

**TEXAS DEPARTMENT OF TRANSPORTATION  
SPECIAL SPECIFICATION  
BASE MOUNTED CABINET FOR RAMP METER SIGNAL CONTROLLER**

1.0 **SCOPE**

1.1 This specification describes the minimum acceptable requirements for a base mounted cabinet to house a microprocessor-based, vehicle actuated freeway access Ramp Meter Signal Controller.

2.0 **DESIGN REQUIREMENTS**

2.1 Unless otherwise called for in the Invitation to Bid, the cabinet shall be a base mount cabinet with the following external dimensions:

Width - 44 inches  
Height - 77 inches  
Depth - 22 2 inches

The height, width, and depth dimensions may be plus 4 inches, minus 2 inches.

2.2 The base mounting holes shall be located in the base at the corners of a 25.5 inch by 12.5 inch rectangle. The holes shall be slotted to allow the cabinet to be adjusted plus or minus 2 inch along the short dimension of the cabinet and shall be large enough to accommodate a 1 inch diameter bolt.

2.3 Four 5/8 inch (minimum) by 8 inch galvanized anchor bolts with nuts and washers and a mounting template shall be provided for each cabinet.

2.4 The cabinet shall be constructed using unpainted sheet aluminum with a minimum thickness of 0.125 inch. No wood, wood fiber products, or other flammable material shall be used in the cabinet. All welds shall be neat and of uniform consistency.

2.5 The cabinet shall be completely weatherproofed to prevent the entry of water. All unwelded seams shall be sealed with a clear or aluminum colored weather-seal compound. Aluminum lifting eyes or ears shall be permanently attached or built into the cabinet to permit the purchaser to lift the cabinet with a sling. The corners of each eye or ear shall be rounded.

2.6 Vertical shelf support channels shall be provided to permit adjustment of shelf locations in the field. The channels shall have a single continuous slot to allow shelves to be placed at any height within the cabinet. Channels with fixed notches or holes are not acceptable.

2.7 Each cabinet shall be equipped with an extra set of unistrut channels or a keyhole panel on either side of the front section of the cabinet to permit the purchaser to mount additional equipment as necessary.

2.8 Shelves shall be at least 14 inches deep and be located in the cabinet to provide a 2 inch clearance between the back of the shelf and the back of the cabinet.

2.9 The cabinet shall be complete with shelves for supporting all control equipment and accessories

necessary to fulfill the requirements of the Invitation to Bid on all attachments thereof. There shall be additional shelf space to accommodate a 12 position loop detector amplifier card rack and an additional space 12 inches high, 16 inches wide, and 14 inches in depth.

- 2.10 The cabinet shall be vented and cooled by a thermostatically controlled fan. The fan shall be a commercially available model with a capacity of at least 100 CFM. The thermostat shall be an adjustable type with an adjustment range of 70/ to 110/F. A press-to-test switch shall be provided to test the operation of the fan.
- 2.11 The intake for the vent system shall be filtered with an air conditioning filter. The minimum filter dimensions shall be 16 inches wide by 12 inches high by one inch thick. The filter shall be securely mounted so that any air entering the cabinet must pass through the filter. The cabinet opening for intake of air shall be large enough to use the entire filter. The air intake and exhaust vent shall be screened to prevent entry of insects. The screen shall have openings no larger than .0125 sq. in. The total free air opening of the exhaust vent shall be large enough to prevent excessive back pressure on the fan.
- 2.12 The cabinet shall be provided with a unique five digit serial number which shall be stamped directly on the inside of the cabinet or engraved on a metal or metalized Mylar plate, epoxied or riveted with aluminum rivets to the inside of the cabinet. The digits shall be at least 0.2 inch in height and located on the upper right sidewall of the cabinet near the front. Dissimilar materials shall be separated by an inert dielectric.
- 2.13 All outputs and inputs shall be terminated at terminal strips within the controller cabinet and all terminals shall have a legend with the designation of each terminal.
- 2.14 All active components shall be solid state unless otherwise specified.
- 2.15 **Back Panel**
  - 2.15.1 The back panel shall be designed to accept 2 load switches and a two circuit solid state flasher. A minimum of one flash transfer relay shall be provided to permit the purchaser to use the load switches in any combination without having to add more relays.
  - 2.15.2 The back panel shall be hinged at the bottom and shall fold down and out from the top for maintenance with all components (load switches, relays, etc.) in place. It shall be possible to gain full access to the back of the back panel in less than two minutes using simple tools. Wire termination points on the back of the back panel shall be numbered or identified to correspond to the labeling on the face of the panel. No printed circuit back panels shall be permitted. No components shall be mounted behind the back panel. Transient suppression devices for relay coils are excepted from this requirement.
  - 2.15.3 The bottom edge of the back panel shall be at least six inches above the base of the cabinet.
  - 2.15.4 Terminals shall be available for interconnection between the cabinet and a Local Control Unit. All LCU signals shall be brought through posted 6-32 X 1/4 inch binder head screw terminals with removable shorting bars installed. The following functions shall have terminals clearly labeled:

