# NEMA TS2 Traffic Controller Assemblies JSP-00-04A

**1.0 Description.** This work shall consist of furnishing and installing a NEMA TS2 traffic controller assembly at the location shown on the plans.

**2.0 Training**. MoDOT may require training on the maintenance and operation of NEMA TS2 controller assemblies. Maintenance and operation personnel shall be trained on programming, troubleshooting, maintenance and repair of controllers and all serviceable equipment. Training shall include field level troubleshooting and bench repair. This training shall be for a minimum of sixteen hours over two days. Training shall be conducted at a time and location mutually agreeable by the contractor and the engineer.

**3.0 Equipment.** Delete Secs 902.11, 1092.4.3 and 902.13 in their entirety and substitute the following:

**902.11 Traffic Controller Assemblies.** Traffic controller assemblies are defined as the complete assembly of all required equipment and components for control of traffic signal indications. Traffic controller assemblies shall conform to the requirements of the latest revision of NEMA Standards Publications No. TS 2, hereafter called NEMA. Each assembly shall consist of a controller cabinet, controller unit, back panel, malfunction management unit, all required wiring, switches and connectors and all other equipment as defined in these specifications and as shown on the plans. Double controller assemblies to control two intersections shall consist of a controller cabinet, two controller units, two back panels, two malfunction management units all required wiring, switches and connectors and all other equipment as defined in these specifications and as shown on the plans.

**902.11.1 General.**

**902.11.1.1 Voltage and Temperature Variations.** Variations in the voltage of the power supply from 89 to 135 volts or sustained temperatures inside the cabinet between -30 F(-34 C) and +165 F (+74 C) shall not change the timing of any functions or cause electrical or mechanical damage. Heater elements shall not be used to attain compliance with these requirements.

**902.11.1.2 Fuse Protection.** All controllers and other specified auxiliary equipment shall be properly protected with fuses on each applicable unit. Fuses shall be installed in 1/4 twist or screw-in type fuse holders or shall be automotive blade-type fuses. Pop-out fuse holders shall not be used. There shall be no exposed high voltage contacts on the outside of any unit.

**902.11.1.3 Manuals and Wiring Diagrams.** Three instruction manuals covering all operational and maintenance information shall be furnished with each controller unit, on-street system master, malfunction management unit, for each type of detector, and any other auxiliary unit(s) provided as specified. Four complete cabinet wiring diagrams shall be provided with each controller assembly. The cabinet wiring diagrams shall include labeling for all field terminal connections and shall provide an orientation of the terminal layout that conforms to the intersection information specified.

**902.11.1.4 Warranty.** All controller units, on-street system masters units, malfunction management units, terminals and facilities, detectors and any other auxiliary unit(s) provided as specified shall be warranted by the manufacturer to be free from defects in workmanship and material for at least one year from the date of project acceptance. Any components found to be defective during the warranty period shall be replaced free of charge. All warranties provided shall be transferred to the Commission upon project acceptance. No direct payment will be made for warranties.

**902.11.2 Controller Units (CU).** This section supplements NEMA in describing the general specifications for actuated solid state controller units. If requested by the engineer, the contractor shall provide a prototype controller for testing and evaluation.

**902.11.2.1 CU Configuration.**

(a) CUs shall be NEMA Actuated Type 2 with the following connectors:

Port 1

Port 2

Port 3

Connector A

Connector B

Connector C

(b) CUs shall be capable of operation of a minimum of 12 vehicle and pedestrian phases and 8 overlaps.

(c) All phases and overlaps shall be activated or inactivated by program entry.

**902.11.2.2 Actuated Coordination.** Actuated coordination shall conform to NEMA and the following:

(a) Signal phases controlling the movements on which signal progression is desired (coordinated phases) shall be serviced during a guaranteed period as specified by programming. While under coordination, the designated coordinated phase(s) shall be capable of releasing from a hold status and operating in the actuated mode. The CU shall operate in actuated mode from a designated hold release point to the corresponding force off point(s) of the coordinated phase(s). If the coordinated phase(s) gaps out or reaches the force off point and there is a conflicting phase with a call or recall, the CU shall terminate the coordinated phase(s) and service the next phase in the sequence with a call or recall.

