

**DISTRICT OF COLUMBIA  
DEPARTMENT OF TRANSPORTATION  
STANDARD SPECIFICATIONS FOR HIGHWAYS AND STRUCTURES  
SUPPLEMENTAL SPECIFICATIONS**



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**U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION**



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## 2007-TS-001

### TYPE 170 MICROPROCESSOR-BASED TRAFFIC SIGNAL CONTROLLER AND CABINET ASSEMBLY

#### 1.0 GENERAL

- 1.1 The Contractor shall supply Type 170 Traffic Signal Controller System-Hardware Specifications provided by the Federal Highway Administration, Implementation Package FHWA-IP-78-16, including all subsequent addenda. The controller assemblies shall consist of a type 170E Controller, a cabinet, a cabinet base, and auxiliary equipment necessary for a complete electrical system, all mounted in the controller cabinet. Specifications for auxiliary equipment, which may be purchase separately, are contained within this document. This specification (issued July 10, 2003) supersedes all previous issues.
- 1.2 All equipment furnished under these specifications shall be of solid –state design. Use of vacuum gaseous tube or electro-mechanical devices with the equipment is not acceptable unless otherwise indicated.
- 1.3 The equipment to be furnished shall be in compliance with the “Traffic Signal Control Equipment Specifications” published by the State of California, Business, Transportation & Housing Agency; Department of Transportation (CALTRANS), dated January 1989, and all current Addenda, through Addendum 8, and revisions, except as modified in these specifications. In the event of a conflict these specifications shall prevail.
- 1.4 All components supplied under this contract shall be listed on the CALTRANS Qualified Product List (QPL) that is in effect on the issue date of this invitation. In the case of the enhanced conflict monitor monitor, and 170E controller, the vendor’s enhanced monitor and 170E controller shall be listed on the CALTRANS QPL that is in effect on the issue date of this invitation. In the case of the modified 336SS and 332 cabinets, the vendor shall have a standard 336 cabinet, 332 cabinet, or 332A cabinet that is listed on the CALTRANS QPL that is in effect on the issue date of this invitation. (All references to 336 shall mean 336SS cabinet). The modified equipment shall be of substantially similar design and production quality, as determined by the District of Columbia or its designated representative, as those standard items that are listed on the CALTRANS QPL. Any other equipment that is not addressed by the CALTRANS TSCES specification that is in effect on the issue date of this invitation is not covered by this requirement. For each piece of equipment that is covered by this requirement, the vendor shall submit a notarized certification the equipment is listed on the QPL that was in effect on the date of issue of this invitation. Failure to provide this certification shall cause the bid to be rejected as unresponsive. If during the course of the contract, any piece of equipment ceases to be listed on then current QPL, the District may, at its option, require the vendor to provide a suitable replacement that is listed on the then current QPL at no additional cost.
- 1.5 Documentation and Equipment Acceptance
- 1.6 Two (2) manuals shall be supplied with each item.
- 1.7 Manuals shall be printed using a Gothic Legal 12 (or equal size) typeface font, on 8.5 by 11 inch paper. Schematics, layouts, parts list and plan details shall have a minimum font size of Gothic Legal 18 and may be on 11 by 17 inch sheets, but the sheets must be neatly folded to 8.5 by 11 inch size. The manual shall be bound in durable covers.
- 1.8 Each manual shall include the following:
  - 1.8.1 General Description
  - 1.8.2 General Characteristics
  - 1.8.3 Installation
  - 1.8.4 Adjustments
  - 1.8.5 Theory of Operation
  - 1.8.6 Systems Description (include block diagram)

- 1.8.7 Detailed Description of Circuit Operation, with Signature Analysis
- 1.8.8 Maintenance
- 1.8.9 Preventive Maintenance
- 1.8.10 Trouble Analysis
- 1.8.11 Trouble Shooting Sequence Chart
- 1.8.12 Wave Forms and Description
- 1.8.13 Voltage Measurements
- 1.8.14 Alignment Procedures
- 1.8.15 Parts list (to include circuit and board designation, part type and class, power rating and component manufacturer and original manufacturer's part number.
- 1.8.16 Electrical Interconnection Drawing.
- 1.8.17 Schematic and Logic Diagram.
- 1.8.18 Assembly drawings and a pictorial diagram showing physical locations and identification of each component.
- 1.8.19 The serial numbers and revision numbers of equipment covered by manuals shall be printed on the front cover of the manuals.
- 1.8.20 Manuals for the Model 170E Controller Unit, 332 cabinets, 336 cabinets, and all plug in units shall be furnished with the item and enclosed in the shipping container.
- 1.8.21 Prior to final printing, a preliminary draft of all manuals shall be submitted to the Engineer for approval. The vendor also shall submit one prototype of each piece of equipment that is being provided. Within 60 days, the District will review the documentation and equipment for compliance with specifications. After the review is complete, the District will notify the vendor of any changes or corrections that may be required. The vendor shall remedy the defect and shall re-submit the equipment and documentation within 10 days. The District will complete subsequent reviews within 45 days. No equipment may be shipped until the District has approved all equipment designs and associated documentation. The District, at its discretion, may cancel the order after any failure of the equipment or documentation to meet specification requirements. No payment shall be made for any equipment or associated shipping costs for any piece of equipment that does not meet specification requirements.
- 1.8.22 Training.
- 1.8.23 On orders of 100 or more cabinets, the Contractor selected shall provide experienced instructors and training material in order to present formal classroom as well as "hands-on" training in the operation and maintenance of equipment being supplied as part of this contract.
- 1.8.24 Two (2) training courses shall be conducted in the area of 170E controller and cabinet operations and 170 controller and cabinet maintenance. Thirty (30) hours of instruction shall be provided for each course. The courses shall be held in the District of Columbia at facilities provided by the District or at leased facilities provided by the Contractor. The courses shall be conducted at a time mutually agreed upon by the District and the Contractor. The training material generated for each course shall contain "hand-outs" for each attendee, which shall serve not only as subject guidance, but also as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following the course completion.
- 1.8.25 At least sixty (60) days prior to the commencement of the training courses, the Contractor shall submit to the Engineer, a detailed course curriculum, draft manuals and materials, and a resume of the instructor(s). The Engineer will review the course submittal data within in thirty (30) days and will return his comments to the vendor. The vendor shall make the indicated corrections and re-submit the materials. Training courses shall not commence until thirty (30) days after the Engineer's approval of the course submittals.

- 1.8.26 The Contractor shall provide fifteen (15) copies of the approved course materials (or copies for all scheduled attendees and two (2) spare copies, whichever is greater) at least fifteen (15) days in advance of the scheduled course.
- 1.8.27 Each of the two (2) training courses shall consist of five (5) consecutive days of six (6) hours each of classroom and "hands-on" training in accordance with the approved training curriculum. No more than twelve (12) operational and maintenance personnel will attend each course.
- 1.8.28 Manufacturer's personnel shall conduct two (2) Model 170E Controller training courses. The courses shall completely cover the operation and maintenance of the controller, cabinet, and all auxiliary equipment. The course shall provide all necessary instruction to ensure complete operations, troubleshooting, and repair training.
- 1.9 Supplementary Equipment Training
  - 1.9.1 When supplemental equipment is required per section 1.6A, the Contractor(s) selected shall provide a one-time minimum of twelve (12) hours of formal classroom as well as "hands-on training for District of Columbia personnel in the operation and maintenance of equipment being supplied as part of this contract. The training shall be conducted over a period of two (2) consecutive days.
  - 1.9.2 Manufacturer's personnel shall conduct Supplementary Equipment Training. The Supplemental Equipment Training shall provide sufficient "hands-on" training for proper application of this equipment in the maintenance of the 170E Controller, Cabinet Assemblies, and Auxiliary Equipment.
  - 1.9.3 Training shall be coincidental with the delivery of the first piece of equipment and completed within three (3) months after the first delivery.

**2.0 MODEL 170E CONTROLLERS**

- 2.1 The Model 170E Controller Units shall conform to the provisions of Chapter 2 of Specification FHWA-IP-78-16, and these Specifications.
- 2.2 The Model 170E Controller Units shall conform to the provisions of the "Traffic Signal Control Equipment Specifications" published by the State of California, Business, Transportation, & Housing Agency; Department of Transportation (CALTRANS), dated January 1989, and all current Addenda, through Addendum 8, and Revisions, except as modified in these specifications. In the event of a conflict these specifications shall prevail.
- 2.3 Each controller assembly supplied shall include the following equipment:

<u>QUANTITY</u>	<u>DESCRIPTION</u>
1	Model 336-SS Cabinet with Base Adapter
1	Type 170E HC11 Controller Unit with Program module
1	Pull-out drawer
2	Model 496 modem
2	Fluorescent lamp fixtures
18	Model 200 Switch Packs (Load Switch)
2	Model 204 Flasher Units
2	Enhanced Conflict Monitor Unit (Model 218 DC or Model 225)
4	Model 242 Two-Channel D.C. Isolators
4	Model 222 Two-Channel Loop Detector Amplifiers
4	Cabinet Anchor Rods and Bolts (Only provide with new foundations?)
1	Input File
1	Output File with Hard-wired option
1	Auxiliary Output File with Hard-wired option
1	Power Distribution Assembly (PDA #2) with Circuit Breaker Option
1	Communications Assembly
7	Model 430 "Heavy Duty Relays"
20	Jumper Plugs for Output File Flash Programming (12 Red, 4 Yellow, 4 White)

**TYPE 170 MICROPROCESSOR-BASED TRAFFIC SIGNAL CONTROLLER AND CABINET ASSEMBLY**

<u>QUANTITY</u>	<u>DESCRIPTION</u>
1	STEP Diagnostic Program with Manuals
1	LADIAG R3F Diagnostics with Manuals
1	PC Downloading cable
1	PC Extension cable – to extend PC Downloading cable

2.4 170E HC11 Controller Unit

- 2.4.1 This specification pertains to the 8HC11 CPU Module and Model 412HC Program Module.
- 2.4.2 The model 170E traffic controller unit shall meet all requirements of this specification.
- 2.4.3 The 68HC11 CPU board shall replace the standard CPU module for the Model 170E controller. It shall use a 68HC11F1 microprocessor instead of a 6802 microprocessor.
- 2.4.4 The 412HC Program Module shall be a non-functional Program Module that will be used in place of the standard Model 412C Program Module.
- 2.4.5 The 68HC11 based CPU Module shall use a 68HC11F1 MPU to replace the existing 6802 MPU-based CPU module installed in standard 170E controllers. The MPU shall operate at a crystal-controlled frequency of 9.8MHz. The MPU chip shall be socket mounted in an AMP PLCC socket #821547-1 series HPT or equal.
- 2.4.6 All components on the 68HC11 CPU module and the module in its entirety shall be Year 2000 compliant.
- 2.4.7 The 68HC11 CPU Board shall have four (4) 68B50 Asynchronous Communications Interface Adapters (ACIA). The 68B50 communication IC's shall be used and shall operate with a crystal frequency of 9.8 MHz. Each ACIA shall have individual jumpers to select 5 different communication baud rates -1200, 2400, 4800, 9600, 19,200, and 38,400 bps. There shall be no IRQ inhibit jumpers provided; therefore, all ACIAs shall be active. Programs should be written to initialize the four communications ACIA chips upon startup. An IRQ status register shall be provided that conforms to the provisions of the "Traffic Signal Control Equipment Specifications" (TSCES) published by the State of California, Business, Transportation, & Housing Agency; Department of Transportation (CALTRANS), dated January 1989, and all current Addenda, through addendum 8.
- 2.4.8 It shall be possible to swap ports 2 and 3 by means of a Port Swap jumper on the 68HC11 CPU Board.
- 2.4.9 EPROM and RAM shall be resident on the CPU board, and shall be socket mounted. The EPROM socket shall be a 32-pin ZIF force Device. The RAM socket shall be a 28 pin Augat 828 series or equal. The EPROM shall be a type 27C010 or Engineer approved equal.
- 2.4.10 RAM will be continuous from locations \$0000 to \$6FFF. RAM shall be a ZERO power device exclusively. The RAM on the 68HC11 CPU Board shall be a zero power device with a Real Time Clock. The Real Time Clock address shall be in the I/O map at locations \$7FF8 to \$7FFF. The following System Address map shall be supported.

