, and steady WALK, flashing DON'T WALK and steady DON'T WALK for pedestrian movements.

3.4.7. The transfer of the right-of-way from any traffic movement shall take place only after a proper clearance period. The clearance period for each vehicular interval

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shall consist of a YELLOW interval and an ALL RED interval. Each shall be timed separately and the ALL RED interval may be omitted by a simple timing adjustment. The YELLOW shall be a protected / guaranteed interval timing a minimum of 3 seconds that cannot be overridden.

- 3.4.8. RECALL/DEMAND controls shall be provided in the controller for each phase to perform the following functions:
- To place a recurring demand for vehicle service on that phase (MINIMUM RECALL)
  - To place a permanent demand for vehicle service on that phase such that Green timing will extend to MAXIMUM (MAXIMUM RECALL)
  - To place a recurring demand for pedestrian service on that phase (PEDESTRIAN RECALL). This control shall not cause the pedestrian interval to extend or recycle until an opposing phase is serviced
- 3.4.9. There shall be provisions for storing demands for vehicle and/or pedestrian service on each phase. A means shall be provided in the controller to disable storage of vehicle demands on each phase (lock/non-lock).
- 3.4.10. STOP TIMING - The controller shall be provided with an input, such that when activated, causes timing in the current interval to stop.
- 3.4.11. MANUAL CONTROL - Means shall be provided to enable an external circuit to advance the controller through intervals of the normal signal sequence. The controller will be "STOP TIMED" when under manual control by means of selector switch(s) in the controller cabinet. When under manual controller, it shall not be possible to alter the timing of the YELLOW and ALL RED clearance intervals. Provisions should be included to optionally "protect" pedestrian clearance while under manual control
- 3.4.12. START-UP - Means shall be provided to configure the controller to initialize in the following sequence of modes:
- POWER-UP-FLASH mode (0-250 Seconds)
  - START-UP ALL-RED mode (0-250 Seconds)
  - Define the beginning of GREEN, YELLOW or RED intervals on selected phase(s)
- 3.4.13. Initialization shall occur after power interruptions. Activation of EXTERNAL START input of controller shall cause the controller to skip Power-Up-Flash / Start-Up All-Red modes and Phase Start Up in the selected phase intervals.
- 3.5. OVERLAPS
- 3.5.1. As a minimum, the controller shall provide four (4) internally generated overlaps, designated as (A, B, C and D). The overlaps shall provide Green, Yellow and Red outputs and shall be individually programmable, allowing for standard,

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protective-permissive, lead, lag, extension, or provide extended green time for the parent phase.

- 3.5.2. The protected-permissive overlap shall blank during the 'protected' phase green, display amber during the 'protected' phase amber/red clearance interval and follow the display of the green/amber/red of the 'permissive' parent phase.
- 3.5.3. The CU shall be capable of pedestrian overlaps, allowing pedestrian displays to overlap any combination of phases with a pedestrian movement.
- 3.5.4. Controllers shall provide a means for the timing of a fixed "Signal Ahead Warning" interval prior to the end of the GREEN interval of the phase. An output that signals the start of this "Signal Ahead Warning" interval shall be provided that can be used to turn on "Signal Ahead Warning" beacons on the roadway. This output signal shall be off at the start of the phase GREEN interval.

### **3.6. COORDINATION**

- 3.6.1. As a minimum, the CU will provide for an internal coordinator. The coordinator will accept commands from Hardwire interconnect systems, Time Base programs and / or from the System interface. The coordinator will contain a minimum of 16 timing plans, each with independently defined cycle length, phase splits, and 3 offsets.
- 3.6.2. The reference point / synchronization source for each of the coordination cycle clocks shall be midnight (00:00) of each day. The CU coordinator will automatically perform the offset adjustments required to bring the controller back into coordination with the network. It should be possible to define when the offset correction takes place.
- 3.6.3. Splits and offsets shall be defined by "seconds" (0-255) in one-second increments. Definition of splits and offsets in percentages of cycle lengths is not acceptable.

### **3.7. TIME BASE CONTROL**

- 3.7.1. The controller will maintain an accurate Time-of-Day/Date clock calendar, which shall be used for all Time Base control. This clock shall have back-up facilities to recover from power outages of up to 30 days. The clock shall track the 60Hz line and make corrections each midnight. The controller should also support synchronizing the controller TOD clock to a WWV time source automatically.
- 3.7.2. The clock/calendar shall provide for automatically making Daylight Savings adjustments as per the standards adopted throughout North America (Ahead - 02:00 Second Sunday March, Back – 02:00 First Sunday November). The clock/calendar shall automatically make adjustments for leap years. Vendor shall provide support for any future changes to Daylight Savings standards.

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- 3.7.3. The controller shall provide for definition of at least 48 Time-of-Day events/commands/programs. Each event / command shall define the state of all the available features, scheduled time and date (1- minute resolution, 24-Hr format) and classification type. An event type can be classified as occurring: every day, weekdays, weekend days, a particular day of week (Mon, Tues, ....., Sun), or as a "one time event" (Special Event) occurring on a specific date. Events/commands/programs remain in effect until superseded by another event. (Exception: One-Time-Events override other types of events and remain in effect until clock passes through midnight.)
- 3.7.4. The time-based control shall include optional selection of the following minimum features:
- control of CNA-1, CNA-2, Walk Rest Modifier
  - control of Phase and/or PED OMITS
  - control of MIN/MAX/PED Recalls per Phase
  - control of MAX2 select per Phase
  - control of Phase Rotation (Lead/Lag)
  - control of 3 auxiliary solid state outputs (Special Functions)
  - control of "FLASH" mode
  - Time control of "Free Mode" / "Coordinated"
  - Data Collection: collect detector data on time-of-day, day-of-week basis. Collect volume and occupancy data during user defined 1-255 minute sample periods. Retain last 64 sample periods, new data overwrites oldest data

Note: Some of these functions/features may alternately be provided via the coordinator.