(b) For non-coordinated actuated phases, vehicle and pedestrian detectors shall remain active. The non-coordinated actuated phases may gap out prior to the force off point or shall be forced off at the force-off point and the next phase in the sequence with a call or recall shall be serviced. The coordinator shall provide selectable recall by signal plan for non-coordinated phases. The coordinator shall be capable of fixed time operation for any and all active phases by timing plan.

(c) The coordinator shall be capable of generating individual force-off points for each available phase in each timing plan even though it may not be necessary to use all of phases. The position of the force-off points shall be settable at any percentage point or seconds in any selected timing plan. The coordinator shall be capable of placing force-off points at fixed points in the cycle or floating points as selected by programming. With floating force-offs split times govern the force-off point in each cycle regardless of the starting point of the phase.

(d) The coordinator shall have all of the following methods of synchronizing to the master sync pulse:

(1) Dwell. The coordinator shall establish a new offset by stopping the cycle timer in the coordinated phase(s) green, until the new offset value is reached.

(2) Dwell with Interrupt. The coordinator shall establish a new offset by stopping the cycle timer in the coordinated phase(s) green. The maximum time the coordinator can dwell shall be adjustable from 1 to 99 seconds.

(3) Short-way. The coordinator shall establish a new offset by the shortest route possible.

(e) For hardwire systems, if the sync monitor detects a fault the controller shall revert to internal time based control unless no time based control is programmed. In that case, the CU shall revert to free mode.

**902.11.2.3 Time Base Control.** Time Base Control shall conform to NEMA and the following:

(a) The CU shall be zero time based, settable to the second, programmable for 52 weeks, accommodate at least 3 weekly programs, 12 day programs and not less than 12 exception day programs. Total event changes shall not be less than 160. It shall be possible to interrogate the CU to determine the year, month, day, hour, minute, second, a.m. and p.m., as well as program information programmed in the unit. Indicators shall show the condition of all outputs.

(b) The first program of the day shall be implemented at the beginning of the minute selected. When changing from one cycle length to another while in the coordination mode, the change to the new cycle length shall not occur until the present cycle length has terminated. If the controller is operated in the free mode between cycle lengths, the next cycle length programmed shall begin at the beginning of the minute selected.

(c) The CU shall be capable of generating a daily reference point at which time all coordinated cycles are resynchronized. This daily reference point shall be either 12:00 midnight or a selectable time of which 12:00 midnight could be selected. The resynchronization reference time is an arbitrary point in time which marks the beginning of all cycles on a daily basis.

(d) The CU shall be capable of generating an absolute reference point at which time all coordinated cycles are resynchronized. This absolute reference point shall be a selectable time by date and hour and minute which marks the beginning of all cycles.

(e) Timing base shall be the 60 hertz power line frequency. Timing error shall not exceed plus or minus one second per month from any adjacent CU operating from the same power company substation. Timing error due to power failure or low voltage shall not exceed plus or minus 0.005 percent.

**902.11.2.4 Detector Functions.** The CU shall allow vehicle and pedestrian detector inputs to be programmed to any available phase. In addition to normal detector operation, the CU shall have the following programmable functions for vehicle detector inputs.

(a) Call Detector. A mode of operation where the detection of a vehicle places a locking call into the assigned phase when the assigned phase is not green.

(b) Detector Switching. Besides the normal assigned phase, the detector input can be programmed to switch to a secondary phase while the secondary phase is green and the assigned phase is not green. In all other conditions the detector input acts as a normal detector input for the assigned phase.

(c) Extend Function. While the assigned phase is green, each detector actuation input is extended a programmed amount of time with a range of at least 0 to 99 seconds.

(d) Delay Function. While the assigned phase is not green each detector actuation input is delayed a programmed amount of time with a range of at least 0 to 99 seconds.

**902.11.2.5 Special Functions.** Any special functions, special sequences, or modes of operation specified in the plans or required to operate the specified signal phasing and timing shall be included in the programming capability of the CU.