<u>Address</u>	<u>Function</u>	<u>Size (Bytes)</u>	<u>Bank Mode</u>	<u>Dual Port RAM</u>
0000-6FFF	NVRAM	28K	NA	Disabled
0000-5FFF	NVRAM	24K	NA	Enabled
6000-6FFF	Dual Port RAM	4K	NA	Enabled
7000	Location Switch	1	NA	NA
7001	MCU Registers	1	NA	NA
7002	Port G	1	NA	NA
7003-7009	MCU Registers	7	NA	NA
700A	Feature Switch	1	NA	NA
700B-705F	MCU Registers	85	NA	NA
7060-73FF	Volatile CPU RAM	~1K	NA	NA
7400	DTA Minutes	1	NA	NA
7401-740A	I/O	10	NA	NA
740B-740E	Not Used	4	NA	NA
740F	DTA Seconds	1	NA	NA

<u>Address</u>	<u>Function</u>	<u>Size (Bytes)</u>	<u>Bank Mode</u>	<u>Dual Port RAM</u>
7410-7417	ACIA 1 to 4	8	NA	NA
7418-74FF	Reserved	232	NA	NA
7500-7507	Reserved	8	NA	Disabled
7500-7507	DPRAM Semaphores	8	NA	Enabled
7508-75FE	Reserved	247	NA	NA
75FF (Read)	IRQ Status Port	1	NA	NA
75FF (Write)	RTC Reset	1	NA	NA
7600-7FF7	NVRAM	2K	NA	NA
7FF8-7FFF	NVRAM (Real Time) Clock/Calendar	8	NA	NA
8000-FFFF	PROM	32K*	Disabled	NA
8000-FFFF	PROM	32K*	Enabled	NA

\*Bank Switched

- 2.4.11 A jumper select shall be provided to switch locations \$6000 to \$6FFF from Internal to External mode for access to the remote Dual Port location. The status of the jumper position shall be read on the IRQ register-bit five (5). When an enhanced Program Module is used with this system, it will only have access to addresses \$6000 through 6FFF for dual port operation.
- 2.4.12 The CPU module shall support 32K x 8 and 128K x 8 EPROM devices. EPROM size shall be jumper selectable.
- 2.4.13 When using a 128K EPROM, a bank switch shall be enabled with the EPROM memory system. This bank switch shall function by moving to the upper 64K segment of the EPROM. This bank switch jumper controls address line A16. The bank shall be activated by a write to location \$7002 (directly connected to Port G on 68HC11 MPU), which will cause memory to go to the upper 64K of the 128K EPROM. This will enable an extra 32K of EPROM memory via bank switching. The status of A16 will read on the IRQ status register-bit six (6).
- 2.4.14 Feature and location switches shall be provided on the front portion of the 68HC11 CPU board. Switch Actuators shall be accessible from the front of the controller when the controller door is open. It shall be possible to set the Location and Feature DIP switches without removal of the CPU module. Each switch shall be an 8-position front reading dip switch. The Location Switch shall be mounted above the Feature Switch.
- 2.4.15 The Location and Feature switches shall be decoded as follows: Features switch shall be addressed at \$700A-Port E. Location Switches shall be addressed at \$7000-Port A. A header shall be provided near the front of the module for the SPI and serial interface pins.
- 2.4.16 It shall be possible to select whether the controller uses RAM on the CPU board or on the Program Module for memory functions in address range \$6000 to \$6FFF. The selection shall be made by making the appropriate jumper setting. If the jumper is set to the internal position, the CPU shall use the NORVRAM on the CPU module for operations in the address range of \$6000 to \$6FFF. If the jumper is set to the external position, the CPU shall use the RAM on the program module for operations involving address range \$6000 to \$6FFF.
- 2.4.17 Each CPU Board shall be furnished with a Non-Volatile RAM with Real Time Clock. The Real Time Clock components shall be Year 2000 compatible.
- 2.4.18 There shall be one LED indicator located on the front of the CPU board, which shall be controlled via a software output of Port G bit 3.
- 2.4.19 The +12VDC, +5VDC and -12VDC voltages input in the CPU board shall have transorb protection.
- 2.4.20 It shall be possible to map all memory locations to the 68HC11 CPU board. Manufacturer shall configure the 68HC11 CPU board to support the following:
- Use 27C010 EPROM on CPU Board
  - Map all NOVRAM on CPU Board
  - Map \$6000-\$6FFF Memory to CPU Board
- 2.4.21 Each CPU board shall be furnished with two blank 27C010 EPROMs.
- 2.4.22 The 68HC11 CPU board shall fit and operate correctly in standard 170E controllers.

- 2.4.23 The 68HC11 CPU board shall be compatible with the 68HC11 versions of local controller software programs used in the District of Columbia. It shall not be necessary to use a Program Module with local controller software programs currently in use in the District of Columbia.
- 2.4.24 Each Model 170E controller shall be provided with a 412HC nonfunctional PROM module.
- 2.4.25 The 412HC PROM module shall be similar in appearance and construction to a Model 412C program module, except that it shall have no electronic components.
- 2.4.26 At a minimum, the 412HC shall consist of an unpopulated printed circuit board, a front panel, and a handle. The 412HC11 module have the legend “412HC” permanently silk-screened on the outside of the module. The legend for the module number shall be a minimum of 10 mm high.
- 2.4.27 A legend indicating the function of the Location and Feature switches shall be silk screened on the upper left corner of the 412HC module.

Legend for Feature Switch	
Legend	Address
SU-1	7000 Bit 0
SU-2	7000 Bit 1
SU-3	7000 Bit 2
SP-1	7000 Bit 3
SP-2	7000 Bit 4
SP-3	7000 Bit 5
IF-1	7000 Bit 6
IF-2	7000 Bit 7

Legend for Location Switch	
Legend	Address
ADDR 1	7001 Bit 0
ADDR 2	7001 Bit 1
ADDR 4	7001 Bit 2
ADDR 8	7001 Bit 3
DET	7001 Bit 4
ACT	7001 Bit 5
INT-S	7001 Bit 6
INT-M	7001 Bit 7

The 412HC module shall not be equipped with a DB-9 serial connector. The DB-9 connector for port 4 shall be mounted on the front chassis of the Model 170E controller.

- 2.4.28 All markings must be permanently silk-screened on the 412HC program module. No adhesive labels or dry-transfer may be used.
- 2.4.29 Provide two (2) spare modules for every ten (10) model 170E –HC11 controllers supplied.
  - Input Board
  - Output Board
  - CPU Board
  - Modem
  - Utility (Display)Board
  - Power Supply Module

**3.0 MODEL 336-SS CABINETS**

- 3.1 This section defines the specifications applicable to the Model 336-SS cabinets with base adapters. All cabinets shall comply with the provisions of Specification FHWAIP- 78-16 and CALTRANS Traffic Signal Control Equipment Specification (TSCES), except as modified herein. Cabinet and adapter dimensions are shown in the separately attached Exhibits 1 and 3. Two types of base adapters will be provided.
- 3.2 The Model 336-SS cabinet shall be a weatherproof cabinet with dimensions shown in the Exhibits. The cabinet top shall be slanted to right side, side that is 90 degrees from front and rear, to prevent standing water.

- 3.3 The cabinet and doors shall be fabricated from 0.125-inch minimum thickness sheet aluminum. All exterior seams for cabinet and doors shall be welded. All exterior welds shall be ground smooth. All edges shall be finished to a radius of 0.025-inch minimum.
- 3.4 Cabinet fabrication shall conform to the requirements of ASTM Designation: B 209 for 5052-H32 aluminum sheets.
- 3.5 Welding on cabinets shall be done by the gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes. Electrodes shall conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy base welding electrodes.
- 3.6 Procedures, welders, and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification", and to the practices recommended in AWS C5.6.
- 3.7 The surface of each aluminum cabinet shall be finished to conform to the requirements of Military Specification MIL-A-8625C ("Anodic Coatings for Aluminum and Aluminum Alloys") for a Type II, Class I coating, except that the anodic coating shall have a minimum thickness of 0.0007 inch and a minimum coating weight of 27 milligrams per square inch. Prior to applying the anodic coating, the cabinets shall be cleaned and etched as follows:
  - 3.7.1 Clean by immersion in inhibited alkaline cleaner such as Oakite 61A or Diversey 909, or equivalent, six to eight ounces per gallon, 160°F for five minutes.
  - 3.7.2 Rinse in cold water.
  - 3.7.3 Etch in a solution of sodium fluoride, one and one-half ounces plus sodium hydroxide, four to six ounces per gallon, at 140° to 150°F for 15 minutes.
  - 3.7.4 Rinse in cold water.
  - 3.7.5 De-smut in a 50 percent by volume nitric acid solution at room temperature for two minutes.
  - 3.7.6 Rinse in cold water.
  - 3.7.7 The anodic coating shall be sealed in a five percent aqueous solution of nickel acetate (pH 5.0 to 6.5) for 15 minutes at 208° to 212°F.
- 3.7.8 The cabinet shall have single front and rear doors, each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall be removable. The operating handle shall be zinc-plated steel with a 7.5 inch overall length and provided with a 5/8 inch Allen-type hex head. The cabinet doorframe shall be double-flanged out on all four sides and shall be provided with strikers to hold tension on and form a firm seal between door gasketing and cabinet doorframe. The flange width shall be a minimum of 1/2 inch. The depth of the double flange shall be a minimum of one inch from the outside edge to the cabinet surface. The dimensions of the cabinet door opening shall be as shown in the Exhibits. Cabinet locks shall be the solid brass, 6-in tumbler, rim-type. The locks shall have rectangular, spring-loaded bolts. The bolts shall be 0.375-inch long and 0.75-inch wide by 0.375-inch thick (dimension tolerance is  $\pm 0.125$ -inch). The locks shall be left-hand on the front door and right-hand on the rear door. Keys shall be removable in the locked position only. The lock shall be rigidly mounted. The front portion of the lock shall extend 0.25-inch to 0.375-inch beyond the outside surface of the door. The locks shall be of custom keying to be determined by Contractor in consultation with DDOT.
- 3.7.9 Two keys shall be furnished with each cabinet for the cabinet door lock. A total of two removable handles shall be furnished per cabinet. Keys and handles shall not be interchangeable with keys and handles provided with existing cabinets. Keys shall be distinctively shaped as compared with standard number 2 or 3 keys. A ring shall be welded to the end of each door handle that allows placement of the handle on a minimum 3/16" tether or key ring. See Appendix B for alterations to the locking components to support the electronic cabinet security lock.
- 3.7.10 The latching mechanism shall be a 3-point draw roller type. Push rods shall be turned edgewise at the outward supports and shall be 0.25-inch by 0.75-inch, minimum. Supports shall be 0.105-inch steel, minimum. Rollers shall have a minimum diameter of 0.375-inch and shall be equipped with ball bearings

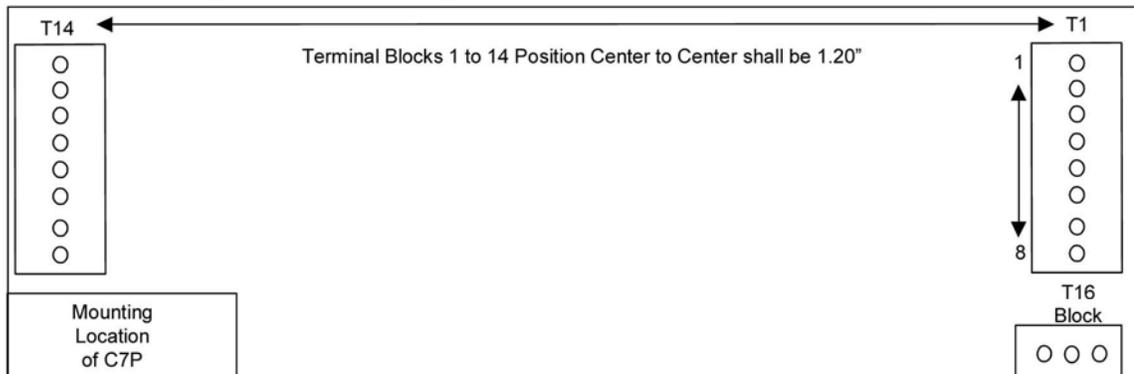
- and nylon wheels. The center catch shall be fabricated of 0.1875-inch steel, minimum. See Appendix B for alterations to the locking components to support the electronic cabinet security lock.
- 3.7.11 The Model 336-SS door's hinging shall be assessed by the Contractor but be comprised of a minimum of four butt hinges. Each hinge shall have a fixed pin. Front and rear doors shall be provided with catches to hold the door open at 90 degrees and 180 degrees, plus or minus 10 degrees. The catches shall be capable of holding the door open at 90 degrees in a 60-mph wind at an angle perpendicular to the plane of the door. The front door shall open from the left, and the rear door shall open from the right when facing the doors. Door hinges, pins, and bolts shall be made of stainless steel. The hinges shall be bolted to the cabinet. The hinge pins and bolts shall not be accessible to vandals.
- 3.7.12 The police panel door shall be equipped with a lock keyed for a master police key. The police panel shall be mounted on the rear door of the cabinet. Police panel assembly shall extend no further than 1.5 to 2 inches from the back of the rear door. It shall be possible to store the removable cabinet door handle in the police panel.
- 3.7.13 Two keys shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1-3/4 inches in length. The lock and the key shall not match those of the existing controller cabinets.
- 3.7.14 A standard Electronic Industries Association (EIA) 19-inch rack cage shall be installed inside the cabinet for mounting the controller unit, pull-out hinged-top drawer, input file, power supply, output file, power distribution assembly, communications assembly and other devices as indicated in Exhibit 1. The EIA rack portion of the cage shall consist of two (2) pairs of full length, continuous, adjustable equipment mounting angles of 0.1345-inch nominal thickness zinc-plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B. The angles shall be supported top and bottom by welded support angles to form a cage.
- 3.7.15 The cabinet shall have ramps on either side level with the bottom edge of the door opening to provide horizontal support for the cage. The cage shall be vertically attached to each side of the cabinet at four points, two at the top and two at the bottom of the rails. Cage and horizontal support mating surfaces shall not be coated in any way to increase resistance of connection to chassis ground.
- 3.7.16 Two zinc-plated controller unit supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of 3.0 inches. The angles shall be mounted 7.25 inches, minimum, from the top of the EIA rails and shall be adjustable vertically to ensure at least a 7.25-inch vertical opening for mounting the Model 170E Controller Unit.
- 3.7.17 Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inches minimum thickness closed-cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.
- 3.7.18 A pull out hinged-top drawer, having sliding tracks, with lockout and quick disconnect feature shall be provided as shown in the cabinet drawings. The pull-out drawer shall extend a minimum of 355 mm. It shall be possible to lift the hinged top to permit storage of documents and other small articles in the interior of drawer. The hinged top shall be covered with Formica® or other equivalent smooth, durable, chemical resistant plastic sheet. The minimum interior dimensions of the drawer shall be 25.4 mm high x 330.2 mm deep x 406.4 mm wide. The drawer shall be capable of supporting a weight of 20 kg when fully extended.
- 3.7.19 Bottom of Cabinet Base Adapter shall mate with existing foundation and temporary concrete portable base and top of Cabinet Base Adapter shall mate with cabinet – see and confirm dimensions in Exhibits 1 through 4.
- 3.8 Cabinet Ventilation Requirements
- 3.8.1 Each cabinet shall be equipped with two electric fans with ball bearings and a capacity of at least 100 cubic feet of air per minute for each. Each fan shall be independently wired of one another and each shall have separate thermostat control.
- 3.8.2 Each fan shall be mounted within the cabinet and vented out the top of the cabinet.
- 3.8.3 Each fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33°C and 65°C with a differential of not more than 6°C between automatic turn on and turn off. The cabinet fan circuits shall be fused at 125 percent of the amperage of the fan motor. The fuse holders shall be easily

accessible from the front of the cabinet. It shall not be necessary to reach into the cavity above the 170E controller, or other equipment, in order to access the fuse holders for the fans.