24 VDC External Power  
 Supply at 0.5 amps minimum  
 Logic Ground  
 Chassis Ground  
 AC Neutral  
 120 V AC  
 Indicator Light Disable  
 Remote Control In  
 Remote Metering Level Output 0  
 Remote Metering Level Output 1  
 Remote Metering Level Output 2  
 Remote Metering Level Input 0  
 Remote Metering Level Input 1  
 Remote Metering Level Input 2  
 On-Line Command  
 On-Line Confirm  
 Emergency Flash Command  
 Emergency Flash Confirm  
 Local Control Confirm  
 Demand Detector Recall Command  
 Demand Detector Recall Confirm  
 Manual Push-button In  
 Auto/Manual In  
 Queue Detector In  
 Demand Detector In  
 Merge Detector In  
 Bypass Detector In  
 Freeway 1 Detector In  
 Freeway 2 Detector In  
 Freeway 3 Detector In  
 Green Signal Out  
 Yellow Signal Out  
 Red Signal Out  
 Bypass Green Signal Output  
 Bypass Yellow Signal Output  
 Bypass Red Signal Output  
 Flash Signal Out 0  
 Flash Signal Out 1

- 2.15.5 The controller assembly shall provide 2 load switch sockets. Two load switches shall be supplied with each cabinet.
- 2.15.6 The load switches and flasher shall be supported by a bracket(s), designed to accept all NEMA type load switches and flashers that will support the switch and prevent vibration from dislodging it from the socket in the back panel.
- 2.15.7 The load switch outputs shall be brought out through posted 10-32 X 5/16 inch binder head screw terminals. Field wiring for the signal heads shall be connected at this terminal strip.
- 2.15.8 Each load switch output shall have a MOV device with a minimum rating of 20 Joules connected from

the terminal to the cabinet ground. The MOV's may be mounted either on the front or the back of the panel. In either case, the MOV's shall not obstruct or interfere with the field wiring. The ground shall consist of a bus bar connected to the back panel. The bus bar shall be connected to the cabinet by an insulated braided copper ground strap. The strap shall be bonded to the cabinet and shall not interfere with the lowering of the back panel.

## 2.16 **D Connector Panel**

2.16.1 A D Connector panel shall be provided that contains all terminations for the interface between the detectors and the controller unit as well as for communication inputs to the controller. The panel shall be located on the left side of the cabinet interior. The following shall be terminated on the D connector panel.

Freeway Detector 4 In  
Freeway Detector 5In  
Freeway Detector 6 In  
Freeway Detector 7 In  
Freeway Detector 8 In  
Freeway Detector 9 In  
Freeway Detector 10 In  
Freeway Detector 11 In  
Freeway Detector 12 In  
Freeway Detector 13 In  
Freeway Detector 14 In  
Freeway Detector 15 In  
Freeway Detector 16 In  
Exit Ramp Detector In  
Com

2.16.2 All pins defined in Appendix I shall be available at terminal strip connections on the preemption/communication panel. The terminals shall be posted 8-32 X 1/4" binder head screw terminals.

2.16.3 The interconnect cable from the panel to the controller unit shall consist of a 57 pin AMP 206437-1 with 206138-1 cable clamp plastic-shell twist-lock connector or exact equivalent. The interconnect connector pins shall be gold plated male pins. The exact pin part number will depend on the vendor's available tooling. The cable shall be of sufficient length to reach across the entire height of a 54 inch high cabinet. Each wire of the cable shall be 19 strand copper. All 57 wires shall be present in the cable.

## 3.0 **DETECTOR PANEL, CARD RACK, AND DETECTORS**

3.1 The cabinet shall have a loop detector panel mounted on the left side of the cabinet. This panel shall provide for all connections between loops at the street and the detector amplifiers, pedestrian call isolation, detector test switches, and connection between card rack detector amplifiers and the controller unit as described in the following sections.