**902.11.3 Malfunction Management Unit (MMU).** Each controller assembly shall contain a malfunction management unit external to the controller circuitry conforming to NEMA. When the MMU actuates flashing operation, the controller shall freeze or stop timing with the stop time switch in Normal position in the condition causing the actuation until manually reset.

**902.11.3.1** Phases or overlaps with only one signal head shall have load resistors installed across the outputs to prevent a single lamp failure from actuating the MMU.

**902.11.4 Terminals and Facilities.** All terminals and facilities in the controller assembly shall conform to NEMA TS2 Type 1 and the following requirements. For double controller assemblies, two complete sets of all terminals and facilities shall be provided with all items contained in the same compartment as the associated CU.

**902.11.4.1 Wiring and Terminations**

(a) Field Wiring. Incoming field circuits shall be routed horizontally from the conduit to the back of the cabinet, then vertically to the terminal block. All field leads shall be identified by means of round aluminum identification tags with a minimum thickness of 0.1 mils (2.5 mm) attached to the cables with a copper wire to correspond with the plans. The outgoing signal circuits shall be of the same polarity as the line side of the power supply and the common return of the signal circuits shall be of the same polarity as the ground side of the power supply. The power supply shall be provided through three single conductor cables. All field conductors shall be terminated in the controller cabinet on a 600-volt heavy duty one piece mechanical screw connector offset tang assembly attached to a barrier terminal strip. Each mechanical screw connector shall accommodate up to four No. 12 AWG (2.5 mm2) conductors. Each field circuit shall be protected with a 150-volt metal oxide varistor (MOV) with an 80 Joule rating connected to cabinet ground. The MOVs shall be accessible on the front of the back panel and easily replaceable. For double controller cabinets, all wiring for each intersection shall be terminated in the same compartment of the cabinet as the signal controller for that intersection.

(b) Back Panel Wiring. All wiring carrying 120 volts AC shall be discrete insulated wires and shall be soldered directly to lugs on the back of terminal blocks or sockets. All discrete wiring on the back side of the back panel shall be neatly bundled and secured with plastic cable ties.

(c) Any multi-conductor cable shall be contained in an expandable braided sleeve.

(d) Input/output terminals shall be configured according to the following NEMA configurations:

Specified Operation NEMA Configuration (NEMA Table 5.3.1-1)

2 through 8 Phases Configuration 3 (12 Load Switch Positions)

9 through 12 Phases or more than Configuration 4 (16 Load Switch Positions)

4 Overlaps or Pedestrian Phases

(e) In addition to the minimum NEMA requirements, four pedestrian call input terminals shall be provided.

(f) If hardwire interconnection is specified, the following input/output terminals shall be provided:

Timing Plan A Output

Timing Plan B Output

Timing Plan C Output

Timing Plan D Output

Offset 1 Output

Offset 2 Output

Offset 3 Output

Timing Plan A Input

Timing Plan B Input

Timing Plan C Input

Timing Plan D Input

Offset 1 Input

Offset 2 Input

Offset 3 Input

Interconnect Common

(g) Buss Interface Units (BIU) and BIU racks shall be provided for all required terminals and facilities.

(h) All Port 1 cable connectors shall have positive strain relief latches such that tension on the cable will not disconnect the connector from the unit they are connected to.

**902.11.4.2 Switches and Controls**. Each controller cabinet shall be furnished with the following switches and controls. For double controller cabinets, two sets of switches and controls are provided, one set for each controller installed in each compartment.

(a) Power Interrupt Switch - A switch located inside the main cabinet shall interrupt electrical power to the controller during maintenance on the controller. Operation of this switch shall not affect the flash operation. This switch shall not be accessible via the police panel.

(b) Flash Switches - The following switches shall place the signal on flash. Operation of these switches shall not affect the electrical power supply to the controller. When the signals are returned to normal operation the external start shall be activated causing the controller to revert to the programmed initialization phase(s).

(1) Each controller cabinet shall be furnished with a clearly labeled flash switch mounted in the access or police panel.