- 3.8.4 Intakes (including filters) shall be modified from Caltrans requirements to pass a minimum of 100 cubic feet of air per minute per intake, with intakes on both the front and rear doors. The exhaust area shall accommodate the intake areas.
- 3.9 Cabinet Lighting and Door Open Switching Requirements
  - 3.9.1 Fluorescent lamps shall be installed in the top of the front and rear of the cabinets. Switches shall be installed on the front and rear doors for both lamp control and door open alarms. Opening of either or both doors shall illuminate both lights. Opening of either door shall provide a single ground true input signal to the 170E controller.
  - 3.9.2 Each fluorescent lamp and switch shall be equipped with noise suppression devices. Activation of the fluorescent lamps and associated switches shall not cause any disruption of the 170E controller or any other electrical or electronic device in the cabinet. The Contractor shall install sufficient RFI and surge suppression equipment to assure that operation of the fluorescent lamps shall not disrupt the operation of other equipment in the cabinet.
  - 3.9.3 Fluorescent lamps and associated ballasts shall be rated for high output in cold environments, providing high light output in ambient temperature of -25° C.
  - 3.9.4 The cabinet lamp circuit shall be fused. The fuse holder shall be easily accessible from the front of the cabinet. It shall not be necessary to reach into the cavity above the 170E controller, or other equipment, in order to access the fuse holder for the cabinet lamps. The fuse holders and switches shall not interfere with the removal of the cabinet rack assembly.
- 3.10 Cabinet Assemblies
  - 3.10.1 Input File
  - 3.10.2 The input file shall utilize 5.25 inches of rack height. The input file shall inter-mate with and support 14 input devices as indicated in Figure 3.1.

**Figure 3.1 INPUT FILE LAYOUT**

**NOTE: Terminal Blocks T1 to T14 shall be mechanically supported to the chassis of the File and shall be 8 Position 8-32 Screw Barrier Type as called out in the Specifications**



T1 to T14 Position Assignment			T16 Position Assignment	
Pos	Pin	Function	Pos	Function
1	SP	Spare	1	AC+ (Hot)
2	F	Ch 1 Output	2	AC- (Neutral)
3	W	Ch 2 Output	3	Equip. Grd
4	D	Ch 1 Input		
5	E	Ch 1 Input		
6	J	Ch 2 Input		
7	K	Ch 2 Input		
8	L	Eq. Grnd		

- 3.10.3 The input file shall provide card guides (top and bottom) and a 22-pin, single-readout, edge-connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.
- 3.10.4 Pins F and W for each slot shall terminate on the terminal blocks mounted on the rear of the input file and shall connect to the proper controller unit inputs in the connector C7P. Common grounding of output emitters shall be permitted and the Bus brought out to C7P.
- 3.10.5 Conductors from connector C1 to the input file shall be terminated at C7S. A dummy plug shall be mounted on the cabinet wall to secure C7S when an input file is not used in the cabinet. Captive screws and sockets shall be provided for securing C7S to the dummy receptacle or C7P located on the input file. C7S pins shall be removable by use of a single pin extractor. Connector C7 shall be a 37 Pin "D" type connector, wired in accordance with Table 3.1.
- 3.10.6 The Input File shall be equipped with a connector to supply power to terminal block T16. The connector shall be designated as connector C8P. The connector shall be a Waldom-Molex 3 conductor connector. The male end shall be connected to terminal board T16. A mating female connector shall be installed in the cabinet and shall be wired according to Table 3.2 and shall be designated as connector C8S: Where an input file is installed in a cabinet, connector C8P shall be connected to C8S. Where no input file is installed a dummy plug shall be inserted into connector C8S to prevent inadvertent exposure to the conductors in C8S. Each cabinet shall be supplied with a dummy plug that is attached to the cabinet housing via a non-conducting tether.
- 3.10.7 Field wire terminal blocks shall be mounted vertically on the back of the assembly. The blocks shall be eight (8) position barrier type with marker strips, and shall be provided 8/32 x 5/16 inch minimum nickel-plated brass binder head screws and nickel-plated brass inserts.
- 3.10.8 The edge connectors shall be double-sided connectors with the numbered side of each pin shorted to its respective lettered side internally.
- 3.10.9 The card guide shall begin 1.0 ± 0.5 inches back from the front face of the file.
- 3.10.10 The input file shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately above and below the items they are to identify.
- 3.10.11 With the exception of connectors C8-P and C8-S, input files provided under this Contract shall be electrically and mechanically interchangeable with input files installed in existing cabinets in use with the District.

Table 3.1 CONNECTOR C7 WIRING

SOURCE	VIA	DESTINATION
IF-1F	1	C1-56
IF-1W	2	C1-60
IF-2F	3	C1-39
IF-2W	4	C1-43
IF-3F	5	C1-58
IF-3W	6	C1-62
IF-4F	7	C1-41
IF-4W	8	C1-45
IF-5F	9	C1-55
IF-5W	10	C1-59
IF-6F	11	C1-40
IF-6W	12	C1-44
IF-7F	13	C1-57
IF-7W	14	C1-61
IF-8F	15	C1-42
IF-8W	16	C1-46
IF-9F	17	C1-67
IF-9W	18	C1-69
IF-10F	19	C1-68
IF-10W	20	C1-70
IF-11F	21	C1-47
IF-11W	22	C1-48
IF-12F	23	C1-49
IF-12W	24	C1-50
IF-13F	25	C1-51
IF-13W	26	C1-52
IF-14F	27	C1-53
IF-14W	28	C1-54
N/C	29	N/C
N/C	30	N/C
N/C	31	N/C
N/C	32	N/C
N/C	33	N/C
IF-1 – IF-14 A	34	DC Ground
IF-1 – IF-14 B	35	+24 VDC
IF-1 – IF-14 C	36	C1-102 Detector Reset
IF-1–IF-14 H& W	37	C1-14 Input DC Ground

Table 3.2 CONNECTOR C8 WIRING

POSITION	FUNCTION
1	AC+
2	AC-
3	Ground

- 3.11 Power Distribution Assembly
- 3.11.1 A type PDA#2 power distribution assembly shall be furnished and mounted on the EIA 19-inch rack utilizing seven inches of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails including terminal blocks.
- 3.11.2 The power distribution assembly shall be provided with marker strips to identify flasher units in the assembly. The marker strip shall be of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately below the flasher units they are to identify.
- 3.11.3 The following equipment shall be provided with the power distribution assembly:
- One Duplex NEMA 5-15R Controller Receptacle
  - Two Duplex NEMA 5-15R Equipment Receptacle (one with GFI)
  - One 1 Pole 50 Amperes minimum, 120 VAC Main Circuit Breaker
  - Six Single Pole, 15 Amperes, 120 VAC Signal Bus Circuit Breakers with Auxiliary Switch Feature and Medium Trip Delay Characteristic
  - One 2 Pole Ganged, 20 Amp, 120 VAC Flash Bus Circuit Breaker
  - One Mercury Contactor - rated minimum 60 Amperes, 120 VAC
  - Two Model 204 Flasher Units and Sockets
  - One Model 206 Power Supply Module and Socket
  - One Model 430 Heavy Duty Relay & Socket (Transfer Relay)\*
  - One AUTO/FLASH Control Switch
  - One Flash on Indicator Light
  - Three 10 Position Terminal Blocks T1, T2 & T4
  - 4 Position TBK T3
- 3.11.4 The six signal circuit breakers shall be wired and routed per the "Circuit Breaker Option One Line Diagram" of the CALTRANS Traffic Signal Control Equipment Specifications" (TSCES), published January 1989, and all subsequent addenda. The auxiliary switch in each breaker shall be open when the circuit breaker contacts are closed. The auxiliary switches on the signal circuit breakers shall be wired in parallel so that the tripping of any load switch breaker shall energize the mercury contactor coils, flash transfer relay coils, and the Flash On indicator. The auxiliary switch contacts shall be rated at 5 Amperes, 120 VAC. The auxiliary switch terminals shall be of the 'fast on' type.
- 3.11.5 All circuit breakers shall have interrupting capacities in accordance with the current edition of the NFPA National Electrical Code. Notwithstanding the minimum requirements established by the National Electrical Code, all circuit breakers shall have sufficient interrupting capacities to effectively and safely halt the flow of current during any short circuit event.
- 3.11.6 The Main Circuit Breaker shall be rated for 50 Amperes at 120 VAC. The Equipment receptacles shall be NEMA 5-15R duplex type.
- 3.11.7 The Front Panel equipment receptacle shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on 6 milliamperes of ground-fault current and shall not occur on less than 4 milliamperes of ground-fault current.
- 3.11.8 An "Auto/Flash" switch shall be provided which, when placed in "Flash" position (down), shall energize the Mercury Contractor (MC) Coil. When the switch is placed in the "Auto" position (up), the switch packs shall control the signal indications. The switch shall be a single-pole, single-throw toggle switch rated for 20 amperes at 120 volts AC.
- 3.11.9 A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The Flasher Unit Output shall illuminate the lamp whenever the cabinet is in flash.
- 3.11.10 The controller unit receptacle shall be a NEMA Duplex Type 5-15R mounted on the back of the cabinet assembly. A second NEMA Duplex Type 5 15R receptacle shall be provided on the rear of the power

- distribution assembly. The receptacle shall be labeled 'Equipment' and shall be wired to the load (protected) side ground fault receptacle on the front of the power distribution assembly.
- 3.11.11 Terminal blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of the same type as specified for signal field wire terminal blocks. Two spare positions shall be provided. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks. Terminal position assignments shall be as shown on the plans.
- 3.11.12 The Flash Relays shall conform to the provisions in Chapter 17, "Heavy Duty Relays, Model 430," of Specification FHWA-IP-78-16 and CALTRANS Traffic Signal Control Equipment Specifications (TSCES).
- 3.11.13 A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contacts remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.
- 3.11.14 A stand alone fully enclosed NEMA 5-15R duplex receptacle shall be provided for red-light camera power. The receptacle shall be wired to the load side of the Auxiliary Circuit Breaker. The location of the receptacle shall consider convenient access, proximity to other 120VAC terminal blocks and safety, such as mounted to the rack or service panel. The GFI shall not affect red light camera receptacle power. Service Panel space for two (2) additional fully enclosed NEMA 5-15R duplex receptacles shall be considered for future ITMS equipment. Cabinet layout drawings shall depict the position of the receptacles. The Power One-Line Diagram shall also depict the inclusion of the receptacles. The receptacles shall be wired to the load side of the Auxiliary Circuit Breaker. The location of the receptacles shall consider convenient access, proximity to other 120VAC terminal blocks and safety. The GFI shall not affect receptacle power. In conjunction with Section 5.4.2.6, the Contractor shall consider whether an additional Auxiliary Circuit Breaker shall be required in the cabinet.
- 3.12 Output File with Hardwired Motherboard
- 3.12.1 Nylon card guides shall be provided to support the switch packs and the monitor unit.
- 3.12.2 The output file shall utilize 10.5 inches of rack height and shall be capable of containing twelve switch packs, four flash transfer relays, and the monitor unit. Four Model 430 flash transfer relays, one Enhanced Monitor Unit, one isolation relay, and one logic relay shall be furnished with each output file.
- 3.12.3 The output file shall be "hard-wired". With the exception of the red interface board for the conflict monitor, printed circuit boards shall not be used in the construction of the output file.
- 3.12.4 The output file shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately below the item they are to identify. Field terminal strips on the rear of the output file shall be permanently labeled to show Switch Pack number, Phase number, and Channel (G, Y, R) for each field terminal. In addition, a vertical white marker strip, at least 0.25" wide, shall be placed adjacent to each terminal strip.
- 3.12.5 Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the file without the use of tools.
- 3.12.6 Field wire terminal blocks shall be mounted vertically on the back of the assembly. The three terminal blocks shall be the 12-position type.
- 3.12.7 The controller unit outputs to the output file shall be connected through Connector C4.
- 3.12.8 The C6P receptacle located on the output file shall be used to inter-mate with the green and yellow output signals of the auxiliary output file. It shall be a 16 pin male circular round connector, AMP Series 1 CPC Standard Sex Square Flange Receptacle. The receptacle on the output file shall be a C6P connector shall be wired to Channel 13 through 18 of the Enhanced Conflict Monitor in accordance with the pin assignments shown in Table 3.3.
- 3.12.9 The C6A receptacle located on the output file shall be used to inter-mate with the red output signals of the auxiliary output file. It shall be a 16 pin male circular round connector, AMP Series 1 CPC Standard Sex

Square Flange Receptacle. A pin shall be installed in the Pin 16 location of the C6A connector on the output file. There shall be no connection to this pin. The C6A connector shall be wired to Channel 13 through 18 of the Enhanced Conflict Monitor in accordance with the Pin Assignments shown in Table 3.4

3.12.10 The red and yellow signals circuits of all switch packs shall be available at a Molex Type 1375 receptacle which shall inter-mate with a Molex Type 1375 plug to allow flash programming. Plug connectors, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment.

3.12.11 The monitor connector shall be a rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156-inch centers. The connector shall inter-mate with the Enhanced Monitor Unit. The monitor edge connector shall be "hard-wired" to the rest of the output files. Printed circuit boards shall not be used to connect the edge connector of the conflict monitor.

3.12.12 It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with the front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

3.12.13 The monitor unit connector shall be wired in accordance with the pin assignment shown on the plans and the tables in Section 3 of these specifications. Output files supplied under this contract shall be fully compatible with Enhanced monitors currently in use in the District.

3.12.14 The monitor unit compartment including the housed Enhanced Monitor unit shall extend no further than 1.25 inches in front of the 19-inch rack front surface. The switch pack socket connector front surface shall be no more than 8.5 inches in depth from the front surface of the output file.

