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COMPARTMENT

APPENDIX B: CONTROLLER PROGRAMMING SHEET

UPDATE HISTORY			
Version	Section	Notes	Status
V 1.0	Original release - May 2005		
V 1.1	Second release - November 2005		
V 1.2	Third release - June 2007		
V 1.3	Fourth release – Feb 2008		
V 1.4	Special Release with Transit Priority Requirements— August 2008		
V 1.4A	Limited release for reference, not for production – Jan 2009		
V 1.4B	Sixth release – February 2009		
V 1.5	Seventh release – January, 2010		
V1.6	1.	Controller compatible with TransSuite list	ADDED
	4.7	Requirement for 16 Load Switches	ADDED
	6.1	Cabinet Configuration for 16 Load Switches	UPDATED
	6.2.2	Space for a second detector loop input panel	ADDED
	7.10	Pair of “C” Channel	Modified
	9.8	Prototype Cabinet	REMOVED
	9.9	Delivery	REMOVED

1. SCOPE

This specification sets forth the minimum requirements for vehicle and pedestrian traffic signal controller, cabinet, components, and assemblies that will be used with the City of Toronto's traffic control system, TransCore TransSuite system. The following controllers had shown compatibility with TransCore TransSuite system:

- Econolite ASC/3-1000 - TS2 Type1 and ASC/3-2100 - TS2 Type 2
- Econolite ASC/2S-1000 - TS2 Type 1
- Peek Model : Peek 3101 E - TS2 Type 1
- Siemens Eagle Model: EPAC 3668 M51 – TS2 Type 1

Any controllers, other than the above (with firmware versions that have already been successfully passed the system compatibility tests), must demonstrate compatibility with TransCore TransSuite system.

This specification is intended to specify a NEMA TS 2-2003 Type 1 controller and cabinet as defined in the NEMA TS 2-2003 standard. As a minimum, the controller, cabinet (including all components and subassemblies), and operation shall meet or exceed the NEMA standard except as noted herein.

2. REFERENCES

For the purpose of this specification all references to:

- a) 'NEMA standards' shall refer to 'NEMA TS2-2003' and all revisions;
- b) 'The City' shall refer to 'City of Toronto'.

2.1.1. City of Toronto Standards

TTS 804.100	Construction Specification for Cable Installation
TTS 809.100	Construction Specification for Installation of Traffic Signal Controllers
TTS 813.100	Construction Specifications for Grounding

2.1.2. National Electrical Manufacturers Association (NEMA)

TS 2-2003	Traffic Controller Assemblies with NTCIP Requirements (V02.06), hereinafter referenced as TS2
NTCIP 1101:1996	National Transportation Communications for ITS Protocol (NTCIP) Simple Transportation Management Framework
NTCIP 1201:1996	National Transportation Communications for ITS Protocol (NTCIP) Global Object Definitions

- NTCIP 1202:1996 National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Actuated Traffic Signal Controller Units, includes Amendment 1
- NTCIP 2001:1996 National Transportation Communications for ITS Protocol (NTCIP) Class B Profile
- NTCIP 1103:V01.25 National Transportation Communications for ITS Protocol (NTCIP) – Traffic Management Protocols for SNMP and STMP and TRAPS (Section 6)

3. GENERAL TECHNICAL REQUIREMENTS

- 3.1. Any vendors who wish to supply controllers, other than those listed in section 1 of this document, shall provide documentation to verify their compatibility to the TransCore TransSuite System.
- 3.2. The term Vendor, Supplier, Manufacturer, and Bidder all refer to the business entity with which the City will execute a contract for the supply of the traffic control equipment based on these specifications.
- 3.3. Equipment shall conform to the latest revision of NEMA TS2 “Traffic Controller Assemblies with NTCIP Requirements”. This specification amends and clarifies the TS2 specification. Where differences between the TS2 specification and this document occur, this specification shall govern.
- 3.4. Conformance to Ontario Electrical Safety Authority (ESA) or Canadian Standards Association (CSA) is required.
- 3.5. The vendor shall test their equipment according to the standards defined in the TS2 Specification and provide certificates of compliance to the City. Testing will be performed any time any equipment has been substantively altered. The City may require additional testing as determined by the City. The vendor shall supply copies of the test procedures and the certified test results including specific observations, measurements, and test steps, etc. for review by the City.
- 3.6. The vendor shall provide a detailed description of the quality assurance program and procedures that are used for the design, development, production, and testing of all equipment and software which will be provided under this contract. This information shall be provided WITH THE BID DOCUMENTS, and will be reviewed when making the determination of which vendors are qualified to provide products under this contract. If the vendor is certified as an ISO 9000 organization, the vendor shall provide a copy of this certification with the bid and shall certify that the ISO 9000 certification applies for all business units providing materials under this contract.
- 3.7. The vendor shall supply all the required communication components in the controller necessary to communicate with the TransSuite traffic management system. Such components shall be furnished, delivered, and installed by the manufacturer without additional expense to the City.
- 3.8. The apparent silence of the specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished shall be

regarded as meaning that only the best general practice is to prevail and that only the best material and workmanship is to be used. Interpretation of these Specifications shall be made upon that basis.

3.9. Warranty

Equipment shall be under warranty for a minimum of three (3) years from date of delivery.

- 3.9.1. The period of guarantee coverage shall, in no case, be less than the manufacturer's usual and customary guarantee period. All guarantees that are customarily issued by the Bidder and/or manufacturer shall be provided to the City.
- 3.9.2. The City, or its appointee, with the consent of the manufacturer, may, at the Supplier's discretion, make minor repairs. All other repairs under warranty will be made by the manufacturer at no cost to the City.
- 3.9.3. The supplier shall provide all necessary software/firmware updates, at no cost to the City, to correct any problems that arise after the supply of the controllers.

3.10. Long Term Support

The manufacturer shall ensure that the products offered under this contract will be supported for five years after the warranty period. All components, including custom electronic components, shall be available to the City during this period. Should component parts become obsolete or unavailable, the manufacturer shall provide a repair method and required parts at no additional cost to the City.

3.11. Obsolete Components

Components no longer supported by the manufacturer, components not recommended for new designs, components which have been discontinued or which the manufacturer should have reasonably been expected to know were discontinued, shall not be used in the design and construction of any subassemblies provided under this contract.

3.12. Ambient Temperature: Per NEMA TS2

3.12.1. Cabinet Heater

Each cabinet shall be equipped with a heater adequately sized for the cabinet. The heater shall be thermostatically controlled and the circuit shall be fused. The cabinet shall include circuitry that only activates the heater as necessary at low temperatures to ensure all equipment, including LCD displays, function properly.