### 3.2 **Detector Unit**

- 3.2.1 Loop detector units provided under this item shall meet or exceed the requirements of NEMA TS-1 1989, Section 15, latest review, unless otherwise specified in this specification.
- 3.2.2 The loop detector units shall be digital solid state devices designed for 24 V 2.5 VDC operation and card mounting. Each detector channel shall consume not more than 50 Ma.
- 3.2.3 Each loop detector unit shall be sequentially scan two channels.
- 3.2.4 The front panel of the loop detector unit shall be of metal or an impact resistant plastic material designed to permit easy access to the internal components.
- 3.2.5 The detector unit shall have a minimum of eight sensitivity selections for each channel.
- 3.2.6 Each detector unit channel shall be supplied with the delay and extend output features described below:
1. Delay Output - A variable delay circuit shall be furnished to provide a delayed output. This circuit shall be variable from 0 to at least 30 seconds in one second increments. Detection of a vehicle shall be delayed for the amount of time selected, therefore providing no detector output until a vehicle has been present in the loop for this length of time. This timing shall reset each time the loop is vacated; however, the delay circuit shall be disabled immediately when logic ground is present on pin 1 for channel A or pin 2 for channel B.
  2. Extend Output - A variable extend circuit shall be furnished to provide a carryover output. This circuit shall be variable from 0 to at least 15 seconds in 0.25 second increments or smaller. Detector actuation shall be extended after the vehicle leaves the loop. The timing circuit shall reset after the extension has expired; however, the extend circuit shall not be disabled when logic ground is present at pin 1 or pin 2 of the connector described herein.
- The timing shall be digital and all programming settings shall be accomplished by thumb wheels or dip switches. The delay and extend features described above shall both be programmable for a detector channel.
- 3.2.7 Each detector unit channel shall function in the following two front panel selectable modes:
1. Presence - When a NEMA class 2 vehicle or larger occupies the center of any of the test loops (except for the class 2 vehicle in the 6 x 80 foot loop), the detector unit channel shall maintain a detection output for the length of time the vehicle is in the loop and for the time period programmed for the extend output.
  2. Pulse - A vehicle passing over a loop shall cause an actuation lasting between 75 milliseconds and 150 milliseconds. If a vehicle stops in the loop area, the detector unit channel shall, within three seconds, detect subsequent vehicles passing over the unoccupied area of the loop.
- 3.2.8
- 3.2.9 The detector unit channel, after being actuated continuously for any period, shall regain 100% of the selected sensitivity within 0.5 seconds after the loop is cleared of vehicles regardless of the duration of presence.
- 3.2.10 Each detector unit channel shall have a minimum of 3 switch selectable operating frequencies.

- 3.2.11 The loop input for each channel shall be isolated from the detector circuitry by means of an isolation transformer.
- 3.2.12 The outputs from each detector unit channel shall be solid state and optically isolated.
- 3.2.13 A switch or switch position shall be provided on the front panel to disable each channel output.
- 3.2.14 If a detector loop circuit becomes open, the detector unit channel shall produce an output that shall remain until the malfunction is corrected.
- 3.2.15 The detector unit channel shall be set to produce an output in response to a 0.13% or greater negative change in loop inductance within not more than 5 ms. When the change is removed, the detector unit channel shall terminate its output within not more than 5 ms.
- 3.2.16 All sensitivity, frequency and mode programming for each channel shall be external and located on the face of the unit. Extend, delay and maximum presence time programming may be via dip switches on the circuit board.
- 3.2.17 Indicator(s) on the front panel shall be provided to distinguish between detection, detection delay, or detection extended for each channel.
- 3.2.18 Upon restoration of electrical power after a power failure of any length, the detector unit channel shall automatically return to its normal state of operation within 2 seconds.
- 3.2.19 In addition to the requirements of NEMA TS 1-15.2.21, the detector unit channel shall continue to operate when the resistance between ground and either loop input is varied from 100 megohms to 50 ohms.
- 3.2.20 The connector on the detector card shall be a 2 x 22 pin PCB edge connector with pins on 0.156" centers and gold flashed contacts.

The pin assignments shall be as follows:

<u>PIN</u>	<u>FUNCTION</u>
A	Logic Ground
B	Detector DC Supply
C	External Reset
D	Channel A loop Input
E	Channel A loop Input
F	Channel A output (collector)
H	Channel A output (emitter)
J	Channel B loop Input
K	Channel B loop Input
L	Chassis Ground
W	Channel B output (collector)
X	Channel B output (emitter)
1	Channel A Delay Inhibit
2	Channel B Delay Inhibit
6	Detector Address Bit No. 0
10	Detector Address Bit No. 1
15	Detector Address Bit No. 2
19	Data Transmit
21	Data Receive

3.2.21 All circuit traces shall have a conductivity equivalent to at least two ounces per square foot of copper.

3.2.22 Lightning protection shall be installed within the loop detector unit. The protection shall enable the amplifier to withstand the discharge of a 10 microfarad capacitor charged to plus or minus 1000 volts directly across the detector input pins with no load present.

The protection shall enable the loop detector unit to withstand the discharge of a 10 microfarad capacitor charged to plus or minus 2000 volts directly across either the detector inputs or from either side of the detector inputs to earth ground. For this test, the detector chassis shall be grounded and the detector inputs shall have a dummy resistive load attached equal to 5.0 ohms.

3.2.23 The detector unit shall input a call to the controller unit when the power to the unit is disrupted.

3.2.24 Twelve detector units (2 channels each) shall be provided with the Ramp Metering Cabinet Assembly.

### 3.3 **Functional Requirements**

3.3.1 The loop configurations referred to in this specification shall be those located at the department's loop detector test facility which consists of the following:

1. Four 6 x 6 foot, three turn loops connected in series/parallel.
2. Two 6 x 30 foot, two turn loops.
3. One 6 x 80 foot, one turn loop.
4. Two high speed 6 x 6 foot three turn loops.