### **3.8. PREEMPTION**

- 3.8.1. At a minimum, the CU shall include pre-emption capability, outlined in NEMA Standards Publication TS2 - 2003 v02.06, Section 3.7, having 6 unique pre-empt programs.
- 3.8.2. The pre-empt programs shall accept commands from 6 inputs and provide 6 status outputs indicating when that pre-emption is active.
- 3.8.3. The pre-emption inputs and outputs shall be capable of being assigned (re-mapped) to any input or output pin.
- 3.8.4. The pre-empt routines shall provide for safe operation during the transition states.
- 3.8.5. The pre-emption program shall provide for setting priorities of the pre-emption inputs (Example: Railroad Pre-empt highest priority, Emergency Vehicle(s) successively lower ranked priority, Transit priority, etc.).

### **3.9. PROGRAMMING**



## SPECIFICATION FOR TS2 TYPE 1 FULLY ACTUATED TRAFFIC SIGNAL EQUIPMENT

- 3.9.1. The controller shall provide for the programming of all signal timing intervals and/or controller operating parameters. All data will be entered via a keypad on the front panel - no switches, jumpers, or circuit boards will be used to define controller operations. It shall be possible to determine and modify parameter settings without interrupting the operations of the controller.
- 3.9.2. The controller shall have a simple, logically set out method of entering data. Clearly identifiable mnemonics shall be used to aid in data entry and examination. A clear visual indication of data elements being edited shall be provided. An indication confirming acceptance of data entered will be provided. The controller will incorporate data entry error checking - it will not accept illegal/inappropriate data for parameters.
- 3.9.3. All displays/indicators shall be LCD devices and easily readable in outdoor lighting conditions. The display shall also have back-lighting so that the display is visible in low light conditions.
- 3.9.4. Displays/indicators shall be provided and appropriately identified to determine the status and operation of the controller. As a minimum, the displays/indicators shall provide the following information:

### Controller:

- Phase(s) currently in service
- Phase(s) to be serviced next
- Type of interval(s) currently being timed
- Time remaining in displayed interval(s)
- Presence of VEH and PED. calls on each phase
- Phase termination type: a) GAP OUT b) MAX-TIME OUT
- Status of controller inputs

### Coordinator:

- Cycle length, Offset, Split presently in use.
- Current value of local or master cycle counter
- Indication of master cycle '0' point.
- Co-ordination ON/OFF (Free/Coord)

### Time-of-Day:

- Current Time-of-Day (24-Hr. format)
- Current Date (Day, Month, Year), Day of week (Mon,Tues..)
- T.O.D. ON/OFF
- Current Event/Command/Program in effect

**3.9.5. The Controller shall provide logic statement programming.**

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As a minimum this logic program shall include:

- 100 Logic Statements (AND/OR/NAND/NOR/XOR Operations)
- The ability to access all input and output signals
- The ability to change all input and output signals
- IF/THEN/ELSE logic statements

## 3.10. NTCIP REQUIREMENTS

- 3.10.1. The CU shall be capable of supporting the requirements specified by the current edition of the National Transportation and Communication for ITS Protocol (NTCIP) Standards (Refer to NEMA Standards Publication TS2 - 2003 v02.06 - Section 3.3.6).
- 3.10.2. The CU shall be capable of complying with requirements of Conformance Group Level 2 for supporting data elements from NTCIP1201 – Global Object Definitions and NTCIP 1202 – Actuated Signal Control.
- 3.10.3. The CU shall be capable of complying with the standards specified for the communication protocols for the Simple Network Management Protocol (SNMP) and the Simple Transportation Management Protocol (STMP).
- 3.10.4. The CU shall be supplied with a built in Ethernet Port.

## 4. MALFUNCTION MANAGEMENT UNIT (MMU)

### 4.1. TS2 REQUIREMENTS

- 4.1.1. The MMU shall meet the current requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 4.

### 4.2. FUNCTIONALITY

- 4.2.1. The MMU shall check for potential conflicts of all GREEN, YELLOW and WALK signal indications at the field connection terminals. The MMU shall also detect absence of any required RED signal voltage at the field connection terminals and monitor the presence of proper controller operating voltages.
- 4.2.2. Upon detection of conflicting indications or improper operating voltages, the MMU shall place the signals in an emergency flash condition and simultaneously apply "STOP TIME" to the controller.
- 4.2.3. The MMU shall be so designed that only a manual resetting will allow the intersection to revert to normal operation following detection of a fault. The MMU shall require manual resetting if a power outage occurs after the fault has been detected. The MMU shall not require resetting after a power failure if a fault has not been detected prior to loss of power.

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4.2.4. The MMU for the TS2 TYPE 1 controller assemblies shall operate as a Type 16 unit. Each channel shall consist of three (3) 120 VAC inputs - GREEN, YELLOW, and RED. Each channel shall be fully programmable.

4.2.5. In addition to the standard NEMA features, the MMU shall also:

- detect violation of Minimum Clearance interval timings
- detect simultaneous Green and Yellow indications on the same channel
- detect simultaneous Green and Red indications on the same channel

4.2.6. The MMU should come complete with user friendly diagnostic software, capable of running on Windows 2000/NT/XP operating systems. The software should be capable of setting the real time clock, retrieving MMU event logs, and printing out the MMU's current settings & configuration.

4.3. PHYSICAL

4.3.1. The MMU shall have front panel mounted indicators to provide a real-time, visual display of the signal status of each channel and of each input of that channel. The display shall be "latched" to indicate the status at the time of the failure.