3.12.15 Red Monitor Program Card - A red monitor program card shall be mounted on the rear of the output file assembly. It shall connect allow the user to select whether the red signal going to the monitor comes from the load switch red output or from an AC+ source. This allows unused channels to be connected to the AC+ source. It shall be possible to individually program each of the eighteen load switch red channels. A removable jumper shall be provided for each channel. The jumper shall have 2 male pins. It shall mate with a three pin female receptacle on the red monitor program card that shall allow the user to select AC+ or

**Table 3.3 CONNECTOR C6P WIRING**

SOURCE	CONTACT	DESTINATION (Enhanced Monitor Unit Pin Assignment)
SWPK 13-Pin 7	1	2
SWPK 13-Pin 5	2	8
SWPK 14-Pin 7	3	5
SWPK 14-Pin 5	4	11
SWPK 15-Pin 7	5	C
SWPK 15-Pin 5	6	K
SWPK 16-Pin 7	7	F
SWPK 16-Pin 5	8	N
SWPK 17-Pin 7	9	14
SWPK 17-Pin 5	10	P
SWPK 18-Pin 7	11	17
SWPK 18-Pin 5	12	T
N/C	13	N/C
N/C	14	N/C
N/C	15	N/C
Keying Plug	16	See Note*

\*A Keying Plug shall be installed in position 16 of the C6P connector from the auxiliary output file.

**Table 3.4 CONNECTOR C6A WIRING**

SOURCE	CONTACT	DESTINATION (DC Monitor Unit Pin Assignment)
SWPK 13 Red	1	P20 Ch 13
SWPK 14 Red	2	P20 Ch 14
Locating Pin	3	See Note*
SWPK 15 Red	4	P20 Ch 15
SWPK 16 Red	5	P20 Ch 16
SWPK 17 Red	6	P20 Ch 17
SWPK 18 Red	7	P20 Ch 18
N/C	8	N/C
N/C	9	N/C
N/C	10	N/C
N/C	11	N/C
N/C	12	N/C
N/C	13	N/C
N/C	14	N/C
N/C	15	N/C
N/C	16	See Note**

\*A Keying Plug shall be installed in position 3 of the C6A connector from the auxiliary output file.

\*\* A Blank Pin shall be installed in position 16 of the C6A receptacle on the output file. There shall be no connection to this pin.

- Load Switch Red Output as the source for the conflict monitor red input. A removable clear acrylic access cover shall be provided to protect personnel from accidental contact with the red monitor program card.
- 3.12.16 The red monitor program card shall include a relay that disables the red enable line to the conflict monitor when pin C1-101 from the Model 170E controller is energized, indicating software flash. A jumper, similar to those specified in the preceding paragraph shall be provided to enable and disable this feature.
- 3.13 Communications Assembly
- 3.13.1 The communications assembly shall be furnished and mounted on the EIA 19-inch rack utilizing not more than 5.25 inches (3U) of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails including terminal blocks.
- 3.13.2 Within the controller cabinet, the communications cable shall be separated from the other cabinet cables and terminated on the communications assembly.
- 3.13.3 The communications assembly shall be provided with marker strips to identify wire pair numbers in the assembly. The marker strips shall be of material that can be easily and legibly written on using a pencil or ballpoint pen.
- 3.13.4 The following equipment shall be provided with the communications assembly:
- 1 Model R66MI-50 Termination Block with Grounding Bus attached. Grounding bus shall be terminated at the cabinet ground with No. 8 AWG THHN cable.
  - 50 bridging clips
  - 1 phone jack (stereo ¼")
  - 12 Model COHP 200 Arrestors or approved equivalent
  - 6 Model COHP 350 Arrestors or approved equivalent.
  - C2 Connector Harness of minimum 48" length, wired neatly and secured to the inside of the cabinet walls or rack, so that enough of the harness is available to connect to the controller and the remainder is out of harms way. Harness shall not be rolled up at back of Communications Assembly.
  - The 66-type block shall have its 6 x 50 66-type clips arranged as two (2) rows of 50 x 3. One side of the termination block (50 x 3) shall be used to terminate the incoming cable and the other side of the block (50 x 3) shall be used to terminate the outgoing cable. Fifty 2-position bridging clips shall be furnished with each assembly and shall be made of the same material as the 66-type pushdown clips. The bridging clips shall be reusable.
  - The Contractor shall provide suitable terminal strips for connection of Master/Sub-Unit harnesses.
- 3.14 Flash Transfer Relay
- 3.14.1 Flash transfer relays shall conform to the provisions in Chapter 17 of Specification FHWA-IP-78-16, "Heavy Duty Relays, Model 430" and CALTRANS Traffic Signal Control Equipment Specifications (TSCES).
- 3.14.2 A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contacts remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.
- 3.14.3 The coil of the flash transfer relay shall be energized only when the signals are in flashing operation and the police panel "ON/OFF" switch is "ON."
- 3.15 Police Panel
- 3.15.1 A police panel shall be mounted behind the police panel door. The panel shall contain 2DPDT toggle switches. One (1) switch shall be labeled signals "ON/OFF" and the other shall be labeled "FLASH/AUTOMATIC." The "ON/OFF" switch shall be positioned so that the "ON" position is up. Other components related to the cabinet electronic security lock may be mounted to the police panel. See Appendix B for alterations to the locking components to support the electronic cabinet security lock.

- 3.15.2 The switches shall have contacts rated for 20 amperes at 120 volts AC.
- 3.15.3 The front and back of the panel shall be enclosed with a rigid plastic covering so that no parts having line voltage are exposed.
- 3.16 Side Panel
- 3.16.1 Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides.
- 3.16.2 In viewing from the back door, the left-side panel shall be designated as the "Input-Panel," and the right-side panel shall be designated as the "Service Panel."
- 3.16.3 Service Entry Terminal Block terminals shall be protected by a hinged plastic see-through non-conductive flip cover. A mechanism shall be provided to latch the flip cover in an upright position thereby facilitating wiring to the block.
- 3.16.4 A "Red Light Camera Interface Block" shall be mounted to the Service Panel and labeled as indicated herein. The block shall be a four position fuse block, have screw terminal wiring interfaces and hold 3AG fuses with quick-disconnect terminals. The block shall be wired to neutral and ground buses. The block shall accept two sets of green and amber sensing circuits required for the camera operation, but these circuits shall be wired by others.
- 3.16.5 The Contractor shall provide additional terminal blocks for current and future device interfaces for such equipment as advanced vehicle detection (VIDS/RTMS), UPS, over-temperature, door alarm preempt running, LCS, C11 connector harness and other controller interfaces, CCTV and communications equipment on both the Input and Service Panels based on equipment information to be provided by DDOT. Cabinet layout and wiring drawings shall depict the provisions.
- 3.17 Miscellaneous
- 3.17.1 A minimum of 7.25 inches of EIA rack height and 18 inches of depth (16 inches behind and two inches in front of the mounting ears) shall be provided for the Model 170E Controller Unit.
- 3.17.2 The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a common screwdriver:
- Pull-out Drawer Assembly
  - Power Distribution Assembly
  - Input File
  - Output File
  - Auxiliary Output File
  - Communications Assembly
- 3.17.3 All fuses, circuit breakers, switches, (except Police Panel Switches) and indicators shall be readily visible and accessible when the front door is open.
- 3.17.4 The cabinet shall be delivered mounted on a 0.75-inch thick plyboard-reinforced shipping pallet. The pallet shall be bolted to the cabinet base. The cabinet shall be enclosed in a slipover cardboard packing shell. The cabinet type, purchase order number, shipping date, and serial number shall be clearly printed on the outside of the cardboard cover. A minimum 2" block letters shall be used.
- 3.17.5 All equipment in the cabinet shall be clearly and permanently labeled.
- 3.17.6 Transient suppression shall be provided at the relay bases (across relay coils) and in the fan circuit.
- 3.18 Connectors
- 3.18.1 Connector C1P shall contain 104 pin contacts and shall inter-mate with connector C1S mounted on the controller unit chassis. Corner guide pins for connector C1P shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inches in length, equipped with a T Handle.

- 3.18.2 Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The plug connector C4P shall be mounted on the output file. Connector blocks for connector C1 pin and socket connectors shall be constructed of diallylphthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.
- 3.18.3 Connector C6P shall contain 16 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. It shall be an AMP Series 1 CPC connector and shall properly intermate with connectors in existing cabinets. The plug connector C6P shall be mounted on the output file and shall mate with connector C6P and harness located on the Auxiliary Output File. Position 3 of the C6P harness and connector from the auxiliary output file shall have a keying plug. The C6P receptacle on the output file and the C6P connector from the auxiliary output file shall be clearly and permanently labeled.
- 3.18.4 Connector C6A shall contain 16 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. It shall be an AMP Series 1 CPC connector and shall properly intermate with connectors in existing cabinets. The plug connector C6P shall be mounted on the output file and shall mate with connector C6A and harness located on the Auxiliary Output File. Position of the C6A receptacle on the output file shall contain a pin, but no connection shall be made to that pin. Position 16 of the C6A harness and connector from the auxiliary output file shall have a keying plug. The C6A receptacle on the output file and the C6A connector from the auxiliary output file shall be clearly and permanently labeled.
- 3.19 Cabinet Wiring Diagram
- 3.19.1 Two sets of non-fading cabinet wiring diagrams shall be supplied with each cabinet. The diagrams shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy-duty side-opening clear vinyl pouch and permanently attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram.
- 3.19.2 Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the COTR for review prior to production. Approval by the COTR does not lessen the Contractor's responsibility to meet the specifications.
- 3.20 Auxiliary Output File
- 3.20.1 The auxiliary output file shall utilize 5.25 inches of rack height and shall be capable of containing six switch packs and two flash transfer relays. Two flash transfer relays shall be provided with each auxiliary output file.
- 3.20.2 One auxiliary output file shall be supplied with each model 336-SS cabinet. One auxiliary output file shall be packed separately and delivered with each model 336-SS cabinet. All necessary harnesses and connectors needed to support operation of the auxiliary output file shall be installed in each model 336-SS cabinet. Where the cabinet is shipped with the auxiliary output file packaged separately (as with 336-SS cabinets), the connectors shall be secured and all exposed terminals and conductors shall be covered with heat shrink insulation tubing.
- 3.20.3 Nylon card guides shall be provided to support the switch packs.
- 3.20.4 Switch pack and flash transfer relay sockets shall be readily accessible from the back of the file without the use of tools.
- 3.20.5 Field terminal blocks shall be mounted vertically on the back of the file.
- 3.20.6 Controller unit outputs to the auxiliary output file shall be connected through Connector C5.
- 3.20.7 Connector C5P shall be mounted on the left side of the auxiliary output file back plane located to mate with its associated cabinet harness connector C5S. Connector C5 contact assignments shall be as shown on the plans.
- 3.20.8 The red and yellow signal circuits of all switch packs with the exception of load switches 3, 6, 9, 12, 15, & 18, shall be made available at a Molex receptacle/plug connection for flash programming. Each load switch

- flash programming socket shall have a label that indicates its load switch number (1 to 18). Labeling by phase number is not acceptable.
- 3.20.9 Connectors C6P and C6A and their associated harness shall be wired to the auxiliary output file back plane and shall be used to inter-mate with the C6P and C6A connectors located on the output file. The harness shall be a minimum of two feet in length. Connector contact assignments shall be as shown in Tables 3.4 and 3.5
- 3.21 Flash Transfer Relay
- 3.21.1 Flash transfer relays shall conform to the requirements for heavy-duty relays.
- 3.21.2 A leakage resistor, which shall permit a small amount of current to pass through the relay coil if the contact remains closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.
- 3.21.3 The coil of the flash transfer relay shall be energized only when the signals are in flashing operation.
- 3.21.4 The flash transfer relay shall transfer switch pack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not prohibit the operation of the controller unit 3.21.5 Field terminals on the rear of the auxiliary output file shall be permanently labeled to show Switch Pack Number, Phase Number, Overlap Letter, and Channel (G/Y/R) for each field terminal. In addition, a white marker strip shall be provided to allow additional identification information to be written next to each terminal. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ballpoint pen.
- 3.22 Cabinet Wiring
- 3.22.1 Conductors in the controller cabinet between the service terminals and the signal bus breakers including the chassis ground conductor to Power Distribution Assembly shall be size No. 8 AWG or larger.
- 3.22.2 All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification: MIL-W-1687D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon-jacketed polyvinyl chloride except that conductors No. 14 and larger may be UL Type THHN, with a minimum of seven (7) strands. All conductors carrying 110 VAC or higher voltages shall be No. 14 AWG minimum and shall be sized according to the requirements of the current edition of the NFPA National Electrical code.
- 3.22.3 All conductors shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other side of the conductor.
- 3.22.4 All conductors used in controller cabinet wiring shall conform to the following colorcode requirements:
- 3.22.5 The grounded conductors of AC circuits shall be identified by a continuous white color.
- 3.22.6 The equipment grounding conductors shall be identified by a solid green color.
- 3.22.7 The DC logic ground conductors shall be identified by a solid orange color with a colored (except green) stripe.
- 3.22.8 The ungrounded conductors shall be identified by any color not specified above.
- 3.22.9 All cabinet wiring harnesses shall be neat, firm, and routed to minimize cross talk and electrical interference. Printed circuit motherboards may be used to eliminate or reduce cabinet wiring.
- 3.22.10 Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
- 3.22.11 Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removal assembly may be removed without disturbing conductors not associated with that assembly.
- 3.22.12 All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material. Insulating material, such as silicon sealant may not be used where it shall interfere with the removal of the component.