- 3.3.2 The detector unit channel shall detect all vehicles that traverse public streets and highways and which consist of sufficient conductive material, suitably located to permit recognition by the detector system. For this specification test vehicles shall be as follows:
1. Class 1 - A standard 10 speed, 26 inch bicycle.
  2. Class 2 - 50 CC motorcycle.
  3. Class 3 - Automobile ranging from 1700 to 2000 pounds.
  4. Class 4 - Standard C-50 tractor-trailer combination.
- 3.3.3 The detector unit channel shall detect all of the vehicles described above with all of the configurations specified herein.
- 3.3.4 When detecting test vehicles of the same class as described herein and on any of the test configurations each channel of the detector unit shall include means to adjust sensitivity such that it shall not produce an output when the test vehicle is more than 36 inches from the perimeter of the loop.
- 3.3.5 The detector unit channel shall detect all vehicles described herein on any of the loop configurations described herein traveling in the speed range of three miles per hour to 80 miles per hour.
- 3.4.0 **Detector Card Rack**
- 3.4.1 Two 8 Position detector card racks shall be provided with the Ramp Metering Assembly. The first rack shall accommodate 7 two channel detectors for the upstream operation (Demand, Queue 1, FW 1, FW 2, FW 3, FW 4, FW 5, FW 6, FW 7, FW 8, Merge, Queue 2, and Bypass detectors) using detector channels 1 through 13. The second rack shall accommodate 5 two channel detector units for the downstream detectors using detector channels 1 through 9 (FW 1, FW 2, FW 3, FW 4, FW 5, FW 6, FW 7, FW 8, and Exit Ramp)
- 3.4.2 The detector card rack frame shall be fabricated from aluminum and shall have slots set in a modular fashion such that the PCB edge connectors shall plug into the rear while sliding between top and bottom card guides for each module. Mounting flanges shall be provided and be turned outward for ease of access. The detector card rack shall be bolted to a cabinet shelf. It shall be possible to unbolt the rack using simple tools.
- 3.4.3 Each slot in the card rack shall mate with a 2 x 22 pin card-edge connector with 0.156" pin spacings and match the detector card-edge connector. Key slots shall be between pins B & C and between pins M & N. Each card-edge connector shall be secured to the rack by means of threaded hardware to provide mechanical rigidity while still maintaining ease of replacement.
- 3.4.4 All wiring to the rack shall enter and exit in the lower left rear corner when viewed from the front. It shall be labeled and neatly run to other parts of the cabinet and detector termination panel.
- 3.4.5 The slots shall be numbered 1 to 8 left to right when viewed from the front of the rack.
- 3.4.6 Each rack slot shall be wired as follows:



<u>Pin No.</u>	<u>Function</u>
A	Logic Ground
B	Detector DC Supply
C	External Reset
D	Channel A loop input
E	Channel A loop input
F	Channel A output (collector)
H	Channel A output (emitter)
J	Channel B loop input
K	Channel B loop input
L	Chassis Ground
W	Channel B output (collector)
X	Channel B output (emitter)
1	Channel A delay inhibit
2	Channel B delay inhibit
6	Detector Address Bit No. 0
10	Detector Address Bit No. 1
15	Detector Address Bit No. 2
19	Data Transmit
21	Data Receive

All loop inputs shall be wired with shielded twisted pair leads to improve signal isolation. All grounds within the twisted pair leads shall be connected to a chassis ground bus bar on the back of the rack.

- 3.4.7 The external reset inputs (Pin C) shall be bussed to a common point and wired to the detector panel.
- 3.4.8 The channel loop outputs (-) shall not be bussed together in the rack assembly.
- 3.4.9 The channels shall be wired to the detector panel and labeled as follows:

<u>SLOT</u>	<u>CHANNEL</u>	<u>DETECTOR NO.</u>	<u>CHANNEL</u>	<u>DETECTOR NO.</u>
1	A	1	B	2
2	A	3	B	4
3	A	5	B	6
4	A	7	B	8
5	A	9	B	10
6	A	11	B	12
7	A	13	B	14
8	A	15	B	16

- 3.4.10 The Detector DC Supply (Pin B) shall be bussed to a common point and wired to the Intersection Detector Panel.
- 3.4.11 The Chassis Ground (Pin L) shall be bussed to a common point and wired to the Detector Panel.
- 3.4.12 The Data Transmit (Pin 19) shall be bussed to a common point and wired to the Detector Panel.

- 3.4.13 The Data Receive (Pin 21) shall be bussed to a common point and wired to the Intersection Detector Panel.
- 3.4.14 The Logic Ground (Pin A) shall be bussed to a common point and wired to the Detector Panel.
- 3.4.15 The Data Address Bits No. 0, No. 1, and No. 2 for the first eight (8) slots shall be connected to the logic ground as follows:

<u>SLOT</u>	<u>CHANNELS</u>	<u>BIT No. 0</u>	<u>BIT No. 1</u>	<u>BIT No. 2</u>
1	1 - 2	OFF	OFF	OFF
2	3 - 4	ON	OFF	OFF
3	5 - 6	OFF	ON	OFF
4	7 - 8	ON	ON	OFF
5	9 - 10	OFF	OFF	ON
6	11 - 12	ON	OFF	ON
7	13 - 14	OFF	ON	ON
8	15 - 16	ON	ON	ON

OFF = not connected, ON = connected to Logic Ground

### 3.5.0 Power Supply

- 3.5.1 The power supply shall be a shelf mounted, enclosed, 24 VDC power supply capable of supplying a minimum of 3.6 amperes. The front panel of the power supply shall provide a power on LED, a power on-off switch, an appropriate sized fuse for the 120 VAC input line, and a connector. The connector shall have a metallic shell which is connected to the chassis ground internally and shall mate with an MS-3106A-18-1SW cable connector.