3.13. Cabinet Ventilation

- 3.13.1. Each cabinet shall be equipped with an electric exhaust fan which shall use ball bearings and have a capacity of not less than 2.83 cubic meters per minute (100 cubic feet per minute). The cabinet shall be provided with a 193 square millimeters (30 square inches) minimum screened exhaust vent. The exhaust fan and exhaust vent shall be located in the underside of the top of the cabinet and shall be completely wired and interconnected.
- 3.13.2. The area of the exhaust vent and the exhaust fan shall be designed to prevent snow or rain from reaching the fan area and from entering the cabinet's main area regardless of

whether the fan is operating. Design of this area shall include baffling to block the entrance of moisture, yet provide adequate ventilation. This area shall also be sloped to drain any moisture that may get into this area from the outside of the cabinet.

- 3.13.3. The fan shall be capable of operating continuously for a minimum of 20,000 hours in a +50 °C (+122 °F) environment without the need for after-installation maintenance, excluding filter replacement.
- 3.13.4. The cabinet fan circuit shall be adequately fused using a time-delay fuse and be labeled as such. The fan terminals shall be insulated or covered so that no parts, having line voltage, are exposed. The fan fuse shall be located in the vicinity of the fan, and shall be attached to the cabinet housing.
- 3.13.5. The fan shall be screened or otherwise protected to prevent personal injury or the inadvertent encroachment of wires or other internal elements which might be damaged or interfere with the operation of the fan.
- 3.13.6. Each cabinet shall be provided with a thermostat to control the operation of the fan or cooling system.
- 3.13.7. The thermostat shall be located on the inside top portion of the cabinet not lower than 150 millimeters (6 inches) from the top of the cabinet. All fan control contacts shall be protected by RFI suppression devices to eliminate the introduction of EMI noise into the cabinet power supply system.
- 3.13.8. The fan construction and fusing shall be designed such that blockage of the exhaust vents shall not cause the fuse to blow or the fan to be damaged or cause the ingress of water or foreign matter to the cabinet.
- 3.13.9. The top of the inside of the cabinet shall be protected so that water does not accumulate and compromise the operation of the electronic equipment in the cabinet.

3.14. LCD Displays

Controllers with LCD display technology shall ensure that the LCD displays will function properly and shall be readable within the full range of specified ambient temperature.

3.15. Document Pouch

The controller cabinet shall include a sealable clear weatherproof pouch with the minimum dimensions of 325 mm by 375 mm with a zipper or snap enclosure on one end. The pouch shall be mounted on the inside of the door below the police door compartment to store diagrams and manuals. The zipper or snap enclosure side of the pouch shall be on the top and shall not interfere with any switches when mounted.

3.16. Printed Circuit Boards

All printed circuit boards shall meet the requirements of the relevant NEMA Standard plus the following requirements to enhance reliability:

- 3.16.1. Both sides of the printed circuit board shall be covered with a solder mask material.

3.16.2. The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin 1 for all integrated circuit packages shall be designated on all printed circuit boards.

3.17. Adhesives

All adhesives used shall have a minimum of twenty (20) years expected life under adverse field conditions. The manufacturer shall not use 'stick-on' retention devices for any purpose unless specifically authorized by the City. The manufacturer may be required to show proof of the life expectancy of the adhesives proposed; such assurances shall be backed by the manufacturer of the adhesive material.

3.18. Components

All equipment and component parts furnished shall be new, be of the latest design and manufacture, and be in an operable condition at the time of delivery. All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.

3.19. Incidentals

The manufacturer shall be responsible for all incidental accessories necessary to make the traffic controllers and all of its elements complete and ready for operation, even if not particularly specified. Such incidentals shall be furnished, delivered, and installed by the manufacturer without additional compensation or expense to the City. Minor details not usually shown or specified, but necessary for the proper installation and operation of the traffic controllers, shall be included in the manufacturer's bid price, the same as if herein specified. By the submittal of a bid, it is understood and agreed by the bidder that the system description provided herein is complete and includes all equipment necessary for the proper functioning of the traffic controller and all equipment, even though every item may not be specifically mentioned.

3.20. Component Availability

No component shall be of such design, fabrication, nomenclature, or other identification as to preclude the purchase of said component from a wholesale electronics distributor or from the component manufacturer, except as noted.

3.21. Fast Flash Operation

Each cabinet assembly shall support Ontario Fast Flash for flashing advanced green indications. The Ontario fast flash rate shall be 150 – 180 flashes per minute.

3.22. Software/Firmware Testing

It is a requirement of this specification that the controllers other than those listed in section 1 of this document shall demonstrate compatibility with the TransSuite traffic management system installed by TransCore and in operation at the City. The controller manufacturer shall develop a detailed test procedure to demonstrate this compatibility and shall be responsible for demonstrating this compatibility on the system installed in the City. This testing shall verify the integrity of the data, performance of the communications timing, support for Dynamic objects (STMP) and interaction with the standard NTCIP data objects. The test procedure shall also

verify the complete TS2 functionality of the controller, the interaction with the cabinet systems (e.g., MMU, BIU), and such performance issues as clock drift, and variability of the communications timing. Each time a controller firmware change is made, it shall be the responsibility of the controller supplier to repeat the complete test to re-verify the proper operation of the unit as identified herein.

4. ADDITIONAL REQUIREMENTS FOR TS2, TYPE 1 TRAFFIC SIGNALS CONTROL UNIT

- 4.1. From the display, a main menu shall allow the user to select sub-menus of the controller. Sub-menus shall then be displayed to allow the user to select various menus, displays, controls, and parameters. Cursor keys shall allow the user to scroll through menus and change the control unit's parameters.
 - 4.1.1. English language and traffic engineering terminology shall be used. The display organization shall allow traffic personnel to program the controller without using reference cards or manuals.
 - 4.1.2. During parameter entry, the new data shall be displayed as it is entered.
 - 4.1.3. All parameters shall be accessible and capable of being programmed through the front-panel keyboard.
 - 4.1.4. Parameters shall be tested for reasonability as they are entered and the user shall be notified of his error when leaving the parameter field. (e.g., Yellow time less than 3 seconds.)
 - 4.1.5. A copy function shall permit copying all timing data from one phase to another. It shall also permit copying all coordination pattern data from one pattern to another.
- 4.2. The controller unit shall provide dynamic displays to indicate the operational status of the controller unit. The displays shall meet the requirements in TS2 ¶ 3.4.7; 3.5.7; 3.6.5; 3.7.4, and 3.8.4.
- 4.3. The log event displays listed below shall provide a historical listing of controller events. The logs shall be available from displays and shall include no less than 100 of the most recent events. The log shall not be lost after a power failure. Each log entry shall include the date and time of the event and record the necessary information where available. (Also refer to TS2 ¶ 3.4.7; 3.5.7; 3.6.5; & 3.7.4)
 - 4.3.1. Local Alarm Log includes switches in the police panel, the cabinet door open switch, and other alarm inputs.
 - 4.3.2. Error Log shall fully document power events, controller restarts, and any MMU and controller-detected faults.
 - 4.3.3. Detector Fault Log saves detector diagnostic type events.
 - 4.3.4. Volume Count Log will note the volume counts for each sample period.
- 4.4. The vendor shall provide a method to upgrade software / firmware (operating system) in the "field" to a new revision. The total time required to install a software / firmware upgrade and

have the controller configuration restored shall not exceed 20 minutes. The total time that the intersection is flashing during upgrades shall not exceed 5 minutes.