- 3.22.13 Within the cabinet wiring, the DC logic ground and equipment ground shall be Electrically isolated from the AC-grounded conductor and each other by 50 megohms when tested at 250 volts DC, with the power line surge protector disconnected.
- 3.22.14 Conductors from connector C7 to the Input File shall be of sufficient length to allow any conductor to be connected to any detector output terminal (positions S, F, W).
- 3.22.15 The AC- copper terminal bus shall not be grounded to the cabinet or connected to Logic ground and shall provide a minimum of 10 terminals spread evenly over a 6.5" length for connection of field conductors. Nylon screws with a minimum diameter of 0.25-inch shall be used for securing the bus to the service panel. The bus bar shall be made of 0.125" copper and tapped for #10-32 machine screws. Set screw compression terminals shall not be provided.
- 3.22.16 An equipment grounding (earth ground) bus shall be provided in each cabinet. The Bus shall be copper and grounded to the cabinet. . The bus bar shall be made of 0.125" copper and tapped for #10-32 machine screws. Set screw compression terminals shall not be allowed.
- 3.22.17 One side of the load side of the cabinet power supply shall be connected to the DClogic ground bus using a size No. 14 AWG, or larger, stranded copper wire.
- 3.22.18 The DC logic ground bus shall be provided on the input panel as shown on the plans.
- 3.22.19 A size No. 8 AWG, or larger, conductor shall be connected between equipment ground bus and rack rails.
- 3.22.20 5A size No. 6 Bonding Jumper shall be provided with each cabinet assembly. The jumper shall be of sufficient length to reach from the Chassis Ground Bus to the ACbus. As shipped with the cabinet, the bonding jumper shall have both ends terminated securely on the Chassis Ground Bus.
- 3.22.21 All cabinet wiring, including printed circuit boards, shall be of sufficient capacity to Handle the current and power requirements of the circuitry with which the wiring is associated. This includes, but is not limited to, the ability to withstand overcurrents that may occur before tripping operation of the circuit breakers, activation of surge suppressors, and other operation of overcurrent and overvoltage devices that are supplied with the cabinet. In particular, all cabinet wiring shall be able to withstand the effects of normally expected field wiring faults such as bulb failure, bulb filament short circuits, and field wiring short circuits. The Contractor acknowledges that such temporary overcurrents are to be expected in the course of field operations and warrants that cabinet wiring shall not be adversely affected by these occurrences.
- 3.22.22 The Contractor shall warrant that the wiring is of sufficient capacity to withstand all such occurrences as described in Section 5.5.1.17. In addition to other warranties required elsewhere in this specification, Contractor and shall provide a five year warranty covering parts and on-site labor for replacement or repair of any wiring component that fails under normal field service conditions as described in the preceding section. In addition, the Contractor shall provide a five year warranty covering parts and on-site labor to repair and/or replace on any other cabinet component that fails or is damaged as a consequence of the failure of any wiring component to perform in compliance with the requirements of the preceding section.
- 3.22.23 The intent of these requirements is to insure adequate design and construction of cabinet wiring components under normally encountered field service conditions. It is not intended to secure a warrant covering direct lightning strikes or sustained high voltage (greater than 600 volt) short circuits.
- 3.23 Terminal Blocks
- 3.23.1 Terminal blocks shall be provided for terminating all field conductors.
- 3.23.2 The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type with marker strips and shall be provided with 10/32 x 5/8-inch nickel-plated binder head screws and nickel-plated brass inserts.
- 3.23.3 The terminal blocks shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 600 volts rms, minimum.
- 3.23.4 The terminal blocks for the input file and power supply shall be the barrier type with marker strips and shall be provided with 6/32 x 1/2-inch nickel-plated binder head screws and nickel-plated brass inserts.

- 3.23.5 The terminals of the power line service terminal block shall be labeled "L1" and "AC-," and shall be covered with a hinged clear insulating material to prevent inadvertent contact as described in other sections. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 100 amperes at 600 volts, minimum.
- 3.23.6 The Contractor shall provide suitable terminal blocks for the terminations considered in all other sections. Layout and wiring diagrams shall depict terminal blocks.
- 3.24 Power Line Surge Protectors
- 3.24.1 Two types of power line surge protector shall be provided between both line conductors (AC+ and AC-) and equipment ground. The protectors shall be installed at the service terminal block.
- 3.24.2 One type of surge protector shall be the Three-Electrode Gas Tube Type and shall have the following ratings:
- Impulse Breakdown: Less than 1,000 volts in less than 0.1 microseconds at 10 kilovolts/microseconds.
  - Standby Current: Less than one milliamperere.
  - Striking Voltage: Greater than 212 Volts DC.
  - Capable of withstanding 15 pulses of peak current each of which shall rise in eight microseconds and fall in 20 microseconds to one-half the peak voltage at 3-minute intervals. Peak current rating shall be 20,000 Amperes.
- 3.24.3 The other type of surge protector shall be Metal Oxide Varistors (MOV). One shall be installed between AC+ and equipment ground and the other between AC- and equipment ground. The varistors shall have the following ratings:
- Recurrent peak voltage: 212 volts
  - Energy rating maximum: 20 joules
  - Power dissipation: Average 0.85 watts
  - Peak current for pulses: 2,000 amperes for less than 6 microseconds
  - Standby current: Less than 1 milliamperere
- 3.25 Factory Testing
- 3.25.1 The general procedures and equipment, as described below, used in the evaluation of the controller unit, cabinet and auxiliary equipment are a minimum guide and shall not limit the testing and inspection to insure compliance of the equipment with these specifications.
- 3.25.2 These test procedures shall be followed by the Contractor who shall certify that he has Conducted inspection and testing in accordance with these specifications. Inspection - A visual and physical inspection shall include mechanical, dimensional and assembly conformance of all parts of these specifications that can be checked visually or manually with simple measuring devices.
- 3.25.3 Environmental - All components shall properly operate within the following limits:
- Ambient Temperature: -37° to 74°C
  - Humidity: 5 to 95 percent
- 3.25.4 The relative humidity and ambient temperature values in the following table shall not be exceeded.
- Shock-Test - per Military Specification: MIL-STD-810D Method 516.1
  - Vibration - per Military Specification: MIL-STD-810D Method 514.1, equipment class G (Common Carrier).
  - Cabinets shall comply with the requirements of UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment".

AMBIENT TEMPERATURE VERSUS RELATIVE HUMIDITY AT BAROMETRIC PRESSURES (29.92 In. Hg.)		
AMBIENT TEMPERATURE/ DRY BULB (IN °C)	RELATIVE HUMIDITY (IN PERCENT)	AMBIENT TEMPERATURE/ WET BULB (IN °C)
-37 to 1.1	10	-17.2 to 42.7
1.1 to 46.0	95	42.7
48.8	70	42.7
54.4	50	42.7
60.0	38	42.7
65.4	28	42.7
71.2	21	42.7
74	18	42.7

- 3.25.5 All equipment shall continue normal operation when subjected to the following:
- Low Temperature Test - With the item functioning at a line voltage of 90 VAC the ambient temperature shall be lowered from 20°C to -37°C at a rate of not more than 18°C per hour. The item shall be cycled at -37°C for a minimum of five hours then returned to 20°C at the same rate. The test shall be repeated with the line voltage at 135 VAC.
  - High Temperature Test - With the item functioning at a line voltage of 90 VAC the ambient temperature shall be raised from 20°C to 70°C at a rate of not more than 18°C per hour. The item shall be cycled at 70°C for five hours and then returned to 20°C at the same rate. The test shall be repeated with the line voltage at 135 VAC.
- 3.25.6 Electrical - All components shall operate properly within the following limits:
- Applied Line Voltage: 90 to 135 VAC
  - Frequency: 60 (±3.0) Hertz
- 3.25.7 All circuits unless otherwise noted, shall commence operation at or below 90 VAC as the applied voltage is raised from 50 VAC to 90 VAC at a rate of 2 (±0.5) volts per second.
- 3.25.8 All equipment, when housed within its associated cabinet, shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from cabinet shall be tested for compliance with the equipment housed within a DC accepted Model 336-SS cabinet and the cabinet connected to the commercial power lines.
- 3.25.9 All power line surge protection shall enable the equipment being tested to withstand (nondestructive) and operate normally following the discharge of a 25 microfarad capacitor, charged to plus and minus 2,000 volts, applied directly across the AC line (applied at Cabinet Service Terminal Block) at a rate of once every 10 seconds for a maximum of 50 occurrences per test. The unit under test shall be operated at 20° (±5°) C and at 120 (±12) VAC.
- 3.25.10 The Model 400 Modem, M170E Auxiliary Board and Model 412C PROM Module shall be housed in a D.C. Accepted Model 170E Controller Unit, all provided by others, that in turn is housed in the cabinet during the test described above.
- 3.25.11 All equipment shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from the cabinet shall be tested for compliance as follows:
- The equipment shall withstand (nondestructive) and operate normally when one discharge pulse of plus or minus 300 volts is synchronously added to the AC power at the Cabinet Service Terminal Block and moved uniformly over the full wave across 360 degrees or stay at any point of Line Cycle once every second. Peak noise power shall be five kilowatts with a pulse rise time of 500 ns. The unit under test shall be operated at 20° (±5°) C and at 120 (±12) VAC.
- 3.25.12 The Model 400 Modem shall comply with the above conditions when housed in a D.C. accepted Model 170E Controller Unit and tested under the above conditions.

- 3.25.13 The Model 400 shall also operate correctly when installed in the Central Communications Units being used by the District's central computer.
- 3.25.14 In no case shall the modems produce a carrier detect signal or transmit received data the central computer when the incoming carrier level is less than -40 dB.
- 3.25.15 Within the circuit of any device, module or PCB, electrical isolation shall be provided between DC logic ground, equipment ground and the AC grounded conductor. The DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and from each other by 500 megohms, minimum, when tested at the input terminals with 500 VDC.
- 3.25.16 All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage to the cabinet at a rate of 30 openings and closings per minute for a period of two minutes in duration.
- 3.25.17 All equipment shall maintain normal operation during and following a period of at least five hours at -37°C and less than 10% humidity, when 90 VAC is applied to the input terminals of the cabinet.
- 3.25.18 Ventilation Testing. Temperature testing shall be conducted on prototypes with full Ventilation subsystem in operation. When maximum internal ambient temperature and humidity are reached, ambient outside temperature shall be noted. At least one dozen temperature probes shall be positioned at strategic points around the cabinet innards and monitored. Hot spots and moisture shall be noted. Based on the results of the testing, the Contractor shall re-position equipment as required by the COTR.
- 3.26 Testing Certification
- 3.26.1 The Contractor shall supply with each shipment a full test report of the quality control and final test conducted on each item. The test report shall indicate the name of the tester and shall be signed by a responsible manager.
- 3.26.2 The quality control procedure shall include the following:
- Acceptance testing of all supplied components.
  - Physical and functional testing of all components.
  - A minimum 100-hour burn-in of all modules.
  - A minimum 24 hour operation of all complete controller unit and cabinet assemblies.
- 3.27 Auxiliary Equipment
- 3.27.1 The modules and equipment listed in the following paragraphs shall be compatible with the input or output of the Type 170 Controller cabinets specified in Section 5 of these Specifications.
- 3.28 Model 204 Flasher Unit
- 3.28.1 The flasher shall be a solid-state device, producing between 50 and 60 flashes per minute with a 50-percent duty cycle. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting and shall comply with the Model 204 Specification in FHWA-IP-78-16, Chapter 9, and CALTRANS Traffic Signal Control Equipment Specification (TSCES) except as noted herein. The output switch shall be capable of switching any current from 0.03 to 20 amperes of tungsten lamp load at 120 volts, 60 Hertz, or 20 amperes at a power factor of 0.85 at 72°.
- 3.28.2 Flasher units shall be compatible with the District's LED traffic signals.
- 3.29 Model 222 Two-Channel Loop Detector Unit
- 3.29.1 Loop detector sensor units shall be installed to accommodate up to eight (8) loop detector inputs. These units will produce output signals to the controller indicating when vehicles pass over and/or remain over the loops embedded in the roadway. The loop detectors shall be the Model 222 and conform to the provisions of Chapter 4 of Specification FHWA-IP-78-16 and CALTRANS Traffic Signal Control Equipment Specification (TSCES).
- 3.30 Model 242 Two-Channel D.C. Isolators

- 3.30.1 Channel isolators shall be utilized to provide independent isolation between electrical contacts external to the controller for pedestrian pushbuttons and other devices that provide a contact closure as an input. This module shall comply with the provisions of Chapter 7 of Specification FHWA-IP-78-16 and CALTRANS Traffic Signal Control Equipment Specification (TSCES).
- 3.31 Model 200 Switch Packs
- 3.31.1 Signal light circuits shall be controlled externally to each controller unit by 3-circuit solid-state switches, which conform to the specifications for Model 200 Switch Packs as detailed in Chapter 8, Specification FHWA-IP-78-16 and CALTRANS Traffic Signal Control Equipment Specification (TSCES), except as noted herein. Each switch shall have the capability of switching any current from 0.05 to 20.0 amperes of tungsten lamp load at 120 volts 60 Hertz, or 20 amperes at a power factor of 0.85 and a temperature of 70°C.
- 3.31.2 Switch pack units must also be compatible with the District's LED traffic signals
- 3.32 Model 496 Modem Module
- 3.32.1 All modems supplied shall be Model 496 Modem Module.
- 3.32.2 The modem shall provide two-wire half-duplex and four-wire full duplex communications. It shall be switch selectable between half-duplex and full duplex operation. In half duplex, pins X and Y shall be used for Audio In/Out.
- 3.32.3 The modem shall comply with the following requirements:
- Data Rate: 0 to 9600 baud modulation
  - Modulation: Phase coherent frequency shift keying (FSK)
  - Data Format: Asynchronous, serial by bit
  - Line and Signal Requirements: Private Metallic Wire, Distance 10 miles minimum
  - ACIA and Modem Interface: EIA-232-C standards
  - Tone Carrier Frequencies (Transmit & Receive): 11.2 kHz (MARK) and 17.6 kHz (SPACE) with +/- 1% tolerance. The operating band shall be (half power, -3dB) between 9.9 kHz and 18.9 kHz.
  - Transmitting Output Signal Level: 0, -2, -4, -6, and -8 dB (at 14.7 kHz) continuous or switch selectable.
  - Receiver Input Sensitivity: 0 to -40 dB
  - Receiver Band-pass Filter: Shall meet the error rate requirement Specified in Paragraph A.2.15 and shall provide 20 dB/Octave, minimum active attenuation for all frequencies outside the operating band.
  - Clear-to-Send (CTS) Delay: 12 (+/- 2) ms
  - Receive Line Signal Detect Time: 8 (+/- 2) ms mark frequency
  - Minimum Carrier Detect Sensitivity: The modem shall not indicate carrier detect and shall not transmit received data to the controller when received signals are less than -42 (+/- 2) dB at modem carrier frequencies (11.2 kHz and 17.6 kHz).
  - Receive Line Squelch: 6.5 (+/-1) ms, 0 ms (OUT)
  - Soft Carrier (7.8 kHz) Turn Off Time: 10 (+/- 2) ms
  - Modem Recovery Time: Capable of receiving data within 22 ms after completion of transmission.
  - Error Rate: Shall not exceed 1 bit in 100,000 bits, with a signal-to-noise ratio of 16 dB measured with a flat weight over a 300 to 3000 Hz band.
  - Transmit Noise: Less than -50 dB across 600 ohm resistive load within the frequency spectrum of 300 to 3000 Hz at the maximum output.