4.3.2. The MMU shall be contained in an enclosure separate from that of other equipment in the cabinet and shall be designed for placement on a shelf.

4.4. INTERFACE

4.4.1. The MMU shall contain a PORT 1 (SDLC) connector, meeting the requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 4.3.

4.4.2. Connectors A&B of the MMU will be through approved quick-disconnect MS-type connectors and harnesses such that it is directly pin-plug interchangeable with other monitors of like type.

4.5. COMPATIBILITY

4.5.1. Programming of compatibility between channels of the MMU shall make use of a universal removable programming card, interchangeable with other monitors of like series.

4.6. CANADIAN FAST FLASH

4.6.1. The MMU shall support the requirements of the Canadian Fast Flash Standard. The Canadian Fast Flash consists of a flash rate of 100 to 120 beats / minute. Refer to MUTCD for Canada, Section B3.2.4, Table B3-2. This requirement supersedes NEMA Standards outlined in TS1-1989 Section 6.12.

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- 4.6.2. The MMU shall NOT trip for single instances of concurrent conflicting signals present for less than 120 milliseconds. This is to ensure that the monitors do not trip unnecessarily on transient signals (Non-NEMA).
- 4.6.3. The MMU MUST trip when conflicting signals present for more than 250 milliseconds. The MMU may or may not trip on conflicting signals present in the range of 120 to 250 milliseconds (Non-NEMA).
- 4.6.4. MMU MUST trip when conflicting FLASHING signals are present. The monitor MUST sense FLASH rates in the range from 60 to 200 beats / minute with an ON/OFF duty cycle of 50% ± 10%.

**5. TERMINALS & FACILITIES**

**5.1. GENERAL**

- 5.1.1. The Cabinet's Terminals and Facilities supplied shall conform to the standards outlined in the current NEMA Standards Publication TS2 - 2003 v02.06, Section 5. The TF will support TS2 Type 1 Controller Units, MMU type 16, BIU rack, BIU interface, SDLC panel, TS2 Power Supply, Rack Mount Detectors, Detector Panel, and Power Distribution Panel.
- 5.1.2. The Cabinet Assemblies will be supplied without Controllers, Malfunction Management Units, Bus Interface Units, TS2 power supplies, detectors, load switches, flashers and flash transfer relays. Other plug-in items such as, fuses, circuit breakers, status relays, etc shall be supplied.
- 5.1.3. All panels in the cabinet's Terminal and Facilities shall come with a powder coating finish. Other types of finishing may be considered.
- 5.1.4. All panels, components and modules shall be identified using a permanent marking system.

**5.2. WIRING**

- 5.2.1. Each piece of equipment shall have its own, separate, easily identifiable harness(s). All wires in a given harness will be bundled together and will be protected against abrasion (e.g.: use of braided-nylon cable sleeving)
- 5.2.2. All harnesses shall have the full complement of wires. All MMU harness shall be full populated. Unused wires shall be tied back and accessible from the front of the cabinet for future use. Each individual unused wire shall be clearly labelled / identified.
- 5.2.3. Door harness wire shall be of the low temperature type and be rated for -40°C to +74°C. All wiring elsewhere in the cabinet shall have a minimum rating of -10°C to +90°C.

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- 5.2.4. All critical circuits shall be wired directly to terminal blocks by using, crimp style, spade lugs. Unless otherwise approved, the use of intermediate, quick disconnect, connectors, will not be acceptable. Critical circuits are those related to traffic signal inputs/outputs, monitoring, and power supplies. Examples of critical circuits are; output or input field terminals, maintenance panel, police panel, power distribution panel.
- 5.2.5. All solder joints within the CA shall be electrically and mechanically sound, clean, free of resin and properly made. All solder joints / terminals shall be inspected prior to final assembly of the CA. CAs with poorly made solder joints or damage to insulation will be rejected.
- 5.2.6. The Contractor shall supply information detailing the Quality Assurance program in place for soldering and assembly of the various components / module that make up the CA. At the request of the City, the Contractor shall arrange for an inspection of the modules prior to completing the assembly.

**5.3. CONNECTORS / TERMINALS**

- 5.3.1. All electrical connections to the controller unit (CU) and conflict monitor (MMU) shall be made through approved multi-terminal MS connectors and wiring harness. The cabinet harness MS connectors shall be ITT / Cannon KPT / KPSE Series connectors, or equivalent.
- 5.3.2. All terminal blocks shall be permanently identified and labelled A or B side and each terminal shall be clearly labelled.
- 5.3.3. Each wire shall connect to terminal blocks via its own individual solderless lug (no doubling up).
- 5.3.4. All insulated Crimp style lugs (spade & ring) used through out the CA shall be of the nylon type. Each lug shall be sized appropriately for the screw and wire size.
- 5.3.5. Unless otherwise approved, the sockets for the traffic signal load-switches, flashers and flash transfer relays, shall be Beau-Vernitron shallow bracket series 5400.

**5.4. LAYOUT**

- 5.4.1. For general layout of the terminal facility components, refer to Figure 1 of this specification, in appendix A.
- 5.4.2. The BIU / controller interface, BIU rack, Load switches, Flash Transfer Relays, Flasher, Auxiliary Relay, Flash Programming Terminals, Monitor Programming Terminals and Field terminals shall be located on one panel (Load bay) on the back wall, on the lower half on the traffic cabinet.