Connector pin terminations shall be as follows:

<u>PIN</u>	<u>FUNCTION</u>
A	AC Neutral
B	Reserved
C	120 VAC Line
D	Reserved
E	24 VDC Output
F	Reserved
G	Logic Ground
H	Chassis Ground
I	Reserved
J	Reserved

- 3.5.2 One power supply cable per power supply shall be furnished and installed in each cabinet. The wires shall be terminated to bus bars or to terminals on the front of the backpanel or detector panels as appropriate. The connections shall be with forked spade lugs or otherwise as needed. Each individual wire shall be cut to the length required to reach the point at which it is to be connected. There shall be a minimum of ten (10) feet of cable from the mounting point on the panel to the connector. After all wires have been connected, the power supply cable shall be neatly bundled.

### 3.6.0 Detector Panel

- 3.6.1 The Detector Panel shall provide all connections between the detector loops and the detector amplifiers, and detector test switches. It shall also provide for all connections between the detector amplifiers and the Control Unit.
- 3.6.2 The panel shall be constructed of 1/8" aluminum.
- 3.6.3 The panel shall contain a three inch horizontal slot in each corner to accommodate 0.25 inch mounting bolts.
- 3.6.4 Inputs from the loops shall be brought through posted 10-32 X 5/16 inch binder screw terminals.
- 3.6.5 Each loop pair shall be protected by lightning surge suppressors prequalified for use on loop detector inputs by the Departments' Traffic Operations Division Signal Operations Section. The suppressors may be mounted either on the front or behind the panel.
- 3.6.6 The outputs from the detector amplifiers to External Control Units shall be brought through posted 6-32 X 1/4 inch binder head screw terminals with removable shorting bars installed.
- 3.6.7 The panel shall provide the following connection points as a minimum for sixteen (16) detectors:

<u>CONNECTION POINT</u>	<u>NO. OF CONNECTION POINTS</u>
LOOP OUTPUTS (COLLECTORS)	22, 1 FOR EACH DETECTOR
LOOP OUTPUTS (EMITTERS)	22, 1 FOR EACH DETECTOR
DATA TRANSMIT	1
DATA RECEIVE	1
RESET	1
EXTERNAL 24V POWER SUPPLY	1
LOOP INPUTS	44, 2 FOR EACH DETECTOR
LOGIC GROUND	6
SPARES	6
CHASSIS GROUND BUS	1 BUS

- 3.6.8 The loop outputs (Emitters) shall be bussed together with individual clips on the front of the panel. The emitters shall be strapped on the front of the panel to a logic ground terminal.
- 3.6.9 The logic ground terminals shall be bussed on the back of the panel with a bus bar.
- 3.6.10 A chassis ground bus bar shall be provided on the panel and connected to the cabinet by an insulated braided copper ground strap. The strap shall be bonded to the cabinet.
- 3.6.11 An ON-OFF-VEHICLE CALL toggle switch shall be provided for each detector circuit (22 total) to permit the user to disconnect the detector input from the control unit, or permit the user to place a call to the control unit. The VEHICLE CALL position shall place a call to the controller. The ON position shall connect the detector to the control unit. The center OFF position shall disconnect the detector from the control unit.

**3.7.0 Functional Test**

- 3.7.1 In the presence mode, a Class 1, 2, 3 and 4 vehicle stopped over a 6 X 6 foot three turn loop with 100

foot lead-in shall be detected. Class 3 and 4 vehicles shall be continuously detected for a minimum of the time programmed for maximum presence or for at least on half hour.

- 3.7.2 All classes of vehicles moving over a 6 X 6 foot three turn loop with 100 foot lead-in shall generate a single pulse output from the loop detector unit channel in the pulse mode.
- 3.7.3 There shall be no crosstalk between adjacent loops connected to separate channels or loop detector units with or without a vehicle on one of the loops after the loop detector unit channels are adjusted.
- 3.7.4 A 6 X 6 foot three turn loop connected to a detector unit channel in the presence mode shall detect a Class 3 vehicle for not less than 15 minutes and shall, upon departure of this vehicle from the zone of detection recover and, after one second, detect a class 2 vehicle.
- 3.7.5 The 6 X 80 foot loop connected to a detector unit channel with 100 feet of lead-in shall detect class 2, 3 and 4 vehicles. The vehicles shall enter the zone of detection at ten miles per hour and stop. The class 2 vehicle shall be detected for a minimum of three minutes. Class 3 and 4 vehicles shall be detected for the time programmed for maximum presence.
- 3.7.6 The 6 X 30 foot loop adjusted (sensitivity) for any one class of vehicles shall not detect a numerically equal class vehicle passing 36 inches outside any part of the loop's perimeter.
- 3.7.7 A class 1 vehicle traveling at three miles per hour over either a 6 X 6 foot three turn loop with 100 foot lead-in or a 6 X 30 foot quadrapole loop with 100 foot lead-in shall be detected.
- 3.7.8 A 6 X 6 foot loop with 100 foot lead-in connected to a detector unit channel shall continue to operate normally while resistance to ground on one of either loop lead in varied from 100 megohms to 50 ohms gradually in a 15 minute period. As loop integrity is restored gradually in the same time interval, the unit shall continue to operate normally.
- 3.7.9 When an open circuit induced in a loop circuit is restored, the detector unit shall automatically become operational within 2 seconds, or upon termination of the time programmed for maximum presence.
- 3.7.10 A 150 picofarad capacitor will be connected in parallel across a functioning 6 X 6 loop with 100 foot lead-in with a class 3 vehicle over the loop. The loop detector unit channel shall continue to function normally.
- 3.7.11 A loop detector unit channel connected to a 6 X 6 three turn loop with 100 foot lead-in shall detect Class 2, 3 and 4 vehicles traveling from three miles per hour to 80 miles per hour.
- 3.7.12 A loop detector unit channel connected to a 6 X 80 foot single turn loop shall detect class 2, 3 and 4 vehicles moving at three miles per hour.
- 3.7.13 All of the above tests shall also be performed with 1000 foot lead-in except paragraphs 3.7.8 and 3.7.9.
- 3.7.14 Other NEMA environmental tests may be performed.