- 4.5. The display shall have a minimum of 8 lines by 40 characters. A 16 line by 40 character display is preferred.
- 4.6. User programmed configuration information shall be stored for extended periods. The storage of the configuration shall not depend on batteries or energy stored in capacitors.
- 4.7. The control unit's default load switch assignments shall be configured per TS2 ¶ 5.3.1.4.2. **Sixteen (16)** NEMA Standard Load Switches shall be supplied with each cabinet.
- 4.8. The pedestrian inputs shall be configured per TS2 ¶ 5.3.1.4.2.
- 4.9. At a minimum, Port 2 shall be EIA-232-E (DB-25 connector with female pins) configurable for: (Refer to TS2 ¶ 3.3.2)
 - 4.9.1. Data rates: 1,200 – 38,400 baud
 - 4.9.2. Data formats: 8 bit, no parity; 7 bit, even parity; or 7 bit, odd parity
- 4.10. The control unit shall be able to copy the configuration information from the controller to a laptop computer, save the configuration on the computer's disk, and transfer the same configuration to another controller. The vendor shall supply any software required for upload/download to the control unit from the laptop computer. The vendor shall provide a right to install the software for a minimum ten (10) laptop and/or desk top computers that may be owned by the City and /or the City's representatives.
- 4.11. The control unit shall be able to copy and restore the configuration information directly from control unit to control unit.
- 4.12. At a minimum, Port 3 shall meet all requirements of TS2 ¶ 3.3.3. An Ethernet communication port with a standard RJ45 connector shall be provided.
- 4.13. NTCIP Requirements:
 - 4.13.1. The controller unit shall be compatible with the TransCore TransSuite Traffic Control System.
 - 4.13.2. The controller unit shall support the following conformance groups as defined in NTCIP 1201:1996 and NTCIP 1202:1996 and shown in Exhibit 4-1.

Exhibit 4-1: NTCIP Conformance Table

Conformance Group	Reference	Requirement
Configuration	1201:1996	Mandatory
Database Management	1201:1996	Optional
Time Management	1201:1996	Mandatory
Timebase Event Schedule	1201:1996	Optional
Report	1201:1996	Optional
STMP	1201:1996	Mandatory
PMPP	1201:1996	Mandatory

Conformance Group	Reference	Requirement
Phase	1202:1996	Mandatory
Detector	1202:1996	Mandatory
Volume Occupancy Report	1202:1996	Mandatory
Unit	1202:1996	Mandatory
Special Function	1202:1996	Mandatory
Coordination	1202:1996	Mandatory
Time Base	1202:1996	Optional
Preempt	1202:1996	Mandatory
Ring	1202:1996	Mandatory
Channel	1202:1996	Mandatory
Overlap	1202:1996	Mandatory
TS2 Port 1	1202:1996	Mandatory

4.13.3. The central system will define five (5) dynamic objects within each controller as shown in Exhibit 4-2. Note that this information is included here to allow the controller vendor to better understand the intended use of the dynamic (STMP) objects. These selected objects are subject to change and will be dynamically programmed by the central system.

Exhibit 4-2: Dynamic Object Configuration

Object Name	Object ID (1.3.6.1.4.1206.)
Dynamic Object 1	
PhaseGroupGreen1	4.2.1.1.4.1.4.1
PhaseGroupGreen2	4.2.1.1.4.1.4.2
OvlpGroupGreen1	4.2.1.9.4.1.4.1
PhaseGroupWalk1	4.2.1.1.4.1.7.1
PhaseGroupWalk2	4.2.1.1.4.1.7.2
DetectorStatusGroup1	4.2.1.2.4.1.2.1
DetectorStatusGroup2	4.2.1.2.4.1.2.2
PhaseGroupPedCall1	4.2.1.1.4.1.9.1
PhaseGroupPedCall2	4.2.1.1.4.1.9.2
CoordPatternStatus	4.2.1.4.10.0
ShortAlarm	4.2.1.3.9.0
MiscAlarm1	4.2.1.3.12.1.2.1
GlobalSetIDParam	4.2.6.1.1.0
Dynamic Object 2	
PhaseGroupGreen1	4.2.1.1.4.1.4.1
PhaseGroupGreen2	4.2.1.1.4.1.4.2
OvlpGroupGreen1	4.2.1.9.4.1.4.1
DetectorStatusGroup1	4.2.1.2.4.1.2.1
DetectorStatusGroup2	4.2.1.2.4.1.2.2
Dynamic Object 3	
OidTime	4.2.6.3.1.0
OidDST	4.2.6.3.2.0

Object Name	Object ID (1.3.6.1.4.1206.)
Dynamic Object 4	
SystemPatternControl	4.2.1.4.14.0
SystemFunctionControl1	4.2.1.3.14.1.2.1
SystemFunctionControl2	4.2.1.3.14.1.2.2
SystemFunctionControl3	4.2.1.3.14.1.2.3
SystemFunctionControl4	4.2.1.3.14.1.2.4
Dynamic Object 5	
Sequence	4.2.1.2.5.1.0
VOPeriod	4.2.1.2.5.2.0
Volume1	4.2.1.2.5.4.1.1.1
Occupancy1	4.2.1.2.5.4.1.2.1
Volume2	4.2.1.2.5.4.1.1.2
Occupancy2	4.2.1.2.5.4.1.2.2
Volume3	4.2.1.2.5.4.1.1.3
Occupancy3	4.2.1.2.5.4.1.2.3
Volume4	4.2.1.2.5.4.1.1.4
Occupancy4	4.2.1.2.5.4.1.2.4
Volume5	4.2.1.2.5.4.1.1.5
Occupancy5	4.2.1.2.5.4.1.2.5
Volume6	4.2.1.2.5.4.1.1.6
Occupancy6	4.2.1.2.5.4.1.2.6
Volume7	4.2.1.2.5.4.1.1.7
Occupancy7	4.2.1.2.5.4.1.2.7
Volume8	4.2.1.2.5.4.1.1.8
Occupancy8	4.2.1.2.5.4.1.2.8
Volume9	4.2.1.2.5.4.1.1.9
Occupancy9	4.2.1.2.5.4.1.2.9
Volume10	4.2.1.2.5.4.1.1.10
Occupancy10	4.2.1.2.5.4.1.2.10
Volume11	4.2.1.2.5.4.1.1.11
Occupancy11	4.2.1.2.5.4.1.2.11
Volume12	4.2.1.2.5.4.1.1.12
Occupancy12	4.2.1.2.5.4.1.2.12
Volume13	4.2.1.2.5.4.1.1.13
Occupancy13	4.2.1.2.5.4.1.2.13
Volume14	4.2.1.2.5.4.1.1.14
Occupancy14	4.2.1.2.5.4.1.2.14
Volume15	4.2.1.2.5.4.1.1.15
Occupancy15	4.2.1.2.5.4.1.2.15
Volume16	4.2.1.2.5.4.1.1.16
Occupancy16	4.2.1.2.5.4.1.2.16

4.13.4. The controller unit shall respond with data for dynamic objects 1 and 2 within 40 milliseconds of receiving the STMP GET command.