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- 5.4.3. The Power Distribution Panel shall be located on the lower right portion of the traffic cabinet and contain the Main disconnect.
- 5.4.4. The SDLC panel shall be located just above the Power distribution Panel on the right side.
- 5.4.5. The Detector Panel and Auxiliary Panels shall be located on the lower left portion of the traffic cabinet.
- 5.4.6. An area shall be provided just above the Detector panel for a system communication panel on the left side of the cabinet. The system communication panel is not part of this specification. This panel is approximately 177mm H x 330mm W (7"H x 13"W).
- 5.4.7. The Traffic Controller and MMU shall be located on the bottom shelf.
- 5.4.8. The Detector Rack and TS2 power supply shall be located on the top shelf.

**5.5. CONFIGURATION**

- 5.5.1. For general Terminal Facility (TF) configuration, refer to Figure 2 of this specification, in Appendix A.
- 5.5.2. The 8-phase / 42 circuit Terminal Facility (TF) shall accommodate fourteen (14) load switches providing forty-two (42) signal outputs, six (6) flash transfer relays, one (1) 204 flasher, and one (1) auxiliary relay.
- 5.5.3. The 8-phase / 42 circuit Terminal Facility (TF) shall be initially configured with the following load relays:
  - Load Relay #1-#8: Phase 1 thru Phase 8 VEH
  - Load Relay #9-#12: Even Phase PEDS (Red/Green) & Spares (Yellow)
  - Load Relay #13-#14: Auxiliary (e.g.: OLP's, Audible Ped / Signal Ahead)
- 5.5.4. Load Switch #13 and #14 shall have a separate fuse block supplying them.
- 5.5.5. An extra fuse block (spare) shall be added for auxiliary items and shall be fed from the line filter.
- 5.5.6. The main panel (load bay) shall be hinged at the bottom allowing the panel to tilt forward, allowing access to the back of the panel, or be mounted and wired in such a way to allow easy removal for accessing the back of the panel.
- 5.5.7. The cabinet TF shall be wired in such a way that modifications to the initial configurations can be easily carried out for specific applications.

**5.6. TYPE 1 CONTROLLER INTERFACE**

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- 5.6.1. The Type 1 TF shall use Bus Interface Units, (BIUs) conforming to Section 8 of this specification for all CU input and output functions.
- 5.6.2. The I/O Terminal strips/blocks provided, for the Type 1 interface, shall be single row 20 position barrier feed-through solder terminal type. (Marathon 1697GP or equivalent) Terminal blocks shall be arranged in such a way that they will not interfere with the entrance, routing and connection of incoming conductors.
- 5.6.3. For detailed information on the BIU interface panel, inputs and outputs, refer to Figure 16, in Appendix A.

**5.7. BUS INTERFACE UNIT (BIU) RACK**

- 5.7.1. A BIU rack shall be provided to accommodate up to 3 BIUs. The BIU rack shall meet the minimum requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 5.3.1.4.
- 5.7.2. A dual row 64 pin female DIN 41612 type B connector shall be provided for each BIU position. Card guides shall be provided for each BIU, top and bottom. The BIU address pins shall be wired appropriately for each rack position.
- 5.7.3. The BIU rack shall be wired to provide 8 pedestrian inputs to the detector panel.

**5.8. SDLC PANEL**

- 5.8.1. The TF shall come complete with a central panel to terminate the SDLC communication cables. The SDLC panel shall be approximately 102mm H x 254mm W (4"H x 10"W).
- 5.8.2. An appropriate terminal block or connector shall be used to terminate all SDLC cables.

**5.9. FLASH PROGRAM TERMINAL BLOCK**

- 5.9.1. It shall be possible to configure the flash of either YELLOW or RED to any signal circuit by means of jumpers on a Flash Program (FP) terminal block(s). The terminal blocks shall be two-position barrier feed-through solder terminal type (Marathon 601-2104 series or equivalent), rated for the appropriate amperage. Changing flash programming by moving wires around on the field terminals is not acceptable. Spare terminals may be used for other things like spare FTR, or relay contact points.
- 5.9.2. For detailed information on the FP terminal block, refer to Figure 16, in Appendix A, of this specification.

**5.10. MMU PROGRAM TERMINAL BLOCK**

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5.10.1. It shall be possible to terminate unused MMU channel, RED inputs to 120V AC+ (Tie Reds High) by means of a jumper on a MMU Programming terminal block(s). The MMU terminal block will also allow other MMU channel inputs, to be removed from signal circuits, by means of a jumper. The terminal blocks shall be two-position barrier feed-through solder terminal type (Marathon 601-2104 series or equivalent), rated for the appropriate amperage. Tying REDS high at the field terminals or lifting monitor wires to remove them from the signal circuits is not acceptable. Spare terminals may be used as termination points for other MMU functions, such as MMU AC power and Fault Relay, Start Delay contacts.

5.10.2. For detailed information on the MP terminal block, refer to Figure 16, in Appendix A, of this specification.

**5.11. FIELD TERMINALS**

5.11.1. Heavy duty barrier terminal blocks shall be used for the traffic signal field terminals and they shall be capable of accepting up to four (4) #14 AWG solid conductors. Rail mount terminal blocks are not acceptable. Heavy duty, dead front, Marathon 1500 series field terminal blocks, with removable link, shall be used. Alternately, Marathon 1100 series blocks may be considered.

5.11.2. The signal output field terminals shall be located near the bottom of the cabinet, no less than 5-inches from the bottom of the cabinet.

5.11.3. The field terminal blocks shall consist of two (2), 12 position blocks and one (1), 8 position terminal block.

5.11.4. Field terminals 1-24 shall be used for phase 1 – 8 RAG signal outputs. The signal outputs shall be configured for GAR from left to right, for each phase.