3.7.15 The engineer may require that two sample detector units, card rack, and power supply be forwarded to the department test facility in Austin for Testing.

#### 4.0 **Cabinet Door**

4.1 The cabinet shall be provided with one door in front that will provide access to the cabinet. The door shall be provided with three hinges with non-removable stainless steel pins, or a full length piano hinge with stainless steel pins spot welded at the top of the hinge. The hinges shall be mounted so that it is not possible to remove them from the door or cabinet without first opening the door. The bottom of the door opening shall extend at least to the bottom level of the back panel.

4.2 The door and hinges shall be braced to withstand a 50 pound per vertical foot of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. Provisions shall be designed to hold the door open at approximately the 90° and 180° positions. A switch shall be wired to the door to deactivate the display when the door is closed (pin 58).

4.3 The cabinet door shall be fitted with a Number 2 Corbin lock and a cast aluminum or chrome plated steel handle with a 2 inch (minimum) shaft and a three point latch. The lock and latch design shall be such that the handle cannot be released until the lock is released. One key shall be provided for each cabinet. The lock shall be located to be clear of the arc of the handle. The door handle shall be capable of being padlocked in the closed position.

4.4 A gasket shall be provided to act as a permanent dust and weather resistant seal at the controller cabinet door facing. The gasket material shall be of a nonabsorbent material and shall maintain its resiliency after long term exposure to the outdoor environment. The gasket shall have a minimum thickness of 3/8 inch. The gasket shall be located in a channel provided for this purpose either on the cabinet or on the door(s). An "L" bracket is acceptable in lieu of this channel if the gasket is fitted snugly against the bracket to insure a uniform dust and weather resistant seal around the entire door facing. Any other method is subject to purchaser approval during inspection of an order.

4.5 A locking auxiliary police door shall be provided in the door of the cabinet to provide access to a panel that shall contain a signal shutdown switch, a signal flash switch, a manual-automatic switch, and a manual advance push-button switch on a six foot retractable cord.

4.6 The police door shall be gasketed to prevent entry of moisture or dust and the lock shall be provided with one brass key.

4.7 A heavy gauge vinyl plastic pouch shall be riveted to the inside of the cabinet door. The pouch shall be approximately 12 X 17 inch and large enough to accommodate a copy of the cabinet wiring diagram, controller manual, and documentation for other accessories.

#### 5.0 **AUXILIARY EQUIPMENT**

5.1 The following switches and necessary related circuitry shall be provided in the police door of the cabinet. mounted in an easily accessible location:

- A. Normal-Test Switch - This switch shall, when in the TEST position, allow the Ramp Meter Signal Controller to operate normally while disconnecting the AC+ power bus for the advance warning flasher and signal load switch outputs and either flash the ramp metering yellow signal or allow all signals to remain dark, depending on the position of the Emergency Flash Switch and the status of the Flash Command Circuit. The Normal-Test Switch, when in the TEST position, shall disconnect the On-Line Command Input and shall provide a logic ground signal on the Local Control Confirm Circuit Output. The switch, when in the NORMAL position, shall cause the Ramp Meter Signal Controller to operate normally.
- B. On-Line Command and On-Line Confirm Circuit - An On-Line Command and On-Line Confirm Circuit shall be provided external to the Ramp Meter Signal Controller. When activated by a logic ground true input, the On-Line command shall cause the Remote Control Input of the Ramp Meter Signal Controller to be activated and shall provide a logic ground signal on the On-Line Confirm Circuit output.
- C. Computer Disable Switch and Local Control Confirm Circuit - A Computer Disable Switch and Local Control Confirm Circuit shall be provided external to the Ramp Meter Signal Controller. The Computer Disable Switch, when in the ON position, shall disconnect the On-Line Command input such that remote computer control can be disabled at the ramp if necessary. The Computer Disable Switch, when in the ON position, shall provide a logic ground signal on the Local Control Confirm Circuit output.