- 4.13.5. In addition to the objects listed above, the controller is to either use the 1202 version 2 object or provide a proprietary object to report a controller transition.
- 4.13.6. Ten (10) copies of an NTCIP Communications Programming Manual shall be supplied with each revision of the software / firmware where there have been communication changes. (An electronic copy of the manual in MS Word may be substituted.) The NTCIP communications manual shall provide reference information about the control unit, indicating the control unit firmware revision level, protocol details, data formats of all supported NTCIP data objects, and relevant parameter setup information (response times, timeouts, etc.). The City shall have the unrestricted right to copy all documentation for maintenance and operational purposes.
- 4.13.7. The vendor shall provide an electronic copy of the Management Information Base (MIB) used for the NTCIP objects supported by the traffic control unit. Note that all data elements used for the configuration or operation of the controller shall be included and defined in the MIB.
- 4.14. The vendor shall provide non-emergency telephone technical support during the warranty period at no additional cost, as required by the City, during normal business hours. When problems cannot be resolved using telephone support, the vendor shall provide on site support within five business days at no additional cost.
- 4.15. One "Installation and Operations" manual and one "Maintenance" manual shall be provided with each Control Unit. They shall be written in English and use terminology that is common to traffic engineering or electronic engineering.
- 4.16. The "Installation and Operations" manual shall include all information necessary to install, program, and operate the Control Unit. It shall include a description of all the features on all the displays, location and function of all board circuit jumpers and switches, and all external connectors and controls.
- 4.17. The "Maintenance" manual shall include all the necessary information to repair and maintain the control unit. This shall include theory of operation, schematics, circuit board layout, wiring diagrams, connector pin-outs, bill of material (with manufacturer's address and manufacturer's part number), and data packet bit-structures.
- 4.18. The vendor shall provide operation and maintenance training at the City's facility for two days. It shall be comprehensive and cover all aspects of controller operation, configuration, and troubleshooting. Training shall include both theoretical and "hands on" training. The vendor shall provide training manuals for each participant (minimum 20) in addition to all other documentation. The vendor shall provide a fully equipped cabinet (complete with controller) and a minimum of five additional controllers for the duration of the training.
- 4.19. The vendor shall provide a troubleshooting guide for the traffic controllers and cabinets. This guide shall describe the symptom, cause, correction sequence for most commonly experienced failures or anomalies. The guide shall be covered during the training program. The guide shall be comprehensive and include troubleshooting to the module level for all plug-in or replaceable elements within the cabinet. The guide is not expected to troubleshoot to the component level on the circuit cards.

- 4.20. The vendor shall provide the City with software / firmware revisions and upgrades for a period continuing until three (3) years after delivery. This provision includes updates to all controller features, including NTCIP. At the City's option, controllers may be returned to the factory for revision or upgrades during the warranty period. The City shall be responsible for shipping to the factory. The vendor shall be responsible for the upgrades and return shipping at no cost to the City. Note: NTCIP Support: this specification has allowed vendors to continue to use proprietary objects in lieu of the NTCIP (1201, 1202) standard objects and the new 1202 block objects. However, vendors providing product under this contract shall be required to supply upgrades to the controller firmware to support the standard objects for all NEMA specified functionality at no additional cost to the City if such software becomes available for the model of controller provided to the City.
- 4.21. The vendor shall inform the City of software / firmware "bugs". This shall be in the form of a report showing all outstanding problems and the resolution of all problems since the previous report. (All information marked as "confidential" shall be considered by the City as confidential and proprietary.) All such bugs shall be corrected in the deployed versions of the traffic controllers during the three year software upgrade period. "Bugs" which directly impact the normal operation of the controller or a feature used by the City shall be corrected and tested within 30 days of notification by the City.
- 4.22. The vendor shall provide a right to copy software / firmware to all other controllers of the same type. The City shall consider these programs as confidential and proprietary.
- 4.23. The vendor shall not disable any features that reduce functionality of the controller unit.
- 4.24. For signals equipped with main street advance phases and programmed with semi-actuated operation, the controller shall be capable of providing the following operation:
- 4.24.1. The decision point for any main street advance phase (phase 1 &/or 5) should be no earlier than the end of the side street green (phase 4 &/or 8).
 - 4.24.2. If a side street call occurs, the main street "Flashing Don't Walk" (FDW) is initiated and the side street call clears before the end of the FDW, then the signal should revert to the main street "Walk" immediately after the FDW. The signal should not serve a "Don't Walk" period.
 - 4.24.3. When the signal is running a coordinated plan, it should not allow late side street calls in permissive windows which would require offset recovery.
5. ADDITIONAL TECHNICAL REQUIREMENTS FOR THE MALFUNCTION MANAGEMENT UNIT
- 5.1. At a minimum, the Malfunction Management Unit (MMU) shall comply with NEMA TS2 standards.
 - 5.2. A MMU manual shall be supplied with each cabinet.
 - 5.3. The following monitoring functions shall be provided:
 - 5.3.1. Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel.

When a Dual Indication is sensed for more than 450 milliseconds, the MMU shall enter the fault mode. When voltages on two inputs of a vehicle channel are sensed as active for less than 200 milliseconds, the MMU shall not transfer to fault mode.

- 5.3.1.1. GY-Dual Indication monitoring shall detect simultaneous inputs of active Green and Yellow field signal inputs on the same channel. It will be used to monitor channels which have an unused Red field signal input tied to AC LINE such as a five section signal head.
- 5.3.1.2. A front panel option switch shall enable GY-Dual Indication Monitoring. When the GY-Dual Indication Monitoring option is enabled, all channels which have the front panel "Field Check/Dual Enable" switches OFF shall be individually monitored for simultaneous active Green and Yellow field signal inputs. All channels which have the front panel Field Check/Dual Enable switches ON (i.e., enabled for Dual Indication Monitoring) shall function as described above in Dual Indication Monitoring.
- 5.3.2. Sixteen Field Check Enable switches shall be provided on the MMU front panel to enable Field Check Monitoring on a per channel basis.
- 5.3.3. Recurrent Pulse Monitoring shall detect Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs.
- 5.3.4. The MMU shall provide External Watchdog Monitor the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry. If the MMU does not receive a change in state on the External Watchdog input for 1500 milliseconds (± 100 milliseconds), the MMU shall enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the CVM/Watchdog indicator. The MMU shall remain in the fault mode until the Reset button or the External Reset input resets the unit. An MMU Power Failure shall reset the CVM/Watchdog fault state of the monitor. The External Watchdog input shall be wired to connector MSB-S.
- 5.3.5. On power-up, reset, and periodically during operation, the Signal Monitor shall compare the current configuration settings with the previously stored value. If the settings have changed, the Signal Monitor shall automatically log the new setting. These settings shall include the Program Card jumpers and all switches.