The modem power requirements are as follows:

<u>Input Voltage</u>	<u>Maximum Current Consumption</u>
+12 VDC	75 milliamperes
-12VDC	75 milliamperes

Indicators shall be provided on the front of the modem to indicate Carrier Detect, Transmit Data, and Receive Data

The Model 496 modem card shall be supplied with blue card ejectors.

3.33 Radio Interference Suppressor

3.33.1 All controller equipment shall be furnished with a radio interference suppressor. The radio interference suppressors shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilohertz to 75 megahertz when used in connection with normal installations. The interference suppressors shall be hermetically sealed in a metal case filled with an insulating compound. Terminals shall be nickelplated, 10-24 brass studs of sufficient external length to provide space for connecting two (2) No. 8 conductors, and shall be so mounted that the terminals cannot be turned in the case, and the termination shall be protected by a removable and replaceable non-conducting transparent cover. Silicon sealant or other similar methods may not be used to provide an insulating cover. Ungrounded terminals shall be properly insulated from each other and shall maintain a surface leakage distance of not less than 1/4- inch between any exposed current conductor and any other metallic part, with an insulation factor of 100-200 megohms dependent on external circuit conditions. Suppressors shall be designed for 125 percent of the total connected load, and in no event less than 25 amperes on 120 volts, 60 Hz, circuits, and shall meet standards of the UL and the EIA.

3.34 Conflict Monitor Requirements

3.34.1 Monitor shall be provided with a windows based interface program. Interface program shall be compatible for use with windows 2000 and XP.

3.34.2 The monitor software shall affix: 'District of Columbia Department of Transportation' in any screen and printout headings.

3.34.3 The District shall be licensed for unlimited use of the monitor interface software and firmware.

3.34.4 The District's licensed use shall be extended to any and all contractors and or consultants authorized and or actively engaged in traffic signal work, and or supplying traffic equipment for the District for as long as they are engaged in such activity with the District. (This licensed use shall only be valid for the DC traffic system).

3.34.5 The District shall be entitled to all revisions of this software that is related to initially delivered functionality.

3.34.6 The District shall be provided with one laptop interface cable for every cabinet supplied.

3.34.7 The District shall be provided with 10 CD copies of the interface software installation files with first shipment of Monitors. The District shall be provided with 100 hard copies of the monitor interface software manual. All installation disks shall include the interface software manual in printable PDF form.

3.34.8 Monitor shall be programmable via interface program and traditional diode/jumper cards.

3.34.9 The monitor shall require a flash sense from the cabinet before any programming can be accepted. All parameters not programmable via diode cards shall be enterable via front panel Intersection ID number shall be stored in the monitor.

3.34.10 Intersection ID change in the monitor shall require re-initialization of all monitor programming to be compatible with all diode's present condition. Programming of monitor shall not be permitted unless ID number is set. All Monitors' programming shall be stored in database form according to currently used controller identification number and name (acisa, or current method).

3.34.11 All programming and log history shall be importable and exportable both addressable by individual intersection, and entire database; to floppy, CD, or over network for transport between workstations, laptops.

- 3.34.12 Following the import of programming data, the interface program will compare the newly imported values against the laptop's stored values. Before exiting the comparison screen or upon trying to save the newly imported data, the interface software shall ask the operator for permission to overwrite existing programming information if imported information is different from that stored in workstation.
- 3.34.13 All status log history information shall be appended to intersection database, and shall be limited to last 25 events. Retrieved log history information will automatically overwrite the existing log history information.
- 3.34.14 Monitor interface software shall be capable of printing out a one for one graphical representation of both program cards. This graphical representation shall resemble the exact card layout and shall be scaled to fit on no more than one page. All printouts shall include ID number and intersection name. All printable information for individual intersections shall be scaled to one page.
- 3.34.15 Monitor interface software shall Upload on demand and view; stored diode cuts and locally programmable parameters. Up load screen shall present a save in database option. Choosing of the save in database option shall ask for permission to overwrite current database information Upload on demand, current stored activity log stored in monitor. Saving of log history information is limited to the last 25 events.
- 3.34.16 An initial programming screen for an intersection just added to the local laptop shall present a diode card with all diodes present.
- 3.34.17 Laptop Interface software Monitor status screen shall include:
- Intersection name and ID
  - Current time and date set in monitor and time and date at time of failure
  - Current temperature and temperature at time of failure
  - Failure/flash type (conflict, watchdog, etc.), if monitor indicates failure Status of all used channels at time of failure Status of all channels as presently operating
  - Current Line voltage and line voltage at time of failure
- 3.34.18 Time and date setting screen shall automatically be presented to operator when laptop communications is established with monitor. A default parameter may be set up to bypass the screen and automatically set the monitor's time and date.
- 3.34.19 All monitors shall be delivered with 2 of each program/jumper cards required to program monitor. The District shall be supplied with 20 spare diode/jumper kits. This kit shall be housed in a compartmented durable plastic box. Each kit shall include 100 replacement Diodes. Each kit shall include 50 pre bent jumpers to fit yellow inhibit and enhancement card.
- 3.34.20 A solid state monitoring device, herein referred to as Enhanced Monitor, shall be installed so that in the event of conflicting signal indications (vehicular or pedestrian, or both), the monitoring device shall cause the signal system to go into flashing operation. The flashing operations shall lock-in and shall release only upon operation of a reset switch. Operation of the monitor shall energize the stop-timing circuit of the controller unit. This device shall comply with the provisions of Chapter 3, Specification FHWA-IP-78-16, except as noted herein. The use of the term "Model 225" is not intended to specify a specific make and model of monitor; rather it is intended to refer to a monitor that meets the requirements contained within these specifications.
- 3.34.21 The Enhanced monitor unit shall be capable of monitoring a minimum of 18 field signal output circuits at the field terminals.
- 3.34.22 The monitor shall store and display the conflicting indications existing at the moment of conflict. These indications, 18 indicators, shall be mounted on the front panel. The monitor shall retain this display until reset by a front panel push-button, or upon the loss of power.
- 3.34.23 The monitor module shall be equipped with a programming card. The programming card shall be a printed circuit board 1/16 inch thick and shall plug into the module through a slot in the front panel. A programming card shall be supplied with a full complement of #1N4148 diodes, or equivalent. Each programming card shall contain 153 diodes. The programming card shall be logically labeled and laid out for easy identification of the diodes by switch pack.

3.34.24 The wiring of the connector for the conflict monitor programming card shall be in accordance with Table 3.5.

**Table 3.5 CMU PROGRAMMING CARD CONNECTOR WIRING**

PIN	FUNCTION (Circuit Side)	PIN	FUNCTION (Component Side)
1	Channel #2 Green	A	Channel #1 Green
2	Channel #3 Green	B	Channel #2 Green
3	Channel #4 Green	C	Channel #3 Green
4	Channel #5 Green	D	Channel #4 Green
5	Channel #6 Green	E	Channel #5 Green
6	Channel #7 Green	F	Channel #6 Green
7	Channel #8 Green	H	Channel #7 Green
8	Channel #9 Green	J	Channel #8 Green
9	Channel #10 Green	K	Channel #9 Green
10	Channel #11 Green	L	Channel #10 Green
11	Channel #12 Green	M	Channel #11 Green
12	Channel #13 Green	N	Channel #12 Green
13	Channel #14 Green	P	Channel #13 Green
14	Channel #15 Green	R	Channel #14 Green
15	Channel #16 Green	S	Channel #15 Green
16	DC Ground	T	Conflict
17	Channel #17 Green	U	Channel #16 Green
18	Channel #18 Green	V	Channel #17 Green
19	Channel #1 Yellow	W	Channel #9 Yellow
20	Channel #2 Yellow	X	Channel #10 Yellow
21	Channel #3 Yellow	Y	Channel #11 Yellow
22	Channel #4 Yellow	Z	Channel #12 Yellow
23	Channel #5 Yellow	AA	Channel #13 Yellow
24	Channel #6 Yellow	BB	Channel #14 Yellow
---	Locating Key	---	Locating Key
25	Channel #7 Yellow	CC	Channel #15 Yellow
26	Channel #8 Yellow	DD	Channel #16 Yellow
27	No Connection	EE	Channel #17 Yellow
28	Yellow Inhibit Common	FF	Channel #18 Yellow

3.34.25 The connector that mates with the programming card shall be keyed between pins 25 and 25 (BB and CC) with an integral, permanent locating key. The locating key shall be part of the connector molding. Separate programming keys that are attached by adhesive or by pressure fit are not acceptable. One (1) spare programming card shall be supplied with each monitor. If a monitor uses more than one type of programming card, one (1) spare of each type shall be supplied.

3.34.26 The wiring of the Monitor Unit Connector in the Output File shall be in accordance with Tables 3.6 and 3.7

**Table 3.6 MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #1**

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
1	Channel 2 Green	120 VAC	135 VAC	25 VAC	15 MA
2	Channel 13 Green	120 VAC	135 VAC	25 VAC	15 MA
3	Channel 6 Yellow	120 VAC	135 VAC	25 VAC	15 MA
4	Channel 4 Green	120 VAC	135 VAC	25 VAC	15 MA
5	Channel 14 Green	120 VAC	135 VAC	25 VAC	15 MA
6	Channel 8 Yellow	120 VAC	135 VAC	25 VAC	15 MA
7	Channel 5 Green	120 VAC	135 VAC	25 VAC	15 MA
8	Channel 13 Yellow	120 VAC	135 VAC	25 VAC	15 MA
9	Channel 1 Yellow	120 VAC	135 VAC	25 VAC	15 MA

Table 3.6 MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #1

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
10	Channel 7 Green	120 VAC	135 VAC	25 VAC	15 MA
11	Channel 14 Yellow	120 VAC	135 VAC	25 VAC	15 MA
12	Channel 3 Yellow	120 VAC	135 VAC	25 VAC	15 MA
13	Channel 9 Green	120 VAC	135 VAC	25 VAC	15 MA
14	Channel 17 Green	120 VAC	135 VAC	25 VAC	15 MA
15	Channel 11 Yellow	120 VAC	135 VAC	25 VAC	15 MA
16	Channel 9 Yellow	120 VAC	135 VAC	25 VAC	15 MA
17	Channel 18 Green	120 VAC	135 VAC	25 VAC	15 MA
---	Locating Slot				
18	Channel 12 Yellow	120 VAC	135 VAC	25 VAC	15 MA
19	Channel 17 Red				
20	Chassis Ground				
21	AC – (Neutral)				
22	Watchdog Input	DC Ground			
23	+24 VDC	+24 VDC	+26 VDC	+22 VDC	500 MA
24	Tied to Pin 25				
25	Tied to Pin 24				
26	Not Assigned				
27	Not Assigned				
28	Output SW, Side 1				

Table 3.6 MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #2

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
A	Channel 2 Yellow	120 VAC	135 VAC	25 VAC	15 MA
B	Channel 6 Green	120 VAC	135 VAC	25 VAC	15 MA
C	Channel 15 Green	120 VAC	135 VAC	25 VAC	15 MA
D	Channel 4 Yellow	120 VAC	135 VAC	25 VAC	15 MA
E	Channel 8 Green	120 VAC	135 VAC	25 VAC	15 MA
F	Channel 16 Green	120 VAC	135 VAC	25 VAC	15 MA
H	Channel 5 Yellow	120 VAC	135 VAC	25 VAC	15 MA
J	Channel 1 Green	120 VAC	135 VAC	25 VAC	15 MA
K	Channel 15 Yellow	120 VAC	135 VAC	25 VAC	15 MA
L	Channel 7 Yellow	120 VAC	135 VAC	25 VAC	15 MA
M	Channel 3 Green	120 VAC	135 VAC	25 VAC	15 MA
N	Channel 16 Yellow	120 VAC	135 VAC	25 VAC	15 MA
P	Channel 17 Yellow	120 VAC	135 VAC	25 VAC	15 MA
R	Channel 10 Green	120 VAC	135 VAC	25 VAC	15 MA
S	Channel 11 Green	120 VAC	135 VAC	25 VAC	15 MA
T	Channel 18 Yellow	120 VAC	135 VAC	25 VAC	15 MA
U	Channel 10 Yellow	120 VAC	135 VAC	25 VAC	15 MA
---	Locating Slot				
V	Channel 12 Green	120 VAC	135 VAC	25 VAC	15 MA
W	Channel 18 Red				
X	Not Assigned				
Y	DC Ground		DC Ground		
Z	External Reset	DC Ground			
AA	+24 VDC	+24 VDC	+26 VDC	+22 VDC	500 MA

Table 3.6 MONITOR UNIT EDGE CONNECTOR WIRING – SIDE #2

PIN	FUNCTION	LEVEL TO OPERATE	VOLTAGE		CURRENT MAX
			MAX	MIN	
BB	Stop Time				
CC	Special Function 2	120 VAC / 24 VDC	(Note 1)	(Note 1)	15 MA
DD	Special Function 3	120 VAC / 24 VDC	(Note 1)	(Note 1)	15Ma
EE	Output SW, Side 2				
FF	AC+	120 VAC	135 VAC	95 VAC	