5.11.5. Field terminals 25-32 shall be used for pedestrian phases 2, 4, 6, 8. Walk, Don't Walk. The signal outputs shall be configured for W, DW from left to right, for each pedestrian phase. (Due to cabinet width limitations and the interest of saving space the PED Clearance outputs have not been provided at the field terminals)

**5.12. POWER SUPPLY UNIT (PSU)**

5.12.1. The TF shall include a power supply to provide regulated DC power, unregulated AC power and a line frequency reference for the Detector Rack, BIUs, load switches, and other auxiliary equipment. The power supply shall meet the minimum requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 5.3.5.

5.12.2. The power supply shall not exceed 152mm high x 216mm deep (6.0" high by 8.5" deep).



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5.12.3. The power supply harness shall be terminated on a terminal block at the Power Distribution Panel.

5.13. DETECTOR RACK

5.13.1. The TS2 Type 1 M cabinet shall include an 8 channel detector rack. The TS2 type 1 P cabinet shall include a 16 channel detector rack. The detector rack(s) shall meet the minimum requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 5.3.4.

5.13.2. The detector rack shall not exceed 152mm high x 216mm deep (6.0" high, by 8.5" deep).

5.13.3. The detector rack shall provide dual row, 44 terminal, Cinch Jones, card edge connectors (50-44A-30M) or equivalent, centred vertically, in the detector rack for each detector. A dual row 64 pin female DIN 41612 type B connector, shall be provided and centred vertically, for one BIU. Card Guides shall be used on the top and bottom of the detector rack for each connector position.

5.13.4. The detector rack shall be wired to provide minimum of 8 vehicle calls to the detector panel.

5.14. DETECTOR PANEL (Field Terminals)

5.14.1. A designated Detector Panel shall be provided for field loop inputs. The detector panel shall be mounted on the lower left side of the Traffic Cabinet.

5.14.2. In the interest of reliability and saving space in the Traffic Cabinet, the Detector Panel should consist of a Printed Circuit board, with PC mount terminal blocks for the field loop terminations, mounted on one panel.

5.14.3. The M1 cabinet detector panel shall accommodate field terminations for 8 channels of loop detection. The P2 cabinet detector panel shall accommodate field terminations for 16 channels of loop detection. Three adjacent field terminations shall be provided for each loop input.

5.14.4. The 8-channel detector panel shall be approximately 203mm H x 254mm W (8"H x 10" W). The 16 channel detector panels shall be approximately 381mm H x 254mm W (15"H x 10"W).

5.14.5. The detector panel shall be wired to the detector rack with a minimum of 20awg, 19 strands, twisted pair cable, for each detector channel.

5.14.6. The detector panel shall also provide terminals for 8 optically isolated pedestrian inputs. If pedestrian inputs are not allowed for on the detector panel, then a separate panel with appropriate terminals will be provided.

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5.14.7. The detector panel shall include vehicle detector test switches for 8 vehicle phases and there shall be (4) pedestrian test switches. Each switch shall be a 3-position toggle switch: ON, OFF and spring loaded momentary ON. Mounting these test switches on the Maintenance Panel, or other panel, may be considered.

5.15. POLICE PANEL

5.15.1. A small recessed police panel with a separate access door shall be contained within the front door of the cabinet. The police panel shall be equipped with a lock keyed for a standard police key. Two (2) keys shall be supplied with each cabinet.

5.15.2. Refer to Figure 3 in Appendix A, of this specification for approximate size of police panel and door.

5.15.3. The police panel shall contain the following:

- A clearly labelled SIGNAL ON/OFF 2-position toggle switch
- A clearly labelled SIGNAL AUTO/FLASH 2-position toggle switch
- A clearly labelled SIGNAL AUTO/MANUAL 2-position toggle switch
- A handheld pushbutton switch mounted on a 1 meter coiled/retractable cord

5.15.4. The SIGNAL ON/OFF switch shall cause all signal displays to be turned off and remove AC power to the controller.

5.15.5. The SIGNAL AUTO/FLASH switch shall cause the signal to be placed in a flashing operation and remove AC power to the controller.

5.15.6. The SIGNAL AUTO/MANUAL switch shall cause the controller to be operated in the manual mode. The handheld pushbutton shall advance the controller through intervals of the signal sequence. It shall NOT be possible to advance the controller through the clearance intervals.

5.16. MAINTENANCE PANEL

5.16.1. The cabinet shall include a maintenance panel mounted inside on the main door containing the following:

- A GFCI (Ground Fault Circuit Interrupter) duplex convenience outlet
- A labelled SIGNALS ON/OFF 2-position toggle switch
- A labelled SIGNALS AUTO/FLASH 2-position toggle switch
- A labelled SIGNALS AUTO/MANUAL/ADVANCE 3-position toggle switch
- A labelled CONTROLLER ON/OFF 2-position toggle switch
- A labelled STOP TIME 2-position toggle switch
- A labelled Vehicle and Pedestrian detector test switches

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- 5.16.2. The SIGNALS ON/OFF switch shall cause all signal displays to be turned off and shall NOT apply "STOP TIMING" or remove AC power to the controller.
- 5.16.3. The SIGNALS AUTO/FLASH switch shall cause the signals to be placed in a flashing operation and shall NOT apply "STOP TIMING" or remove AC power to the controller.
- 5.16.4. The SIGNALS AUTO/MANUAL/ADVANCE switch shall cause the controller to be operated in the manual mode. The third switch position shall be a spring-loaded momentary contact type and shall serve as an interval advance. It shall NOT be possible to advance through clearance intervals.
- 5.16.5. The CONTROLLER ON/OFF switch shall remove AC power to the controller and cause the signals to be placed in flashing operation subject to position of SIGNALS ON/OFF switch.
- 5.16.6. The STOP TIME switch shall apply "STOP TIME" to the controller (All Rings).
- 5.16.7. Refer to Figure 4, in Appendix A of this specification for details on AC switching control.
- 5.16.8. Refer to Figure 5, in Appendix A of this specification for details on DC switching control.