A programming option shall be provided such that any change in the configuration parameters shall cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode the PGM CARD / CF indicator shall flash at a 4 Hz rate. Depressing the Reset button for 3 seconds shall be required to clear this fault and log the new configuration parameters.

If the programming option is not selected, the unit shall not set the fault mode but will still log the configuration change.

- 5.4. The following display functions shall be provided:

- 5.4.1. A separate Red, Yellow, and Green “Channel Status” indicator shall be provided for each channel to show full intersection status simultaneously.
- 5.4.2. During normal operation the 48 “Channel Status” indicators shall display all active signals. In the fault mode the Channel Status indicators shall display all signals active at the time of the fault for six seconds and then indicate the channels involved in the fault for 2 seconds.
- 5.4.3. The “Field Check Fail” indicator shall illuminate when a Field Check Fault is detected. The Channel Status display shall show the channels on which the Field Check fault occurred.

If “Field Check” errors occur during a Conflict Fault, Red Fail, Clearance Fail, or Dual Indication Fail the Field Check Status indicator shall illuminate. The channels on which the Field Check Status was detected during the fault shall double pulse on the Channel Status Display at the same time as the Field Check Status indicator.
- 5.4.4. If “Recurrent Pulse” inputs were detected during a Conflict Fault, Red Fail, or Dual Indication Fail the Recurrent Pulse Status indicator shall illuminate. The channels on which the Recurrent Pulse Status was detected during the fault shall double pulse on the Channel Status Display at the same time as the Recurrent Pulse Status indicator.
- 5.4.5. The “Dual Indication indicator” shall illuminate when a Dual Indication Fault is detected. The Channel Status display shall show the channels which were detected as Dual Indication.
- 5.4.6. The “Receive” indicator shall illuminate for a 33 milliseconds pulse each time a Port 1 message is correctly received from the Controller Unit.
- 5.4.7. The “Transmit” indicator shall illuminate for a 33 milliseconds pulse each time a Port 1 message is transmitted from the MMU.
- 5.4.8. The “PGM Card” indicator shall illuminate if the Programming Card is absent or not seated properly in the edge connector. The PGM CARD indicator shall flash at a 4 Hz rate if the MMU has been triggered by a Configuration Change fault.
- 5.4.9. The “Y+R Clearance” indicator shall illuminate when the MMU has been triggered by a Yellow Change plus Red Clearance fault.
- 5.5. The Signal Monitor shall be capable of storing in non-volatile memory a minimum of 100 events. Each event shall be marked with the time and date of the event. These events shall consist of fault events, AC Line events, reset events, and configuration change events. The capability to assign a four digit identification number and 30 character description to the unit shall be provided. The event logs shall be uploaded to a PC using software provided by the manufacturer.
- 5.6. The MMU permissive program card shall be wired with the jumpers as described in the NEMA TS2 Standards. Note, where program jumpers have not been installed, the solder pads and holes shall be free of solder.

- 5.7. The MMU shall include a front panel mounted communications connector which shall connect to a laptop computer to allow access to all of the internal operating parameters, status, and event log history. The vendor shall supply the software and cable pin-out information to connect a laptop to the MMU. The vendor shall provide complete documentation of the protocol used for the connection between the laptop and the MMU. The vendor shall provide a right to install the software for a minimum ten (10) laptop and/or desk top computers that may be owned by the City and /or the City's representatives.
- 5.8. The MMU shall be compatible with the flashing permissive operation used in the City. The MMU shall be tested for compatibility with this operation and such operation shall not compromise the ability to detect conflicting operation.

6. ADDITIONAL REQUIREMENTS FOR TERMINALS AND FACILITIES

- 6.1. The cabinet shall be wired as per **configuration 4** –NEMA TS2 standards. (Refer to TS2 ¶ 5.3.1.1 and Table 5-2).
- 6.2. Each cabinet shall be configured and supplied with one loop detector rack, one detector input panel and detector test switches panel. The detector rack shall include one BIU module and eight (8) 2-channel, type-A detector card modules. (This is the option selected from TS2 ¶ 5.3.4 and Table 5-9. Also refer to TS2 ¶ 6..5)
 - 6.2.1. The detector rack shall be configured for eight (8) types-A detector modules to accommodate 1 to 16 channel detector configurations. (Refer to TS2 ¶ 5.3.4, Table 5-10 and Table 5-11.
 - 6.2.2. Space provision shall be made for future addition of a second 8 slot detector rack **and second detector input panel**. An unused BIU cable with connections to SDLC bus and TS2 power supply shall be wired to the shelf location reserved for the future rack. (Also see Paragraph 7.11 of this document)
 - 6.2.3. There shall be provision for termination of the shield (ground) wires from the field loop wiring. A termination point is required for each loop circuit shield. This shall be implemented using a bus bar or terminal block connection at the detector input panel.
 - 6.2.4. Suppressors, (equivalent to EDCO SRA-16C, EDCO SRA-6, or EDCO LCA-6), shall be provided on the detector-input panel to protect the detector module from static discharge.
 - 6.2.5. Additional detector racks with an installation kit (all necessary hardware and cables for field installation of rack and interface panel) shall be available for purchase.
 - 6.2.6. Cabinet shall be equipped with a Detector Test Switch Panel. The test panel shall be mounted on the inside the Cabinet and accessible. The test panel shall include: twelve (12) on-off-momentary test switches to simulate eight (8) vehicle and four (4) pedestrian detector inputs.
- 6.3. The detector interface panel shall be secured to the left sidewall of the cabinet.

- 6.4. To reduce corrosion and increase reliability, a minimum number of connectors for the intended function shall be used in terminals and facilities except where specifically defined in the NEMA TS2 standards. For all connectors that are not pre-defined in the TS2 specification:
 - 6.4.1. Connectors shall have a mechanical locking device holding the mating connectors together.
 - 6.4.2. Connectors shall have stress relief on the connector back shell to secure the cable to the connector.
 - 6.4.3. Connectors shall have gold plated contacts or approved equivalent.
 - 6.4.4. Connectors shall be protected from exposure to the environment when the cabinet door is open.
 - 6.4.5. All wiring points and connections shall be touch safe.
 - 6.4.6. All connectors from cable harnesses to Type 1 controller unit shall be interfaced as per NEMA TS2 standards (Refer to TS2 ¶ 3.3.4). Part number for the MS A connector socket shall be MS3106A-18-1S.
- 6.5. It shall not be necessary to remove the load switch back-panel for maintenance. It shall not be necessary to remove any equipment to tilt the back-panel down. The cabinet shall be free of obstacles when tilting the back-panel down.
- 6.6. One RC network (or equivalent arc suppressor) shall be wired in parallel with the mercury contactor, each flash transfer relay coil, and all other inductive devices.
- 6.7. All Load Switch back-panel wiring shall conform to NEMA/ESA standards.
- 6.8. All controller and Malfunction Management Unit cables shall be of sufficient length to allow the units to be placed on either shelf or the outside top of the cabinet in the operating mode. Connecting cables shall be sleeved in a braided nylon or Kevlar mesh.
- 6.9. TS2 power supply unit shall be provided as per NEMA standards (Refer to TS2 ¶ 5.3.5.)
- 6.10. Flash Transfer Relays: Six (6) flash transfer relay sockets and heavy duty relays shall be provided for the configuration of flashing circuits as per NEMA Standard TS2. The coils of the transfer relays shall be de-energized for flashing operation.
- 6.11. At a minimum, the cabinet power distribution panel shall have the following: (Refer to TS2 ¶ 5.4.2)
 - 6.11.1. Main Breaker (40 Amp) to provide power to the transient suppressor (Refer to TS2 Figure 5-4) and the solid state flasher module.
 - 6.11.2. Auxiliary Breaker (15 Amp) to provide power to the cabinet lamps, fans, GFI power outlet, and to the duplex outlet inside the base extension unit. A flexible three (3) conductor power cable of 1.2 meter shall be connected to the terminal block at the load side of the auxiliary breaker to provide power to the duplex outlet. The length of the cable shall be coiled safely inside the main cabinet for connection during installation to the outlet box in the communication compartment.