The circuitry necessary to perform the above operations shall be of either solid state or relay design. The Flash Command, Remote Control and On-Line Command Circuit inputs and the On-Line Confirm and Flash Confirm Circuit outputs shall terminate at designated terminal strips within the controller cabinet.

All switches shall be properly wired to terminal strips within the cabinet and shall be of proper size for the application. Each switch shall be permanently identified as specified.

## 6.0 **WIRING**

- 6.1 All wiring within the cabinet shall be neat and routed such that opening and closing the door or raising or lowering the back panel will not twist or crimp the wiring. All wiring harnesses shall be either braided, sheathed in nylon mesh sleeving, or made of PVC or polyethylene insulated jacketed cable. Wiring leading to the cabinet door shall be of PVC jacketed cable only.
- 6.2 **Size**
  - 6.2.1 All conductors between the main power circuit breakers and the signal power bus shall be a minimum size 10 AWG stranded copper. All conductors carrying individual signal lamp current shall be a minimum size 16 AWG stranded copper. All AC service lines shall be of sufficient size to carry the maximum current of the circuit or circuits they are provided for. Minimum cabinet conductor wire size shall be 22 AWG stranded copper. All wiring and insulation shall be rated for 600V or greater.
  - 6.2.2 Conductors for AC common shall be white. Conductors for equipment grounding shall be green. Conductors for AC power shall be black. All other conductors shall be a color different than the foregoing.

- 6.3 A barrier terminal block with a minimum of three terminals and one compression fitting designed to accept up to a #4 AWG stranded wire shall be provided for connection of the AC power lines. The block shall be rated at 50 Amperes and shall have double 10-32 X 5/16 inch binder head screw terminals or larger.
- 6.4 All terminals shall be permanently identified in accordance with the cabinet wiring diagram. Where through-panel solder lugs or other suitable connectors are used, both sides of the panel shall have the terminals properly identified. Identification shall be permanently attached and as close to the terminal strip as possible and shall not be affixed to any part which is easily removable from the terminal block panel.
  - 6.4.1 Each controller input and output function shall be distinctly identified with no obstructions, at each terminal point in the cabinet, with both a number and the function designation. The same identification must be used consistently on the cabinet wiring diagrams.
  - 6.4.2 Each load switch socket shall be identified by signal head. No cabinet equipment, including the load switches themselves, may obstruct these identifications.
  - 6.4.3 Each flash transfer base and power relay base shall be properly identified with no possible obstructions.
  - 6.4.4 Each harness within the cabinet shall be distinctly identified by function on the connector end.
  - 6.4.5 The flasher socket shall be distinctly identified with no possible obstruction.
  - 6.4.6 All other sockets needed within the cabinet to fulfill the minimum requirements of the Invitation to Bid, or attachments thereof, shall be distinctly identified.
- 6.5 All controller unit connector pinouts shall be made available on 6-32 X 1/4 inch (minimum) binder head screw terminals on the back panel.
- 6.6 The controller unit harness shall be long enough to reach any point 16 inches above the controller unit shelf.
- 6.7 An unused, spare terminal block providing ten terminals shall be provided. This block shall be double 8-32 X 5/16 inch binder head screw design with shorting bars. These terminal strips shall be located on the lower third of either side of the cabinet.
- 6.8 Copper ground buses shall be provided for both the power supply neutral (common) and chassis ground. Each bus bar must provide a minimum of ten unused terminals with 8-32 X 5/16 inch or larger screws. The AC neutral and chassis ground buses shall be jumpered together with a minimum #10 AWG wire. The logic ground shall be isolated from the AC neutral and terminated on a logic ground bus designed to accept 20 number 20 AWG stranded wires.
- 6.9 Two - 20 Ampere thermal type circuit breakers shall be mounted and wired in the cabinet. One breaker shall protect the base light, trouble light, Ground Fault Circuit Interruption (GFI) receptacle, and fan. The other breaker shall protect the signal load circuits, controller circuits, flasher, and 100D detectors. The breakers shall be Square "D" QUO 150 Series, or equivalent.