**5.17. FLASH CIRCUITS**

- 5.17.1. Separate Flash control circuits shall be provided within the cabinet. Each flasher unit shall provide two (2) circuits for the alternate opening and closing of connections between applied power and the signal circuits required for flashing operation. The flasher sockets shall be a Beau-Vernitron S5406-SB socket.

The solid-state flashers shall conform to the 15 AMP Dual Circuit Flasher as per NEMA Standards Publication TS2 - 2003 v02.06, Section 6.3. (For information only – flashers not supplied as part of this procurement – purchased separately).

- 5.17.2. Electro-mechanical Flash Transfer Relays shall transfer field signal light circuits from the load switches to the flasher. Flash Transfer Relay sockets shall be a Beau-Vernitron S5408-SB socket. Flash Transfer Relays shall be DE-ENERGIZED during flash operation.

The flash transfer relays shall conform to the NEMA Standards Publication TS2 - 2003 v02.06, Section 6.4. (For information only – flash transfer relays not supplied as part of this procurement – purchased separately).

- 5.17.3. The flash control circuit shall be wired in a "fail-safe" manner such that the signals shall automatically revert to and remain in flashing operation whenever the Controller and/or Conflict monitor is disconnected. (Refer to Figure 4 in Appendix A of this specification.)

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5.17.4. It shall be possible to completely remove the controller or auxiliary equipment for inspection or maintenance when the flashing feature is energized without disturbing the flashing feature.

5.17.5. Auxiliary Relay 1 shall be wired in such a way that +120VAC "FLASH STATUS" point on a terminal block shall be available to report to a communication unit the state of the Flash Transfer Relay. This point shall be "ON" (+120VAC) when the Flash Transfer Relay is de-energized.

5.18. GENERAL ELECTRICAL

5.18.1. Outgoing traffic control signals shall be of the same polarity as the line side of the power supply; the common return of the signal circuits shall be of the same polarity as the ground side of the power supply.

5.18.2. The ground side of the power supply shall be grounded to the controller cabinet in an approved manner. Separate ground strips must be connected by #8 AWG stranded conductors.

5.18.3. All wires/cables shall be appropriately sized to carry the current rating of the device or circuit breaker.

5.19. POWER DISTRIBUTION ASSEMBLY (PDA)

5.19.1. Refer to Figure 6, in Appendix A, for detail on Power Distribution and branch circuit protection.

5.19.2. The PDA shall be mounted, in the lower right side, of the enclosure. The PDA shall contain, the Main Disconnect, Circuit Breakers, over current protection, Course and Fine Surge/ Transient Protection, Line Filtering, and Mercury Contactor.

5.19.3. The Power Panel including the Main disconnect shall be approximately 432mm H x 356mm W (17"H x 14"W). (refer to Figure 7 in Appendix A of this specification, for preferred shape and size of power panel.)

5.19.4. The main disconnect breaker shall be housed in a panel designated as being a "Service Entrance" panel (Square D 70 Amp Load Centre #QO2L70S Series G1 or equivalent). The service supply cables and grounding shall enter this panel from the bottom. Wiring to feed the rest of the cabinet shall exit this panel from the top or side. The main disconnect breaker shall be a 40 Amp double pole breaker (Square D #QO250).

5.19.5. The PDA will come complete with CB1 and CB2 breakers. CB1 breaker shall be fed from the main disconnect breaker. This breaker will feed power through the transient suppression devices, through the over current protection fuses, and then on to the traffic signal equipment via a mercury contactor -- refer to NEMA

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"Signal Bus" TS2-5.4.2.3 and Figure 6 in Appendix A of this specification. CB2 breaker shall feed fan, heater, GFCI, cabinet lamp and accessories.

- 5.19.6. The PDA will contain over current protection for all branch circuits in the CA (such as the AC supply to the Load-switches, flashers, and control equipment). These devices shall be fast acting over-current protection. Where fuses are used in place of circuit breakers, the fuse blocks shall be a dead front style, or panel mount fuses, where live circuits are protected from contact.
- 5.19.7. The Power Panel shall come complete with a removable clear lexan guard. (Refer to Figure 8 in Appendix A of this specification for general size and shape.)
- 5.19.8. Transient Suppression Devices shall be connected to the load side of the traffic signal equipment breaker CB1 to provide AC service surge protection, lightning protection and radio interference suppression.
- 5.19.9. The PDA shall contain a neutral bus terminal for field connections with at least 24 terminals. This neutral bus shall be isolated from chassis ground.
- 5.19.10. The PDA shall contain a ground bus terminal for field connections with at least 24 terminals and grounded to cabinet, chassis ground.

### **6. AUXILIARY DEVICES**

As a minimum, the auxiliary devices shall meet the current NEMA Standards Publication TS2 - 2003 v02.06, Section 6.

#### **6.1. LCD INDUCTIVE LOOP DETECTOR**

- 6.1.1. As a minimum, the inductive loop detector shall meet the NEMA standards for 2 Channel Type C rack mount detectors.
- 6.1.2. The detector unit shall contain solid state outputs.
- 6.1.3. The detector shall have a backlit LCD display and provide feedback of channel frequency and sensitivity settings.
- 6.1.4. The LCD display shall provide access to detector diagnostics.

**6.1.5. The detector shall have run, extend and delay functions on the same loop.**

#### **6.2. THREE-CIRCUIT SOLID STATE LOAD SWITCH**

- 6.2.1. The traffic signal load switching shall be accomplished by means of a plug-in solid state 10 Amp load switching devices. The load switches shall mate with a Beau-Vernitron S5412-SB socket. The front panel of the load switch shall be provided with indicators, to indicate the state of each input circuit. The load switch shall meet all NEMA Standards Publication TS2 - 2003 v02.06, Section

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6.2. (For information only – load switches not supplied as part of this procurement – purchased separately).