Table 3.7 MONITOR UNIT PIN ASSIGNMENTS –  
SIDE #1

PIN	FUNCTION	TERMINATION
1	SWPK 2 Green	SP2-7
2	SWPK 13 Green	C6-Pin A
3	SWPK 6 Yellow	SP6-5
4	SWPK 4 Green	SP4-7
5	SWPK 14 Green	C6-Pin C
6	SWPK 8 Yellow	SP8-5
7	SWPK 5 Green	SP5-7
8	SWPK 13 Yellow	C6-Pin B
9	SWPK 1 Yellow	SP1-5
10	SWPK 7 Green	SP7-7
11	SWPK 14 Yellow	C6-Pin D
12	SWPK 3 Yellow	SP3-5
13	SWPK 9 Green	SP9-7
14	SWPK 17 Green	C6-Pin J
15	SWPK 11 Yellow	SP9-5
16	SWPK 9 Yellow	SP9-5
17	SWPK 18 Green	C6-Pin L
18	SWPK 12 Yellow	SP12-5
19	SWPK 17 Red	
20	Chassis Ground	TB01-9
21	AC – (Neutral)	TB01-10
22	Watchdog Timer	C4-37
23	+24 VDC	TB02-1
24	CMU Interlock	Logic Relay Coil
25	CMU Interlock	Logic Ground
26	Not Assigned	N/C
27	Not Assigned	N/C
28	Output SW, Side #1	AC+ – TB01-11

Table 3.7 MONITOR UNIT PIN ASSIGNMENTS –  
SIDE #2

PIN	FUNCTION	TERMINATION
A	SWPK 2 Yellow	SP2-5
B	SWPK 6 Green	SP6-7
C	SWPK 15 Green	C6-Pin E
D	SWPK 4 Yellow	SP4-5
E	SWPK 8 Green	SP8-7
F	SWPK 16 Green	C6-Pin G
H	SWPK 5 Yellow	SP5-5
J	SWPK 1 Green	SP1-7
K	SWPK 15 Yellow	C6-Pin F
L	SWPK 7 Yellow	SP7-5
M	SWPK 3 Green	SP3-7
N	SWPK 16 Yellow	C6-Pin H
P	SWPK 17 Yellow	C6-Pin K
R	SWPK 10 Green	SP10-7
S	SWPK 11 Green	SP11-7
T	SWPK 18 Yellow	C6-Pin M
U	SWPK 10 Yellow	SP10-5
V	SWPK 12 Green	SP12-7
W	SWPK 18 Red	N/C
X	Not Assigned	N/C
Y	DC Ground	TB02-2
Z	External Reset	TB02-5
AA	+24 VDC	TB02-1
BB	Stop Time	TB02-3
CC	Not Assigned	N/C
DD	Not Assigned	N/C
EE	Output SW, Side #2	TB01-12
FF	AC+ (Hot)	TB01-11

- 3.34.27 Conflict monitors being supplied under this contract shall operate properly when installed in existing cabinets that are wired to support existing 218 or 225 conflict monitors.
- 3.34.28 All switch pack signals being monitored shall be in conflict with all other switch pack signals being monitored, unless a diode (anode to numerical pins and cathode to alphabetical pins) has been removed. Removal of a diode shall define a non-conflict.
- 3.34.29 In addition, the yellow signals from all switch packs shall be monitored unless a jumper is placed between the appropriate yellow switch pack pin and a yellow inhibit pin common on the programming card.
- 3.34.30 The green, yellow and red indications for each switch pack phase shall be brought into the monitor individually. The red inputs for channels 1 to 16 and the red enable signal shall be brought into the monitor via a front panel connector. The connector shall be wired in accordance with Table 3.8.

3.34.31 Each switch pack shall be monitored for a ‘No Output’ condition, where ‘No Output’ is defined as a condition where all three outputs of a given switch pack fail to meet minimum voltage threshold criteria as defined in the CALTRANS Traffic Signal Control Signal Equipment Specifications (TSCES). When a no output condition is detected for a switch pack for the duration of time that is specified in section 3.34.33, the monitor shall trip and place the cabinet into a latching flash condition. There shall be an indicator that indicates “No Output” or “Red Fail”. The monitor shall also indicate, via individual indicators for each of the 18 switch packs, which switch pack caused the No Output event. The monitor shall provide, via some permanently attached hardware such as a switch, the disabling of monitoring for No Output failures by individual channel (switch pack).

Table 3.8 CONNECTOR P20 Wiring

PIN NUMBER	ASSIGNMENT
1	Channel 15 Red
2	Channel 16 Red
3	Channel 14 Red
4	Chassis Ground
5	Channel 13 Red
6	Special Function 1
7	Channel 12 Red
8	RR Preempt
9	Channel 10 Red
10	Channel 11 Red
11	Channel 9 Red
12	Channel 8 Red
13	Channel 7 Red
14	Channel 6 Red
15	Channel 5 Red
16	Channel 4 Red
17	Channel 3 Red
18	Channel 2 Red
19	Channel 1 Red
20	Red Enable

3.34.32 The green, yellow, and red indications shall be monitored for multiple output conditions. A multiple output condition shall be defined where the output voltages of more than 1 channel of a given load switch exceeds minimum voltage threshold levels as defined in the CALTRANS Traffic Signal Control Signal Equipment Specifications (TSCES) for a duration of time as specified in section 3.34.33. The fault timers shall start immediately upon detection of any two or more simultaneous outputs and shall continue timing until only one or no output is detected for that switch pack. When a fault condition is detected, the monitor shall illuminate an indicator labeled “Multiple Output”. The monitor shall also indicate, via individual indicators for each of the 18 switch packs, which switch pack caused the Multiple Output fault. The monitor shall provide, via some permanently attached hardware such as a switch, the disabling of monitoring for Multiple Output failures on an individual channel (switch pack).

3.34.33 The monitor shall monitor output signals applied at the field terminals of each switch pack (green, yellow, red). For the conditions described in paragraphs 3.34.31 and 3.34.32, should a fault condition (no output, multiple output) be detected, the unit shall begin timing the duration of this fault condition. If this condition exists for less than 700 milliseconds, the unit will not trigger. If the condition last for more than 1000 milliseconds it will trigger and place the cabinet in a latching flash condition. The unit may or may not trigger if the condition exists for more than 700 milliseconds or less than 1000 milliseconds. For each fault condition, an individual timer shall be maintained for each switch pack. Should more than one switch pack experience a fault at one time, or should one switch pack experience more than one fault condition at one time, each fault timer shall operate independently without being affected by the operation of any other fault detection and timing features. Once a No output or Multiple Output fault has been determined according to the timing requirements in this section, the monitor shall trip and place the cabinet into a latching flash condition.

3.34.34 The monitor shall detect short or missing yellow cycle.

3.34.35 When the unit triggers for a fault condition, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control, or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output as indicated above.

3.34.36 At a minimum, the conflict monitor shall have the following indicators:

AC Power – This indicator shall illuminate when the AC input voltage to the monitor exceeds 103 (+/-2) VAC. It shall be extinguished, when the AC input voltage falls below 98 (+/-2) VAC.

DC Power – This indicator shall illuminate when the 24VDC input to the monitor exceeds the minimum threshold voltage.

Watchdog Error – This indicator shall illuminate when a watchdog error is detected.

Conflict – This indicator shall illuminate when the monitor has detected a conflict.

PC Ajar – This indicator shall illuminate when the program board is not installed or not seated properly.

No Output or Red Fail – This indicator shall illuminate when a no output fault has been detected.

Multiple Output or Switch Fail – This indicator shall illuminate when the monitor has detected a multiple output fault.

Yellow Fail – Shall illuminate when a short or missing yellow cycle is detected.

3.34.37 The monitor shall include signal output status indicators. There shall be one indicator for each channel of each of the 18 switch packs. The indicator for each switch pack shall illuminate when a red, yellow or green output voltage is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status display shall latch and display the output status of each channel at the time the conflict occurred. Should the monitor trip due to a No Output or Multiple Output condition, the signal status indicators shall display the channel(s) that caused the fault and shall latch status display until the monitor is reset.

3.34.38 After a power outage before which there was a fault, the monitor shall correctly show the previous fault. This will include fault type and channel that was in error.

3.34.39 The monitor shall provide a means to send fault and channel status to the controller via a serial port.

3.34.40 The monitor shall have a DB-9 sub-miniature connector that provides an RS-232 interface to the 170E controller. The vendor shall provide an interface cable between the DB-9 connector and the controller's C20S socket. The interface cable shall be wired in accordance with Table 3.9.

**Table 3.9 CMU WIRING HARNESS**

C 20 PIN	FUNCTION	DB-9 MALE PIN (DCE)	COMMENTS
K	TD	3	
L	RD	2	
N	GND	5	
J	RTS	N/C	Jumper to Pin M
M	CTS	N/C	Jumper from Pin J
D	+5 VDC	N/C	Jumper to Pin H
H	CD	N/C	Jumper from Pin D

3.34.41 The monitor shall communicate using the following protocol: at 2400bps, Even Parity, 8 Data Bits, 1 Stop Bit. In response to a status request from the controller, the conflict monitor shall transmit the current conflict monitor status. Status communications shall be in accordance with the message format described in Table 3.6 The conflict shall not initiate any transmission of data except in response to reception of a valid status request. All responses shall conform to the specified message formats. The communications subroutines shall be interrupt-driven. The monitor shall respond within 15 milliseconds of respond of receiving a valid request from the controller. Once the monitor starts transmission of a message to the controller, maximum inter-byte time shall not exceed 15 milliseconds. Communications with the controller shall operate independently of the conflict monitor – that is communications with the 170E controller shall not be adversely affected by other conflict monitor functions; nor shall communications with 170E controller adversely impact the other operations of the conflict monitor.

3.34.42 In response to a status request command, the conflict monitor shall transmit the status information as described in the specified message formats.

3.34.43 The conflict monitor shall provide the following status in response to a status request from the 170E controller:

- All fault status (conflict, AC low, 24V, Watchdog, PC Ajar, Red Fail, Switch Fail, Yellow Fail)
- Enable status (Watchdog, Red Enable)
- Channel status (Green, Yellow, Red) Channels 1 to 18

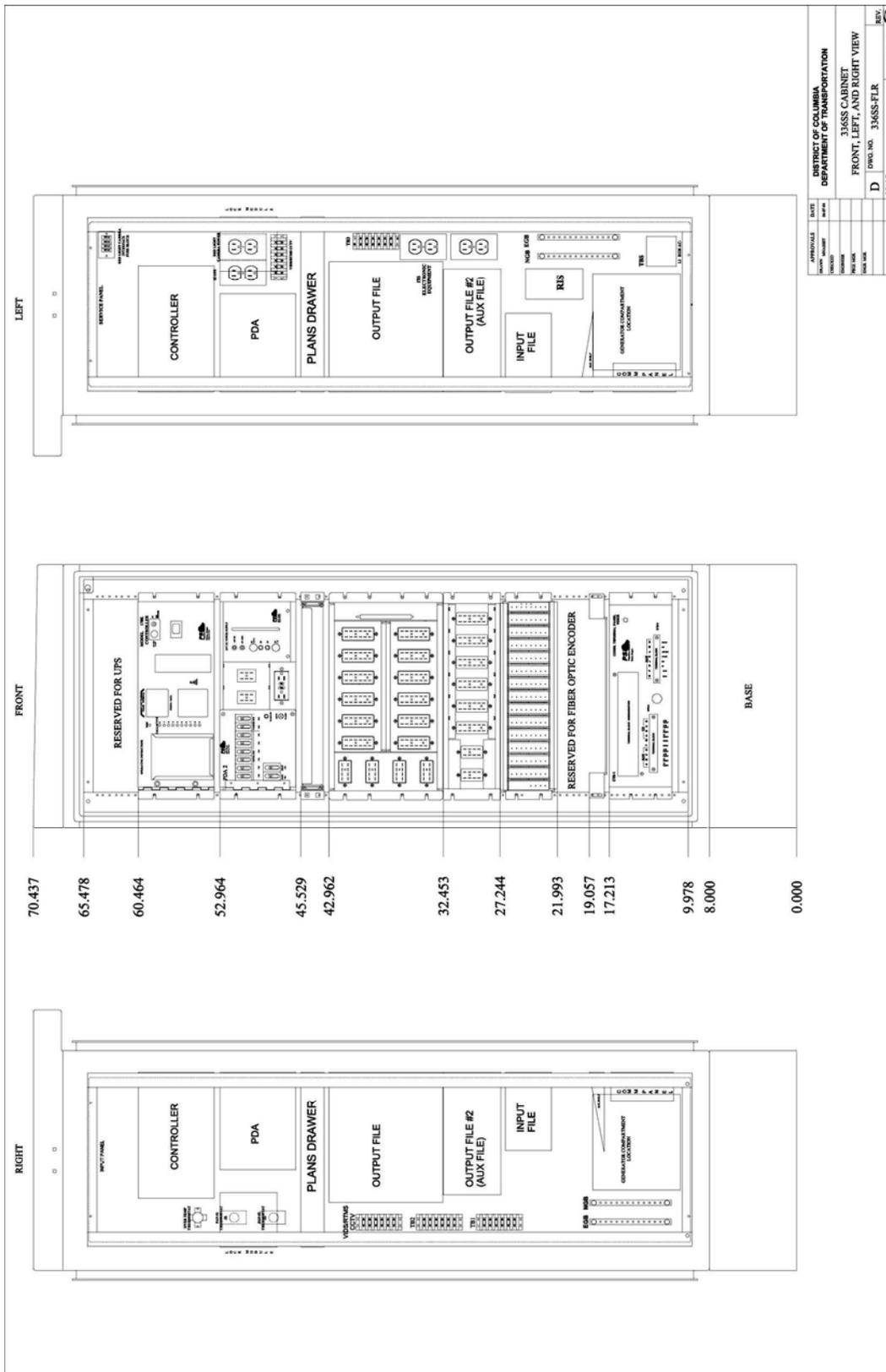
3.34.44 The conflict monitor shall contain a real-time clock that maintains the current Year, Month, Day of Month, Day of Week, Hour, Minute, and Second. The real time clock shall maintain the current time information during power outages. It shall continue to maintain accurate time during power outages of at least 30 days in duration. The real time clock shall provide automatic daylight savings time correction. The monitor shall function correctly in all respects with regard to Year 2000 issues.