(2) Each controller cabinet shall be furnished with a clearly labeled flash switch mounted on the cabinet door in the inside of the cabinet.

(c) Stop Time Switch - A three position switch mounted inside the main cabinet shall provide the following functions:

(1) Stop Time - Causes the controller to stop time.

(2) Normal - Allows the controller to cycle all phases, but during MMU flash causes the controller to stop time.

(3 Run - Allows the controller to cycle all phases and during any flashing operation allows the controller to continue cycling all phases without displaying them on the signal heads.

(d) Switches or relays which completely interrupt power to the signal heads other than the protective circuit breaker shall not be installed in the cabinet.

(e) If specified, a manual operation push button shall be installed in the police panel. The push button shall be wired for manual operation of the signals. The push button shall be water resistant and designed to protect the user against electrical shock and shall be supplied with a coiled cord with a nominal 6 foot (2-m) stretched length. A clearly labeled switch shall also be installed in the police panel to switch between manual or automatic operation of the controller.

**902.11.4.3 Detector Facilities.**

(a) At a minimum, one NEMA Configuration 2 detector rack shall be provided with the associated BIU. If more than 16 detector channels are specified, additional NEMA Configuration 1 or 2 detector racks and associated BIU(s) shall be provided for the required number of detectors. Each detector channel shall be assigned to a separate detector input into the CU.

(b) Detector loop connections shall be provided for the total number of detector channels available in the detector racks supplied as specified above.

(c) Two terminals shall be provided for each detector as follows.

(1) Screw terminal strips mounted vertically on the left side of the cabinet approximately 6 inches (150 mm) from the bottom of the cabinet.

(2) All inductive loop detector inputs shall be protected with two 30-volt metal oxide varistors (MOV) with a 30 Joule rating. An MOV shall be connected between each field terminal and cabinet ground.

(d) The detector rack shall be attached to the controller cabinet shelf by an easily removable attachment. Sufficient wire lengths shall be provided for access to the back of the rack. The rack shall not block the back panel or other termination panels.

(e) Unless shown differently on the plans, each detector field input into the card rack shall be associated with the appropriate card position as follows:

*Channel Card Position*

1 2 3 4 5 6 7 8

1 Phase 1 1 or 6 6 6 3 3 or 8 8 8

2 Phase 5 5 or 2 2 2 7 7 or 4 4 4

(f) Each detector channel shall be clearly labeled with detector number, phase and direction.

**902.11.4.4 Power Distribution**.

(a) Each assembly shall contain a separate aluminum power panel located in the lower right portion of the cabinet containing the following equipment:

(1) Main breaker - one type B circuit breaker conforming to Sec 901.4.4 that shall interrupt power to the controller and signals. The frame size and trip rating is shown on the traffic signal plans or designated in the contract.

(2) Auxiliary breaker - one type B circuit breaker conforming to Sec 901.4.4 that interrupts power to cabinet lamp and receptacle. The frame size and trip rating shall be 15 amperes.

(3) One mercury contactor that controls power to the signal bus.

(4) One radio frequency interference suppresser.

(5) One AC service transient suppression device.

(6) One terminal block for AC power input.

(7) One earth ground bus terminal block.

(8) One isolated AC neutral bus terminal block.

(b) Each controller assembly shall have a fluorescent lighting fixture.

**902.11.5 Auxiliary Interfaces for Controllers.** Interface panels shall be aluminum panels with de-burred edges and rounded corners installed in the controller cabinet containing the required terminals and equipment. Interface panels shall be neatly laid out, neatly wired and easily accessible. For double controller cabinets, the auxiliary interface shall be located in the same compartment as the associated CU.

**902.11.5.1 Pre-emption Interface.** The preemption operation and interface shall conform to NEMA. The pre-emption interface shall include any field wire termination panels, relays or isolators, wiring and connectors required for proper operation. Each preemption field input shall be protected with a metal oxide varistor (MOV). For 120 volt inputs, a 150-volt MOV with an 80 Joule rating shall be used and for 24 volt inputs, a 30-volt MOV with a 30 Joule rating shall be used.