- 6.11.3. Line Filter rated for 60 Amps in accordance with the NEMA TS2 standards.
- 6.11.4. Surge suppressor which shall be designed to prevent damage to or improper operation of the equipment in the event of lightning strikes on, or power surges from the power lines, interconnect cables, etc.
- 6.12. The cabinet shall include a main power terminal block on the supply side of the breakers and a terminal block with a minimum seven (7) terminals (3 unused) on the load side of the auxiliary breaker.
- 6.13. All field terminals shall comply with NEMA TS2 standards.
- 6.14. The cabinet power distribution panel shall have a cover, which covers the side nearest the inside of cabinet and above the panel. The cover shall not limit access to the neutral bus bar or the earth ground bus bar.
- 6.15. The cabinet shall include a contactor to disconnect the power from the signal head displays when the cabinet flash is active. The contactor shall be de-activated when the controller cabinet is in the cabinet flashing condition. The contactor shall be rated for continuous operation and shall be rated for at least 60 amps at 120 VAC.
- 6.16. The cabinet shall be equipped for an emergency flasher in accordance with the NEMA TS2 standards.
 - 6.16.1. The flasher shall be supplied complete with all necessary switches and control relays.
 - 6.16.2. The flasher shall be mounted and connected so that it remains in place and in operation while the rest of the controller timing unit is removed from the cabinet.
 - 6.16.3. When selected for operation, the flasher shall provide a direct connection between the power supply circuit breaker terminals and the selected signal terminals and the power to the balance of the signals shall be disconnected.
 - 6.16.4. The configuration of the flashing operation (red, amber) shall be easily configurable in the field without disassembly of the controller cabinet assemblies.
- 6.17. The convenience GFI receptacle shall be easily accessible and in clear view when the cabinet door is open. (Refer to TS2 ¶ 5.4.2.6)
- 6.18. An auxiliary device power distribution strip shall be installed at a suitable location on the right side-wall of the cabinet for City added devices. The strip shall not have a power switch but shall be included on the internal transient suppression. There shall be no less than two (2) regular three-prong 120 VAC outlets. The power distribution strip shall be attached where there is clear access for the auxiliary device power cords. It shall be attached such that heavy transformer modules will not fall out. There shall be a maximum total power requirement of 10 Amps at 120 VAC. The auxiliary power distribution strip shall be wired from the output of the Transient Suppressor. (Refer to TS2 Figure 5-4)
- 6.19. All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.
- 6.20. Mechanical clamps shall secure all connecting cables and wire runs.

- 6.21. The grounding system in the cabinet shall be divided into three separate circuits (AC Neutral, Earth Ground, and Logic Ground). These ground circuits shall be connected together at a single point as outlined in the NEMA TS2 Standards.
- 6.22. All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.
- 6.23. Field wiring distribution to the signal heads shall conform to the following: (Refer to TS2 ¶ 5.4.2.1)
- 6.23.1. The AC neutral bus bar(s) shall have a minimum of 16 (each), 8-gauge termination points available. Each termination shall be a screw down compression contact similar to Square-D part number PK15GTA.
 - 6.23.2. The earth ground bus bar(s) shall have a minimum of 16 (each), 6-gauge termination points available. Each termination shall be a screw down compression contact similar to Square-D part number PK15GTA.
 - 6.23.3. Screw down barrier block terminations shall be used for field outputs from the load switches.
- 6.24. The cabinet shall be configured to flash in red on load switches 1 – 8, and additional 13 – 16 when required. The flash in red circuit 1 shall be on load switches 1, 2, 5 and 6 and the flash in red circuit 2 shall be on load switches 3, 4, 7 and 8. Load switches 9 – 12 are for pedestrian outputs and shall not flash when the cabinet is in flash mode.
- 6.25. The vendor shall provide four (4) dummy loads for use when there is no signal wired to the load-switch output circuit. The four dummy loads shall be mounted in the same unit. Such dummy loads shall be sufficient to ensure that the load-switch leakage does not falsely trip the MMU during normal operation. The dummy loads shall be mounted and shielded to prevent injury to personnel and damage to the cabinet.
- 6.26. The cabinet shall be wired with preempt status connected as per paragraph 4.7 of this document.
- 6.27. Pedestrian detector inputs shall be wired and configured as shown in Exhibit 6-1. (Pedestrian detector inputs 2, 4, 6, and 8 are to be conveniently located for field wiring.)

Exhibit 6-1: Pedestrian Detector Input Configuration

Pedestrian Detector	BIU - input	Phase
1	1 - opto input 1	1
2	1 - opto input 2	2
3	1 - opto input 3	3
4	1 - opto input 4	4
5	2 - opto input 1	5
6	2 - opto input 2	6
7	2 - opto input 3	7
8	2 - opto input 4	8

- 6.28. The four primary pedestrian calls to phases 2, 4, 6 and 8 shall be wired per Paragraph 4.8 of this document.
- 6.29. The Police Panel shall consist of the following controls (at a minimum):
- 6.29.1. “Signals On” / “Signals Off” switch – When the switch is in “Off” position, the intersection signal display shall be off and the controller shall continue to operate but will revert to the startup interval. When the switch is moved from “Off” to “On” the controller shall re-start. The switch shall be in the up position for “Signals On.”
 - 6.29.2. “Normal (Auto)” / “Flash” switch – When in “Flash”, the intersection signal display shall be flashing and power shall be maintained to the controller. The controller shall not be stop timed when in flash. The controller will rest in the startup position while in the flash. When the switch is moved from “Flash” to “Normal”, the controller shall re-start. The switch shall be in the up position for “Normal.”
 - 6.29.3. “Normal (Auto)” / “Manual” control switch – When in “Manual Control”, the Manual Control Enable input to the control unit shall be activated. The switch shall be in the up position for “Normal.”
 - 6.29.4. Manual Push Button – To be used by police to manually advance interval display.
- 6.30. At a minimum, the control panel inside the cabinet door shall consist of the following controls:
- 6.30.1. “Controller On” / “Controller Off” switch – shall supply power for the controller unit. The switch shall be in the up position for “Controller On.”
 - 6.30.2. “Normal (Auto)” / “Flash” switch – When in “Flash” the intersection shall be in flash mode. The controller shall continue to operate. The switch shall be in the up position for “Normal (Auto)”. (Refer to TS2 ¶ 5.5.1)
 - 6.30.3. “Normal (Run)” / “Test” / “Stop Time” switch – This is a 3 position switch. When in “Normal (Run)” – Stop Time on Fault, if there is a controller or MMU detected fault, the phase timing will stop. In “Test” the controller will continue timing, even with an active fault. When in “Stop Time” the controller will stop the phase time, keeping the intersection in the same phase. The switch shall be in the down position for “Normal (Run)”- Stop on Fault.
- 6.31. All toggle type switches shall be heavy duty and adequately rated for its intended purpose. Single or double-pole switches may be provided, as required. All switches shall be rated for a minimum of 30,000 operations.
- 6.32. All wire routed to the police door-in-door and control panel shall be adequately protected against damage from repetitive opening and closing of the main door.
- 6.33. A door-actuated switch shall turn on the lighting fixture. (Refer to TS2 ¶ 5.4.2.7.3. Also see paragraph 7.15 of this document.)
- 6.34. A door-actuated switch shall activate Alarm 1 when the cabinet door is opened.