6.2.2. The Load-switch shall have LED displays for both (Red-Amber-Green) inputs and outputs.

**6.3. SOLID STATE FLASHER**

6.3.1. Each flasher shall provide two (2) circuits for the alternate opening and closing connections between applied power and the signal lamps required for flashing operation. The flasher shall mate with a Beau-Vernitron S5406-SB socket. The solid-state flashers shall conform to the 15 AMP Dual Circuit Flasher as per NEMA Standards Publication TS2 - 2003 v02.06, Section 6.3. (For information only – flashers not supplied as part of this procurement – purchased separately).

**6.4. FLASH TRANSFER RELAY**

6.4.1. Electro-mechanical Flash Transfer Relays shall transfer field signal light circuits from the load switches to the flasher. These relays shall be covered so that electrically alive parts are not exposed. Flash transfer relays shall mate with a Beau-Vernitron S5408-SB socket. The flash transfer relays shall conform to the NEMA Standards Publication TS2 - 2003 v02.06, Section 6.4. (For information only – flash transfer relays not supplied as part of this procurement – purchased separately).

**7. CABINETS**

**7.1. GENERAL**

7.1.1. There are two sizes of NEMA traffic cabinets required. In this specification there is detailed information for the M1 and P2 cabinets. Where information has not been provided for P2 cabinets, the same standards shall be applied to both cabinets.

**7.2. NEMA REQUIREMENTS**

7.2.1. Cabinet enclosure and exterior seams shall conform to the NEMA Standards Publication 250-1991 for NEMA Type 3R enclosures.

**7.3. CABINET MOUNTING**

7.3.1. Type "M1" and Type "P2" Cabinets will be designed to be base-mounted on a concrete foundation. The cabinet mounting brackets shall be so constructed to be compatible with the mounting holes as per "M1 CABINET CONTROLLER BASE" drawing (Figure 9 in Appendix A of this specification) and "P2 CABINET CONTROLLER BASE" drawing (Figure 10 in Appendix A of this specification).

**7.4. DIMENSIONS**

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7.4.1. Type "M1" cabinet dimensions shall not exceed:

- 84 cm W x 147 cm H x 46 cm D (33" x 58" x 18").

NOTE: The preferred dimensions of the M1 cabinet shall be 84 cm W x 140 cm H x 46 cm D (33" x 55" x 18")

7.4.2. Refer to Figure 11 in Appendix A of this specification for overall dimensions of the M1 cabinet shell.

7.4.3. Type "P2" (2 door) cabinet dimensions shall not exceed:

- 112 cm W x 147 cm H x 66 cm D (44" x 58" x 26").

NOTE: The preferred dimensions of the P cabinet shall be 112 cm W x 140 cm H x 66 cm D (44" x 55" x 26")

7.4.4. No figures have been provided in Appendix A of this specification, for the P2 Traffic Cabinet.

### 7.5. CONSTRUCTION

7.5.1. The cabinet shall be constructed entirely from 3mm (0.125") thick, type 5052-H32, marine grade aluminum. Seam welds must be neatly formed, continuous and smooth, must be sealed and must not be visible from cabinet exterior. Interior seams / welds must be neat, clean and free of spatters and rough edges. All welds shall be finished to acceptable finish to meet powder coating requirements.

7.5.2. The aluminum cabinet shall provide weather and dust protection with adequate strength to provide reasonable vandalism protection for the traffic control equipment. The cabinet shall meet the requirements of a NEMA Type 4 enclosure.

7.5.3. M1 and P2 cabinets shall include two (2) shelves mounted to the vertical unistrut, on the cabinet side walls, with spring nuts and carriage bolts.

7.5.4. Space shall be provided for adequate routing and splicing of wires and cables within the cabinet. The wires and cables shall not be subject to kinks or sharp edges.

7.5.5. Not more than 70% of cabinet space shall be utilized, leaving 30% for air circulation.

7.5.6. The Cabinet exterior and interior shall be powder coated with Super Durable Architectural Grade Polyester UV resistant powder coating with a finished

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thickness of 75 to 125  $\mu\text{m}$  (3-5 mils). Color shall be Federal Standard 16473 Light Grey or equivalent.

### 7.6. REMOVABLE UNISTRUT

7.6.1. The cabinets shall include removable, rail mounted (top and bottom) unistrut. The cabinet shall contain 2 unistrut mounted vertically on each side wall of the cabinet, and 2 unistrut mounted vertically on the back wall of the cabinet, as a minimum. (Refer to Figure 12 in Appendix A of this specification for detail on Top and bottom unistrut rails / brackets.)

7.6.2. The unistrut shall be T&B superstrut, series B1400 (1-5/8" x 13/16"), aluminum or equivalent. (Refer to Figure 13 in Appendix A of this specification for detail on T&B superstrut.)

### 7.7. CABINET DOORS

7.7.1. The door handle / door shall include locking eyelets to allow an external padlock (MASTER ProSeries #6321 or equivalent) to be installed. Spacing between the door handle grip and the door shall not be less than 40 mm. Distance from the top of the fixed eyelet to the bottom of the eyelet on the handle shall not exceed 15 mm. Distance between the fixed eyelet and main body of the handle shall not be less than 27mm.

7.7.2. The cabinet door shall be equipped with a door stop assembly to hold the door open at approximately 90° and 150°, as a minimum.