**902.11.5.2 Hardwire Master and Local Coordination Interface.** The coordination interface shall consist of any field wire termination panels, wiring and connectors required for proper operation. The master coordination interface shall output commands to the local controllers in the system. Local coordination interfaces shall accept command inputs from the master coordination interface. Coordination interfaces shall be connected to one another or to a telephone interconnection unit, by a multi-conductor cable.

The coordination interface shall provide a control terminal strip for 7 or 12 wire interconnect as specified in the plans, vertically or horizontally mounted, that shall be located 6 (150 mm) to 8 (200 mm) inches above the bottom of the cabinet. Control voltages applied to the terminals are associated with the following input/output functions:

7 - Wire 12 – Wire

Neutral Neutral

Timing Plan A (Dial 2) Timing Plan A (Dial 2)

Timing Plan B (Dial 3) Timing Plan B (Dial 3)

Timing Plan C (Split 2) Timing Plan C (Split 2)

Offset 1 Timing Plan D (Split 3)

Offset 2 Offset 1

Automatic Flash Offset 2

Offset 3

Automatic Flash

All command voltages applied to these terminals shall be 120 volts AC. Terminals for interconnect cable shall be fused and provided with a 150-volt metal oxide varistor (MOV) with an 80 Joule rating. Interface circuitry between this terminal strip and the controller shall be by solid state or relay logic.

**902.11.5.3 Closed Loop System Interface.** If the controller assembly will be part of a closed loop system, all components required to interface with the system shall be in accordance with the plans.

**902.11.5.4 Dial-Up Modem Interface.** This panel shall provide for interfacing of a leased, unconditioned telephone drop to a Hayes compatible modem that connects to the on-street system master or local controller as specified in the plans. The panel shall be mounted on the inside of the cabinet on the right side. A telephone network interface, such as a Siecor CAL3000 or other approved interface acceptable to the local phone company shall be attached to the aluminum panel. The telephone interface shall also include the installation of the necessary cable, connectors, etc. to connect the interface to the telephone drop provided by the local telephone company. The contractor shall be responsible for the installation of the phone line and coordinate this through the local telephone company.

**902.11.5.5 Remote "ON - OFF" Switch (Pedestrian Interval Sequence).**  The following type "On - Off" switches shall be furnished as specified:

(a) Type I. This item shall consist of one manually operated heavy duty switch in a circuit not exceeding 18 volts. Necessary relays shall be located in the controller cabinet for including or excluding the pedestrian phase in the phasing sequence or switching signals between flashing and sequence operation. This shall be accomplished by energizing or de-energizing the pedestrian signal indications and push-button detectors. The switch shall be enclosed in a weatherproof, cast aluminum housing equipped for post mounting. The housing shall have a suitable lock, the key of which shall not unlock the controller cabinet. The housing shall be tapped for conduit.

(b) Type II. This item is operationally identical to Type I except the switch may be 120 volts and shall be located in the access panel of the controller cabinet.

**902.11.5.6 Other Interfaces.** Where other interfaces are specified in the plans or required for specified operation, the required circuitry and any other required devices shall be installed on an interface panel or in a suitable metal enclosure.

**902.11.6 Auxiliary Devices.** Each auxiliary unit shall be enclosed in a suitably finished metal or molded plastic case. It shall be mounted in the controller cabinet unless otherwise specified. The function of each auxiliary unit shall be indicated by an identification plate on the case. Auxiliary equipment cases shall be ventilated. Temperature, voltage and frequency shall meet the requirements of Sec 902.4.5 unless otherwise specified.

**902.11.6.1 External Time Switches.** External time switches shall be solid state, key board entry and contain filtering and shielding circuitry to protect the unit's operation against electrical interference. Timing shall be based on the 60 Hz power supply frequency. Each unit shall contain a programmable automatic central daylight time compensation feature. Each unit shall contain a back-up power source to maintain time and memory functions during loss of AC power. Each unit shall provide a weekly program with at least 20 event changes per week.