- 6.35. All cabinet configurations shall be provided with enough RS-485 Port 1 communication cables to allow full capabilities of the cabinet. Each communication cable connector shall be a 15-pin metal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.
- 6.36. A dual slot BIU rack shall be mounted on a shelf inside the cabinet. BIU rack shall be wired to the cabinet with two (2) BIU cards as per NEMA Standard (Refer to TS2 ¶ 5.3.1.4). Slot 1 and slot 2 of the rack shall be wired and configured for BIU4 and BIU3 respectively. BIU 4 output cables 1, 3, 5 & 7 shall be permanently labeled and their wiring shall be terminated to the field terminal block. BIU 3 outputs shall be kept unused for future requirements. The back panel area of the BIU rack shall be accessible.

7. ADDITIONAL REQUIREMENTS FOR THE CABINET

- 7.1. Cabinets shall be available in the size shown in Exhibit 7-1 and with the following configurations: (Reference NEMA TS2 ¶ 7.3)

Exhibit 7-1: Available Cabinet Size and Configuration

	Size 5 cabinet
Width	76.2 cm
Height	121.92 cm
Depth	43.18 cm
Shelves	3
Detector racks	1
Configuration	3

Tolerance on width and depth dimensions is +10%/-0%. These are outside dimensions exclusive of hinges, handle, overhangs, vents, and adapters. Cabinet height shall not exceed 165 cm.

- 7.2. The top of the cabinet shall incorporate a 2.54 cm (1 in) slope down towards the rear to prevent rain accumulation.
- 7.3. The cabinet enclosure comprises the main cabinet plus a base extension unit. The overall perimeter of the top of the base extension unit shall match the bottom of the main cabinet. One piece 3 mm neoprene gasket shall be provided to install between them. All stainless steel hardware to bolt the main cabinet together with base extension unit shall be provided.
- 7.4. An internal ground base flanged lip of 70-mm width shall be incorporated around the entire inside bottom edge perimeter. This flange must allow the enclosure to sit flat against the aluminum controller cabinet base unit that it will be mounted upon.
- 7.5. The cabinet shall be built in accordance with TS2 ¶ 7.2.2.1. Cabinets of “Sheet Aluminum” and shall be built to NEMA 3R cabinet standards. All exterior cabinet and door seams shall be continuously welded with smooth seams. All welds shall be free from any voids. All exterior components shall be rustproof. The exterior shall not have any exposed hardware, except for handles or as otherwise specified. Edges shall be rounded to a radius of .762 mm (0.030 in) minimum.

- 7.6. The main door hinge shall be a one-piece, stainless steel continuous piano hinge with a stainless steel pin running the entire length of the door. The door shall be tamper proof. In addition, a braided ground strap shall be provided between the cabinet shell and the main door. The wire material shall be braided #6 copper as minimum.
- 7.7. A rain channel shall be incorporated around the entire opening edges of the cabinet where the main door meets the cabinet. The design of the main door opening shall prevent liquids from entering the enclosure.
- 7.8. All cabinet openings (when the doors are closed) shall be vermin and insect proof with a permanently installed insect screen. The filter (TS2 ¶ 7.9.2.3) is required but is not adequate for insect proofing. Vent area design shall prevent snow or rain from entering the cabinet. A removable winter plate shall be provided to over the vent opening during winter months.
- 7.9. The vendor shall provide Corbin Lock, number 5R3575--GR Keyway for the main door and Corbin number 035759 for the police door. Keys must be compatible with those currently used by the City. Two keys shall be provided with each cabinet.
- 7.10. There shall be vertical "C" channels for mounting cabinet components to the walls of the cabinet. The channels shall extend to no less than 10.16 cm (4 in) from the top and bottom of the cabinet. The channels shall be arranged in parallel pairs. There shall be one pair of "C" channels on each side wall and two pairs of "C" channels on back wall. The load switch back panel shall be installed on "C" channels that are mounted on the back of the cabinet. Cabinet components shall be mounted on the "C" channels. (Including the power distribution panel, power strip, resistor panel, detector input panel, etc.)
- 7.11. The cabinet shall be supplied with three (3) removable shelves, each a minimum of 25.4 cm (10 in) deep. There shall be one unused shelf with a minimum shelf space measuring 48.26 cm (19 in) wide, 17.78 cm (7 in) high, and 25.4 cm (10 in) deep to accommodate extra detector card rack and other future components.
- 7.12. The main door shall be equipped with a two-point latching mechanism.
- 7.13. The main door shall have a latching mechanism to hold the door open at 90° and 180° with an acceptable tolerance of -30°.
- 7.14. Two sets of complete and accurate cabinet drawings shall be supplied with each cabinet.
- 7.15. The cabinet shall have a flexible arm utility light mounted on the door or as specified by NEMA TS2 standard TS2 ¶ 5.4.2.7. The lamp is to be supplied by the vendor.
- 7.16. There shall be no sharp edges or protrusions on the cabinet whether open or closed which might pose a risk of personnel cuts or injury. All sharp edges shall be sanded and deburred before painting. Cabinets shall be painted in Muncell Grey. (ASA 61 or ASA 70.)
- 7.17. There shall be a two piece removable aluminum plate between the main cabinet enclosure and the base extension unit. The base plate shall have a minimum thickness of 2.5 mm, and shall have the dimensions to cover the base area inside the main cabinet. Base plate design shall incorporate two openings; each shall be on both back corners inside the cabinet for incoming cables. All points within the base-plate where there is a possibility of cable contact shall have protective grommets appropriately in place to prevent wear and damage to cabling.