- 6.10 The circuit breakers shall be equipped with solder less connectors and installed on the right side wall (facing the cabinet) or lower right hand side of the back panel inside the cabinet. The breakers shall be easily accessible. The breakers shall be positioned so that the rating markings are visible.
- 6.11 A GFI type duplex receptacle shall be mounted and wired in the lower right side wall of the cabinet. This receptacle shall be wired on the load side of one of the 20 Amp circuit breakers.
- 6.12 The above breakers are in addition to any auxiliary fuses that may be furnished with the controller to protect component parts, such as transformers, etc.
- 6.13 A lightning surge suppressor prequalified by the Traffic Operations Division Signal Operations shall protect the load side of the main circuit breaker. Prequalification is based on independent laboratory surge tests and the Traffic Operations Division Signal Operations test requirements.
- 6.14 The suppressor ground connection shall be connected to the cabinet by means of a short, heavy copper ground strap. The strap shall be bonded to the cabinet.
- 6.15 A fluorescent light, with switch, shall be installed in the cabinet. This light shall be turned on when the cabinet door is opened, and turn off when the cabinet door is closed. A switch shall also be provided to turn off any incandescent display that may be used in a controller unit or other equipment. An MOV or other such transient suppression device shall be placed across the AC power input to the light.
- 6.16 A radio frequency interference (RFI) suppressor shall be provided and installed on the load side of the signal circuit breaker and shall be protected by the lightning surge suppressor. This filter shall be rated at 50 amperes and shall provide a minimum attenuation of 50 decibels over the frequency range of 200 KiloHertz to 75 Megahertz.
- 6.17 The lightning surge suppressor shall be connected to the RFI as recommended by the manufacturer. Number 10 AWG or larger wire shall be used for connections to the suppressor, RFI, and load switch bus.
- 6.18 Transient suppression devices shall be placed on the coil side of all relays in the cabinet. DC relay coils shall have, as a minimum, a reverse biased diode across the coil. AC relays shall have MOV's or equivalent suppression across their coils. RC networks are acceptable. One suppression device shall be supplied for each relay.
- 6.19 Except where soldered, all wires shall be provided with lugs or other approved terminal fittings for attachment to binding posts. Insulation parts and wire insulation shall be insulated for a minimum of 600 volts.
- 6.20 The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power source.
- 6.21 Transfer relays shall be the plug-in type manufactured by Midtex (Part No. 136-62T3A1) or AEMCO (Part No. 136-4992), or equivalent. The relays shall have contacts a minimum of 3/8 inch diameter in size and shall be rated at a minimum of 30 Amps 102/240 VAC, 20 Amps 28 VDC.
- 6.22 A 50 Amp, mercury wetted, relay shall be wired between the RFI filter output and the load switch power bus. The signal shutdown switch and the flash switch shall control the relay.



## 7.0 **DOCUMENTATION**

- 7.1 Each cabinet shall be provided with the following documentation:
- A. Three complete, accurate, and fully legible cabinet wiring diagrams.
  - B. Complete parts list including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.
  - C. Manufacturer's specifications for cooling fan which includes the CFM rating of fan

## 8.0 **BID REQUIREMENTS**

- 8.1 The supplier's facilities shall be of sufficient size and staffing that any and all warranty repairs to the cabinet assembly provided can be made on a timely basis. Timely return of equipment is interpreted as a period of time no longer than 18 calendar days from the date of receipt by the supplier to the return receipt of the equipment at the specified location. This requirement may be met by field service. Failure to meet these requirements may result in rejection of future bids.
- 8.2 The controller cabinet shall be delivered on 4 X 4 inch runners covered with 1/2 inch plywood to facilitate handling. Runners consisting of stacked 2 X 2 inch boards are not acceptable.

## 9.0 **TEST AND ACCEPTANCE OF CONTROLLER CABINET ASSEMBLY**

- 9.1 One (1) pre-shipment sample is required within 90 days after purchase order date. The sample will undergo lab tests and may be field tested for usability. If the sample meets all specifications and field tests, it will be considered as part of the order. If however, the sample fails to meet all conditions and requirements of the specification or is rejected for non-usability in field tests, the defaulting vendor may be assessed damages for the purchase of the equipment.
- 9.2 The supplier shall burn in each controller cabinet assembly for a period of 48 hours at a temperature of 140/F or for a period of 96 hours at a temperature of 74/F. A certification shall be included with or attached to each controller cabinet indicating the dates of the burn in period, number of hours, and the burn in temperature.
- 9.3 The controller cabinet assembly may be run under load in a shop environment for a period of one week. During this time the entire controller cabinet assembly will be inspected for compliance with the specifications.
- 9.4 The purchaser may then perform any or all tests described in Part 2 of the latest edition of NEMA Standard Publication **TS-2** on two or more complete controller cabinet assemblies on a random sample basis. If any of the assemblies fail any of the tests, the supplier will be permitted to make one complete repair of the order on a timely basis which will be determined by the purchaser and the testing will be redone. The supplier shall reimburse the purchaser for any retesting required during acceptance. The cost for each retest will be based on time and charges and is estimated at **\$1500.00** per test.

- 9.5 Minor discrepancies noted in sampling and test of this item received shall be corrected within a maximum of 30 days of written notice of the discrepancies or as stated in the notice. Major discrepancies that in the opinion of the purchaser will substantially delay receipt and acceptance of the item will be cause for cancellation of the purchase order. Discrepancies found in partial shipments shall be corrected prior to the delivery of subsequent shipments.
- 9.6 The ramp meter signal controllers and cabinets shall be identical to the approved pre-shipment sample. Any deviations from the approved sample shall be submitted for evaluation and approval before any shipment is accepted for payment.
- 9.7 Deviations from the approved sample after shipment of any parts of the order shall be cause for rejection and non-payment of the remainder of the order. Excessive delays or noncompliance by the vendor at any point in the approval process may be cause for cancellation and non-payment.

10.0 **MEASUREMENT**

- 10.1 Measurement shall be made of each controller cabinet assembly with components required to make a complete assembly as specified in the bid proposal.

11.0 **WARRANTY**

The controller cabinet assembly shall be fully warranted for parts and labor for a minimum of 5 years from the date of acceptance.