**902.11.6.2 Dial-Up Modem.** The unit shall be an auto-dial, auto-answer modem and shall be installed in the controller cabinet as specified on the plans. If specified an identical modem shall be installed at the central office computer facility in the MoDOT district office. The modem shall be Hayes compatible capable of responding to the standard "Hayes command set". The modem shall be self-contained. The unit shall be powered by a nominal 120 VAC from the duplex service outlet provided in the cabinet. The modem shall be capable of operating at all standard baud rates from 300 to 56K baud over a standard dial-up, unconditioned telephone line. Installation shall include the appropriate interface cable to connect to an RJ-11 telephone jack on the telephone interface panel, the RS-232 cable from the modem to the system master, all other cabling, connectors and incidental items necessary for operation.

**902.11.7 Controller Cabinets.** Controller cabinets shall be cast aluminum or 0.125 inch (3.2 mm) reinforced sheet aluminum alloy and be of clean-cut design and appearance. The cabinet shall provide ample space for housing all equipment and components. Controller cabinets housing solid state controllers shall be furnished with unused cabinet space measuring 18 inches (450 mm) wide by 12 inches (300 mm) high by 12 inches (300 mm) deep. Cabinet size shall be not less than 54 inches (1350 mm) high by 38 inches (950 mm) wide by 25 inches (625 mm) deep and support a 12 or 16 position back panel. The cabinet shall contain a rigid shelve of such construction that the CU and auxiliary equipment may be withdrawn from the cabinet without breaking any electrical connections or interrupting normal controller operation.

(a) A hinged door or doors shall provide complete access to the interior of the cabinet. Door holds shall be furnished which shall hold the door in an open position at least 90 degrees from the closed position. The doors shall fit against a rain tight gasket. Each door shall be provided with a cabinet lock and shall have a stamped or raised outside designation, "Traffic Control" or other approved identification. An auxiliary door, positioned on each main cabinet door, equipped with a rain tight gasket, shall allow access to a switch panel and shall be equipped with a lock whose key will not unlock the main door. Two keys shall be furnished for each type lock used. The door hinges and pins shall be of corrosion resistant metal. Pins shall be rolled or solid rod, at least 1/8 inch (3.18 mm) in diameter, except if continuous hinges are furnished, the pins shall be continuous the full length of the hinges and shall be not less than 1/16 inch (1.59 mm) in diameter.

(b) The back panel in all controller cabinets shall be hinged at the bottom to permit the top of the panel to be rotated forward and down to an angle of not less than 45 degrees with all components, including load switches, attached for maintenance purposes. The bottom of the back panel shall be not less than 6 inches (150 mm) above the bottom of the cabinet.

(c) Cabinets shall have a thermostatically controlled ventilating fan with exhausting capability, in an enclosure, of at least 150 cubic feet per minute (4.25 m3/min) for cabinets up to 30.5 cubic feet (0.86 m3) and at least 250 cubic feet per minute (7.08 m3/min) for cabinets 30.5 cubic feet (0.86 m3) and more, installed in the top of the cabinet. These cabinets shall be supplied with a replaceable furnace type fiberglass filter of at least one square foot (m2) area mounted behind louvers in the lower one fourth of the door.

(d) Double controller cabinets for two controllers shall be not less than 57 inches (1425 mm) high by 74 inches (1850 mm) wide by 17 inches (425 mm) deep and shall support two 12 position back panels. All double cabinets shall have two doors that are hinged on the outside corners of the cabinet so that the doors open away from each other. Double cabinets shall have a divider between the two halves of the cabinet with an 8-inch (200-mm) opening between the compartments at the bottom of the divider for wiring between the compartments.

**1092.4.3 Induction Loop Detectors.** Induction loop detectors consist of loop detector cable in the pavement, lead-in cables, and associated conduits, pull boxes and loop detector units. The following section covers loop detector units. Other components of loop detectors are covered in other parts of Sec 902 and Division 1000. Loop detector units shall conform to NEMA. If specified, each channel shall have extension and delay timing features as specified in NEMA. Each detector shall have a regulator for the power input. The regulator shall have the appropriate power and voltage rating for operation of the detector.