7.18. Base Extension Unit:

- 7.18.1. The base extension unit shall be built with sheet aluminum meeting the requirements of TS2 standard TS2 ¶ 7.2.2.1. The unit shall include a communication terminal block compartment and its door shall be centered within the face of the base extension unit. The exterior and interior surface shall be painted in Muncell Grey (ASA 61 or ASA 70). The extension unit shall have vents to provide adequate ventilation. Vent area shall be designed to prevent snow or rain from entering to the unit. This area shall be sloped to drain any moisture that may get into this area to inside of the base extension unit. The dimensions of the communications terminal block compartment shall conform to drawing TTD-809.041 in appendix A.
- 7.18.2. The communications terminal block compartment inside the base extension unit shall incorporate:
 - 7.18.2.1. An external mounted stainless steel piano hinge with 2.5 mm diameter hinge pin. The hinge pin shall not be accessible from the outside of the cabinet.
 - 7.18.2.2. A construction that is secured by a “Bell” ¼-20 hex head 38 mm long (1.5 inches) silicon bronze bolt with 6.4 mm (¼ inch) long shoulder reduced to 4.8 mm (3/16 inch) diameter. The door shall be drilled and tapped for ¼-20 bolt. The bolt shall be recessed 25 mm (1 inch) deep from the door surface, with 20 mm chamber diameter (Refer to drawing TTD809.041-R2 in appendix A.
 - 7.18.2.3. A ground terminal and outdoor type duplex outlet shall be provided in the upper left hand corner of the communication terminal block compartment. (Please refer to paragraph 6.11.2 of this document)
- 7.18.3. 10 mm thick closed cell neoprene gasket, matching bottom perimeter of base extension unit shall be provided to install between the concrete pad and the base extension unit.

7.19. Exterior surface of the cabinet shall be free of any labels and wirings

7.20. Load switch panel, controller interface panel, field distribution panel, test panel and power supply panel shall be painted white on front, with all appropriate labels silk-screened in black.

8. ADDITIONAL TECHNICAL REQUIREMENTS FOR AUXILIARY DEVICES

- 8.1. Load switch jumpers shall be supplied (pin 1 to pin 3) for use when a load switch is not installed. If additional jumpers are required for flash transfer relays, the same jumper shall be used. Six (6) load switch jumpers shall be supplied with each cabinet.
- 8.2. This section has been removed.
- 8.3. Normally all maintenance shall not need special tools. Special tools and equipment shall be available for purchase, as required, to perform extended maintenance tasks including, but not limited to, extender cards, memory download programmers for upgrading control firmware, and interface software.

- 8.4. Four (4) spare connections from BIU 2 (input/output 21, 22, 23 & 24) shall be wired to four (4) unused spare terminals at a BIU interface back panel location. These spare terminals on the back panel shall be properly labeled.

9. OTHER REQUIREMENTS

9.1. Technical information to be provided with the quotation.

Each bidder shall submit with their quotation four (4) copies of the following information to the City for preliminary approval:

- Outline Specifications including sketches showing the proposed layout, bill of materials, weights, and dimensions.
- Complete cabinet wiring diagram showing the interconnection and terminals for all wiring in the cabinet.

9.2. Controller Programming.

Before delivery, each controller cabinet shall be programmed and tested based on the “Controller Programming Sheet” in appendix B.

9.3. Shop Drawings.

Within ten (10) calendar days of receipt of a purchase order to supply the equipment specified herein, the Supplier shall submit four (4) copies of the following information to the City for each cabinet ordered:

- Detailed dimensioned layout shop drawings, including plans, elevations, sections and details to show enclosures, structural details, equipment layout and mounting arrangements, anchor bolt locations and exact weight.
- Detailed bill of materials.
- Wiring diagram.
- Details of warning signs and equipment nameplates.

The supplier shall submit four (4) copies of shop drawings for review by the City. Upon approval, three (3) copies of the drawings shall be returned with “permission to Construct” stamp to the supplier. In case of non-acceptance, one (1) of the drawings shall be marked, outlining the unacceptable conditions and returned to the supplier for corrections and re-submission.

Once fabrication of the equipment has commenced, materials and dimensions shown on the final shop drawings shall not be changed without approval of the City. In the event of changes, resubmission of four (4) copies of the revised shop drawings, showing the changes from the final drawings, will be required.

Where the Supplier's submittal includes a deviation from the Specifications, such deviation(s) shall be clearly identified as exception(s) and the Supplier shall specifically request approval of each change. The Supplier shall include a complete description of the deviation and the reason

for the requested change and identify any secondary effects of the change. Approval of any submittal by the City does not constitute approval of any exception(s) or deviation(s) to the Specifications unless specifically noted as described above. Failure on the part of the City to discover areas of non-compliant construction, materials, or operation does not constitute approval of such non-compliance.

9.4. Packaging and Shipment.

Each delivered item shall be individually packaged in its own shipping container and shall be complete and ready for testing.

Each shipping container shall clearly identify, on the top left corner, the following information as applicable:

- Equipment Description
- Contract number
- Manufacturer
- Serial number
- Date of shipment
- Packing list

The supplier shall notify the City of its intent to deliver three (3) business days prior to the shipping date. The supplier is notified that the equipment will only be accepted for delivery during normal working hours on any business day and only with prior authorization.

9.5. Approvals

The cabinet shall be approved for its intended purpose by a recognized safety authority, such as the Canadian Standards Association or the Electrical Safety Authority.

9.6. Inspection

The supplier shall notify the City of the date that the fabrication of the unit will commence. The City shall have free access to the site of manufacturer of the unit while work on the unit is being performed for the purpose of inspecting and examining plant records and certificates, the materials used, the process of fabricating the unit, and to make any tests that may be considered necessary. The supplier shall notify the City when the unit is ready for inspection. All work is subject to an inspection by the City prior to shipment.

9.7. Bar Coding Requirements

Each cabinet, controller and MMU shall be individually bar-coded with sufficient information to uniquely identify the unit. The successful supplier must provide to the City a bar-coding database in Microsoft Excel format. The bar-coding database must provide the following information:

- Unique identification number shown by the bar code.

- Batch number
- Date of manufacture
- Manufacturer name
- Serial number
- Model

Each of cabinet, controller, and MMU unit shall be supplied with three (3) bar code stickers. Bar code stickers shall be supplied as follows:

- One bar code sticker, for the cabinet, shall be affixed to the inside surface of the main door.
- One bar sticker, for the controller, shall be affixed on the front side of the unit.
- One bar code sticker, for the MMU, shall be affixed on the front side of the unit
- Second and third stickers shall be peel-able and placed inside the individual packaging. The peel-able stickers must be self-adhesive so that it can be affixed to an inventory sheet for tracking purposes.

9.8. Prototype Cabinet

Prototype Cabinet Section has been removed from the specification and shall be included in the term of the RFQ document.

9.9. Delivery

Delivery Section has been removed from the specification and shall be included in the term of the RFQ document

9.10. Quality Assurance

The supplier shall follow quality assurance program and procedures as described in section 3.6 of this document. Before delivering the cabinets, each cabinet shall be fully assembled with all components and be subjected to a 24 hours burn-in test. The supplier's quality assurance inspector must sign off on all tests.