7.7.3. The cabinet doors shall be equipped with a louvered filtered vent. The filter shall be a readily replaceable fireproof unit. A metal frame with gaskets shall serve to keep the filter flush and sealed against the cabinet vent. A means shall be provided to close off the vent during winter months. Paper framed filters are not acceptable. (Refer to Figure 3 in Appendix A of this specification for detail on door venting)

**7.7.4. Cabinet door open switch shall be wired to Alarm 1.**

### 7.8. CABINET VENTILATION AND HEATING

7.8.1. The cabinet shall be equipped with a separately fused electric exhaust fan assembly for summer operation. The fan shall be controlled by an adjustable or fixed value thermostat. Manually adjustable thermostats shall be calibrated and labelled to turn on between +25°C and +65°C (increments of 10°C or less). "Fixed" value button or disc thermostats shall turn "ON" at +25°C. Household style thermostats are not acceptable.

7.8.2. The cabinet shall be equipped with a separately fused electrical heater assembly for winter operation. The heater shall be equipped with a guard to protect against burns. This heater shall be mounted on the main door of the cabinet. This heater



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will be 300-350 Watts. (Refer to Figure 14 & 15 in Appendix A of this specification for an example of an appropriate heater bracket and cover.

7.8.3. The heater shall be controlled by an adjustable or fixed value thermostat. Manually adjustable thermostats shall be calibrated and labelled to turn on between -20°C and +10°C (increments of 10°C or less). "Fixed" value button or disc thermostats shall turn "ON" at -10°C.

7.8.4. One dual purpose thermostat switching the fan and heater independently is preferred.

### **7.9. LIGHTING**

7.9.1. The cabinet shall be equipped with a switched, fused lamp to illuminate the inside of the cabinet. The lamp must be mounted in such a way that it does not interfere with accessibility to cabinet components.

### **7.10. QUALITY CONTROL PROGRAM**

7.10.1. The Vendor shall supply information detailing the Quality Assurance program in place for cabinet surface preparation (cleaning, degreasing, etc.) and the application / finishing of the powder coating. At the request of the City, the Vendor shall arrange for an inspection of the product before and after the finish has been applied.

## **8. BUS INTERFACE UNITS (BIU)**

### **8.1. CURRENT REQUIREMENTS**

8.1.1. The BIU shall meet the current requirements of the current NEMA Standards Publication TS2 - 2003 v02.06, Section 8. The BIU shall be Type BIU2, containing the Rack communication port, RX & TX.

## **9. DOCUMENTATION**

### **9.1. MANUALS**

9.1.1. Installation, maintenance and operation manuals shall be formal documents containing the following information pertinent to all equipment supplied in the performance of this contract:

- General description, principles of operation and a thorough explanation of the theory of operation of the equipment and/or the components thereof
- Function of operating controls, operational precautions and operating procedures
- Procedures and techniques for field and/or bench testing to ensure satisfactory operation prior to installation and for post-installation operational-functional checks and repairs

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9.1.1.1. These procedures shall include:

- Adjustment requirements for installation and operation
- Special disassembly and assembly procedures
- Description of tools and/or equipment required for assembly installation, testing and repairing
- Calibration and trouble-shooting data including identification of test points
- Maintenance requirements including schedules where applicable to insure continuous satisfactory service
- Full schematic diagrams, internal and/or interconnecting wiring diagrams

9.1.2. Installation, maintenance and operation manuals should be developed, prepared and arranged in such a manner and in suitable format as to facilitate the training of City personnel.

9.2. CABINET PRINTS

9.2.1. The cabinet wiring diagram/print is to include, for all terminating points within the cabinet, references to every point with which it is directly interconnected (double-ended).

9.2.2. Refer to Figure 16 of Appendix A of this specification for a sample of a double ended wiring diagram.

9.2.3. A digital/electronic version of the cabinet wiring diagram/print shall be provided for each unique cabinet type. These shall be in Microstation \*.DGN format or AutoCAD \*.DWG format.

9.2.4. Three (3) cabinet wiring diagrams/prints and a protective plastic envelope for a print shall be provided with each cabinet supplied.

9.2.5. The cabinet wiring diagram/print is to include, for all control and auxiliary equipment, functional description and identification of input/output pin connections.

9.3. TEST EQUIPMENT LIST

9.3.1. The Vendor shall prepare a listing of those items of test equipment which the Vendor considers necessary for the proper installation and maintenance of the supplied equipment.

9.3.2. Where the Vendor recommends special test equipment, i.e. equipment of special design for the Vendors equipment - the list shall include as a minimum, the following information for each item:

- Equipment or component to be tested
- Firm unit price and quantity recommended

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- Test equipment manufacture and part number
- Manufacturer's name and address

**9.4. REPAIR AND SPARE PARTS**

9.4.1. The Vendor shall provide documentation detailing their process for handling repairs to the equipment supplied. This will address both warranty and post-warranty cases. It shall identify any local support, how and where the product will be shipped, costs, and the turn-around time.

9.4.2. The Vendor shall prepare a listing of those replacement parts which may be required for the maintenance of the equipment supplied for a ten (10) year period. As a minimum, the following must be detailed:

- Part nomenclature and number
- Population per equipment
- Quantity recommended for field use
- Quantity recommended for shop use
- Shelf life
- Estimated annual usage - may be variable quantity
- Price for each quantity recommended - unit and extended

**9.5. GUARANTEE**

9.5.1. The Vendor shall guarantee all equipment and work for a period of at least two (2) years from date of Final Acceptance.

**9.6. TRAINING**

9.6.1. The Vendor shall, at the request of the City, provide for the training of City personnel in the operation and maintenance of supplied equipment. The training shall be provided by qualified instructors and be supplemented by hands-on operation of equipment. Training shall be conducted during normal working hours and in facilities to be provided by the City. Time schedules shall be agreed to by the City. Any cost for any requested training shall be billed as a separate item.

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**APPENDIX A**