**1092.4.3.1 Card Rack Detectors.** All detectors shall be card rack mounted detectors as specified in NEMA unless otherwise specified in the plans.

**1092.4.3.1.1 Card Rack Dual Output Detectors.** Card rack dual output detectors shall conform to NEMA and the following. Dual output detectors shall provide two relay outputs per induction loop detector. One output shall be capable of pulse detection for the purpose of traffic counting, speed and occupancy measurements. The other output shall be capable of presence detection. Each detector output shall be assigned to a separate detector input into the CU.

**1092.4.3.2 Shelf Mounted Detectors.** If shelf mounted detectors are specified, each shelf mounted inductive loop detector unit shall be self-contained. The detector shall conform to the applicable sections of NEMA and the following. The main chassis shall include the power supply for 120 VAC line power, line fuse and MS type connector.

(a) The MS connector shall be a chassis jack, type MS3 102A-18-1P and cable plug, type MS3160A-18-1S, with a type MS3057-10 cable clamp and boot.

(b) Wire size for the cable shall be 18 AWG (1 mm2) minimum and continuous between the connections and the detector panel. Minimum cable length shall be 6 feet (18 m).

(c) The pin connection shall be as follows:

*Pin Function*

A 120 VAC (Common)

B Relay Output (Common)

C 120 VAC (Line)

D Loop Input

E Loop Input

F Relay Output (Normally Open)

G Relay Output (Normally Closed)

H Chassis Ground

I Spare

J Time Control

**902.13 Other Detection Devices.**

**902.13.1 Probe-Type Detectors.** Probe-type detectors shall be as specified on the plans and shall conform to the following.

(a) The sensing probes shall be cylindrical having maximum dimensions of 7/8 inch (21.9 mm) diameter by four inches (100 mm) long. The sensing probes shall be suitable for installation in a one inch (25 mm) diameter bored hole. The interconnecting four conductor cable and lead-in cable shall be suitable for installation in a 1/4 inch (6.25 mm) wide pavement sawed slot.

(b) The jacket on the interconnecting cable and the casing on the sensing probe shall be an abrasion resistant polyurethane elastomer. The device shall be impervious to moisture and chemically resistant to all normal motor vehicle petroleum products. Lead-in cables shall be shielded, chemical resistant and completely waterproof.

(c) The combined probe sets, manufacturer specified lead-in cable and detector probe shall detect all vehicles up to a lead-in cable length of 750 feet (228.6 m) with up to 6 probes per set.

(d) The conductor cable from the probes to the detector panel in the controller assembly shall be as specified by the detector manufacturer, shall be continuous and un-spliced and shall be a minimum of 50 feet (15.2 m) in length. Probes shall be assembled in a set to form a vehicle detector as shown on the plans. No more than 6 probes shall be assembled as a set. The cables between probes shall be long enough to provide the spacing shown on the plans plus 5 feet (1.5 m). If no spacing is shown, 15 feet (5 m) of cable shall be provided between probes. Each set of probes shall have one lead-in cable.

(e) Probes installed under bridge decks shall be protected by completely encapsulating them in a conduit system. The probes shall be oriented so that the detection zone is above the bridge deck and shall be installed in junction boxes with gaskets anchored to the bottom of the deck. The junction boxes shall have a minimum size of 6 (150 x 6 (150) x 4 inches (100 mm) and the probes shall be rigidly anchored in the box. The probes shall be no more than 18 inches (450 mm) below the top of the bridge deck. Conduit shall be sized so that the probe and cable can be pulled through the conduit. Any conduit bends shall be such that probe and cable can be pulled through the bend. External conduit on the structure shall conform to Sec 902.5.3.

**902.13.1.1 Induction Detector Probes**. The encapsulated induction detector probe shall detect the passage or presence of all vehicles with a standard induction loop detector amplifier.

(a) The induction detector probe shall operate in a temperature range from -35 F (-37 C) to +165 F (74 C) with 0 to 100 percent humidity.

(b) The operating field intensity range shall be 0.2 to 1.0 Oersted with a nominal inductance of 20 uH plus 20 uH per 100 feet (30 m) of cable. The nominal DC resistance shall be 0.5 ohms plus 3.2 ohms per 100 feet (30 m) of probe cable.

**902.13.2 Push-Button.** Pedestrian push-button detectors shall be direct push contact type. Each detector shall be a removable contact assembly mounted in a cast aluminum case. The housing shall be shaped to fit the curvature of the post to which it is attached and shall provide a rigid installation. Contacts shall be normally open, entirely insulated from the case and operating button and have connecting terminals. The case shall have one outlet tapped for 1/2-inch (12.5-mm) pipe. The operating button shall be recessed and made of brass or corrosion resistant metal alloy or non-metallic material. The operating voltage shall not exceed 24 volts. The entire assembly shall be weatherproof, secure against electrical shock to the user and of such construction as to withstand continuous hard usage.

**902.13.3 Microwave Vehicle Detectors.** The unit shall detect all licensed vehicles moving within the field of detection at speeds from 2 to 80 miles per hour (3.2 km/hr. to 128.4 k/hr.). The unit shall have a minimum detection range from 3 to 200 feet (1 m to 66.7 m) for all licensed vehicles. The pattern spread of the detection field shall be no more than 16 degrees. The unit shall be self-tuning and capable of continuous operation over a temperature range of -35 F (-37 C) to 165 F (74 C). The unit shall be microprocessor based using Doppler microwave at an operating frequency of 10.525 GHz. The unit shall have Federal Communications Commission (FCC) certification and be tested to the applicable FCC specifications. The unit shall be capable of side-fire mount or overhead mount. The enclosure shall be constructed of aluminum or stainless steel and shall be water resistant. The unit shall be capable of detecting directional traffic and the direction shall be user selectable. All user operated controls and adjustments shall be clearly marked and easily accessible. The unit shall have a relay detection output to the controller with a minimum 5 amp rating and be designed to place a constant call to the controller in the event of any failure. The unit shall have an easily accessible indicator showing activation of detection relay. Required wiring shall be as specified by the manufacturer. Mounting hardware for the type of mounting shown on the plans and power supply equipment shall be as specified by the manufacturer and shall be provided with the unit.

**902.13.4 Ultrasonic Presence Detectors.** The unit shall detect the continuous presence of any object within the field of detection. The unit shall have a minimum detection range from 3 (1 m) to 24 feet (8 m) from the front face of the unit and the detection range shall be adjustable. The detection pattern shall be conical with a nominal beam width of 20 degrees. The unit shall be capable of continuous operation over a temperature range of -35 F (-37 C) to 165 F (74 C). The unit shall be self-tuning and operate in the ultrasonic frequency range. The unit shall be capable of side-fire mount or overhead mount. The unit shall contain a variable detection time delay up to a minimum of 10 seconds. All user operated controls and adjustments shall be clearly marked and easily accessible. The enclosure shall be constructed of aluminum or stainless steel and shall be water resistant. The detector shall have a relay detection output to the controller with a minimum 5 amp rating and be designed to place a constant call to the controller in the event of any failure. The unit shall have an easily accessible indicator showing activation of detection relay. Required wiring shall be as specified by the manufacturer. Mounting hardware for the type of mounting shown on the plans and power supply equipment shall be as specified by the manufacturer and shall be provided with the unit.

**4.0 Construction Requirements.** Construction requirements shall conform to Sec 902.

**5.0 Method of Measurement.** Method of measurement shall conform to Sec 902.

**5.1** Measurement of training including all specified training will be made per each.

**6.0 Basis of Payment**. Accepted NEMA TS2 traffic controller assemblies will be made at the contract unit price per each. Payment will be considered full compensation for all labor, equipment and material to complete the described work.

**6.1** If training is required by the engineer, payment for the training will be made at the contract unit price per each. Payment will be considered full compensation for all labor, equipment and material to complete the described training.

**6.1.1** If training is not required as determined by the engineer, no payment will be made for training.

**6.2** No direct payment will be made for programming the local intersection controllers and the on-street master after installing the system software.