- 3.34.45 The monitor shall update its real time clock in response to a properly formatted transmission from the 170E controller. It shall correctly set the real-time clock in accordance with the message formats described in Table 3.7
- 3.34.46 The contractor shall provide 225 Enhanced conflict monitor currently in utilized by the District. The conflict monitor shall conform to all features and protocols currently in use in the District.

**TYPE 170 MICROPROCESSOR-BASED TRAFFIC SIGNAL CONTROLLER AND CABINET ASSEMBLY**

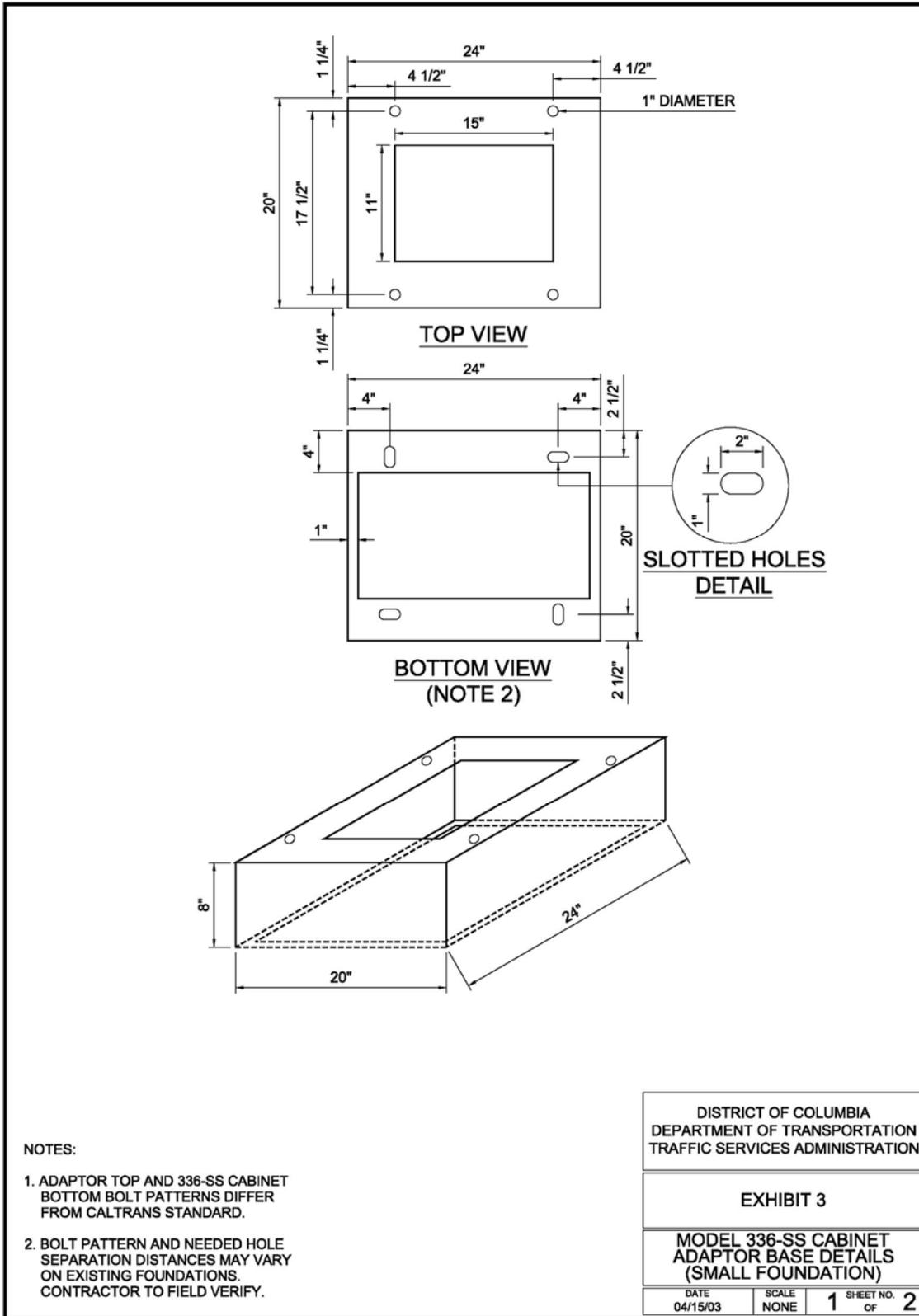
2007-TS-001

Exhibit 1



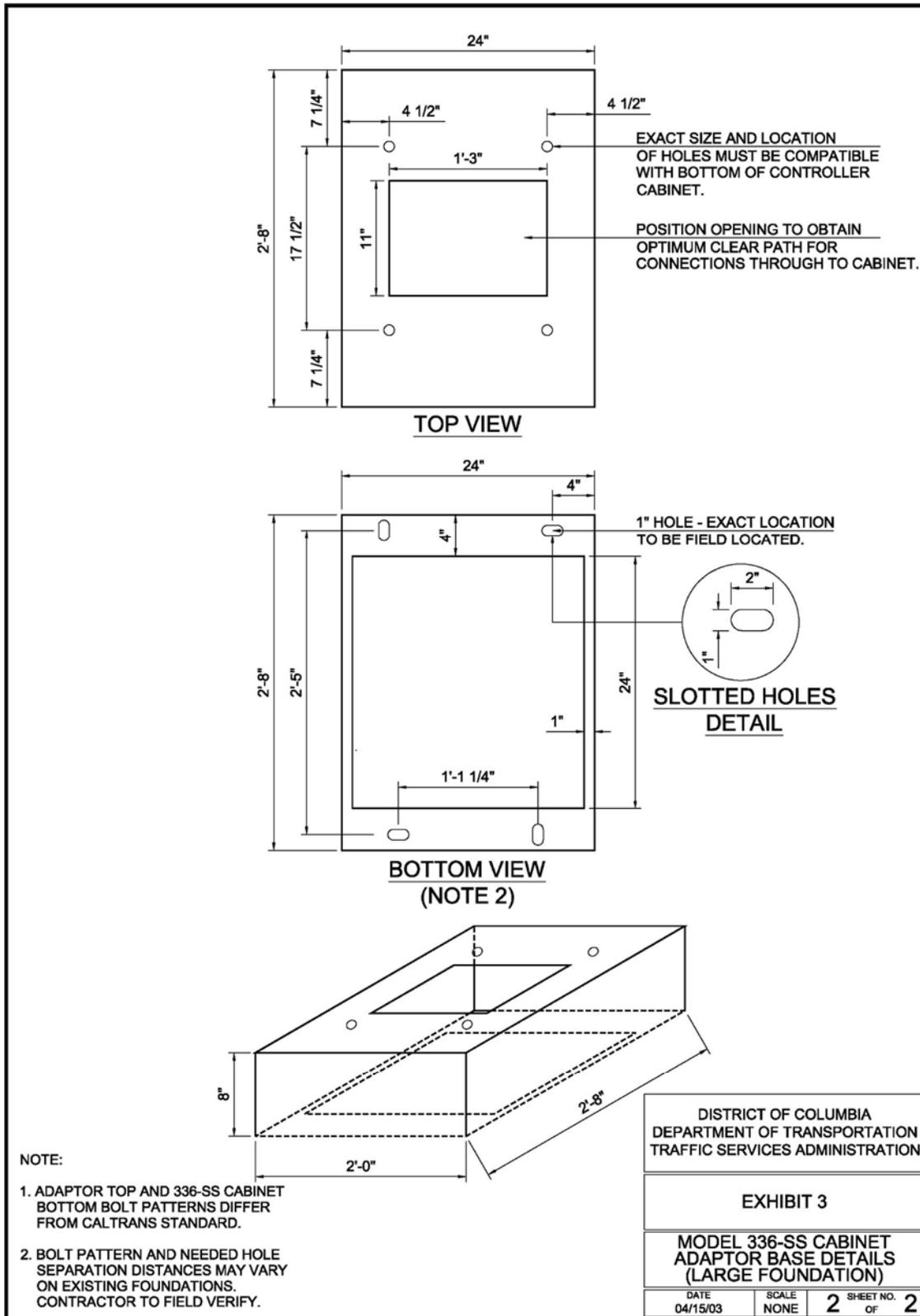
APPROVALS	DATE	SCALE
DESIGNED BY	DATE	
CHECKED BY	DATE	
DATE		
DISTRICT OF COLUMBIA DEPARTMENT OF TRANSPORTATION		
336SS CABINET		
FRONT, LEFT, AND RIGHT VIEW		
D	DRWG. NO.	336SS-FLR
	SCALE	SHEET 1 OF 1

Exhibit 2



//WHB\_DATA/66028/3009/336-SS\_Adaptor\_Base\_Small.doc

Exhibit 2



//WHB\_DATA/86028/3009/336-SS\_Adaptor\_Base\_Large.doc



## 2007-TS-002

### ELECTRONIC SECURITY LOCK

(A) **GENERAL.** Cabinet electronic security lock shall be compatible with and direct replacement in operation and mechanical construction to District Department of Transportation current cabinet electronic security lock.

(B) **FIGURES.**

**FIGURE 1** Electronic Security Lock Subsystem Components

**FIGURE 2** Police Panel Electronic Security Lock Subsystem

(C) **DEFINITIONS.**

**Access Code:** Any system or method which automatically controls the passage of people and vehicles into or out of an area or structure

**Annunciated:** An audible and/or visible signaling device

**Access Time:** The period of time during which an access point is unlocked ( See Shunt Time)

**Audit Trail:** A listing created which may be created in real time, which may be used to monitor the progress of a person through protected areas.

**Buffer Capacity:** The amount of information a system can store, and may include the users, time of day and specific door.

**Database:** A collection of data used and produced by a computer program. The files created at the host of the access control system forms its database.

**Device Address:** Value set on an access control device to determine its unique identity.

**Electromagnetic:** Pertaining to the combined electric & magnetic fields associated with movements of electrons through conductors.

**Enclosure:** A box or cabinet, usually constructed of metal, that houses system components, such as circuit boards, and other electronic and electrochemical controls and circuitry.

**Erasable Programmable Read-Only Memory (EPROM):** A programmed memory (often a chip) that can not only be read, but can be repeatedly erased under high-intensity ultraviolet light and reprogrammed.

**Fail-Secure:** An electronic lock that requires power to unlock. (Also: fail-locked)

**History:** A log of system activity that can be recalled by utilizing the report command. Most systems offer a feature that notifies the console operator of the amount of available storage for history information preventing information from being written over. The message will usually alert the operator to archive the information onto a removable magnetic board.

**Keypad:** A flat device which has buttons that may be pressed in a sequence to send data to a controller, and which differs (said to be “non-QUERTY”) from a typewriter-like computer board.

**Key Lock blocker:** An electromechanical device which is part of the cabinet door locks that cannot physically engage until the key lock is properly engaged.

**Lock Control Unit (LCU) [Note: the PLC is the main part of LCU]:** Micro-computer with inputs and outputs that can be programmed to control and monitor access to the key lock blocker, stores events and communicates with a central data server. Programmable Logic Controller (PLC) is the micro-computer that makes of the LCU. The LCU also includes the thermal fan and power supply for the PLC.

**Momentary Switch:** A switch that, after being activated, automatically returns to its original position; a spring-loaded contact that, when pressed, closes two contacts, and when pressure is removed, opens the contact.

**Operator:** A person at a central location that controls the electronic security lock sub-system.

**Reader:** Refers to the “front end” that a user must interact with to allow access. Readers can be keypads, card readers, and proximity readers.

**Time Schedules:** Allows for access based on time of day, date and user. Also allows for holidays, etc.

**Transaction:** A record created that contains pertinent information about an occurrence in the access control and monitoring system.

**USER:** An authorized person trying to gain access to field cabinets through the electronic lock sub-system.

- (D) **CONCEPT OF OPERATION.** All controller cabinets shall be provided with an electronic security lock sub-system local components. The primary purpose of the electronic security lock sub-system is to provide local components that monitor the status of the authorized and unauthorized entry and closure of the controller cabinet. The sub-system shall read from a central location and be able to store local and transmitted central data. Central reading/writing to the LCU shall be accomplished using a central security server/workstation and the DC ITMS Communications sub-system. The central Security Management Software shall be able to support up to 2,500 Electronic Security Sub-systems (LCUs).

All LCUs shall perform as required from any Traffic Management Center (TMC) or Traffic Operations Center (TOC) that is in primary control of the communications to the LCU. This requirement serves the need for the Integrated Traffic Management System (ITMS) to be able to control the LCU from the appropriate TOC controlling the ITMS system. The ITMS communications system shall provide the channel to address the LCU for this control.

- (E) **DESCRIPTION OF LOCAL COMPONENTS.** The electronic security lock sub-system shall consist of the following main components:

**1. Lock Control Unit (LCU),** including Programmable Logic Controller (PLC)

This unit shall be mounted in the cabinet and shall perform the following functions:

- Accept user input codes from the local cabinet Security Keypad
- Determine the validity of an entered code and open the door lock
- Electromechanically interface to the mechanical cabinet locks to control entry
- Record and transmit data from various events such as authorized cabinet entry, unauthorized entry or attempted code picking.
- Capable of interfacing to the traffic cabinet communications interface through a dedicated serial communications port/channel independent of the signal controller. The serial data port can be configured to accommodate various data or event occurrences from the security sub-system as required by the user.
- LCU includes the PCL, a thermal fan and a power supply.

**2. Keypad (Local User Interface).** This unit shall be mounted behind a secure police panel door and shall perform the following functions:

- Input code entry for cabinet access
- Interface with the Lock Control Unit (LCU)

**3. Backup External Power Supply Terminal (PTS) 12VDC.** This unit shall be mounted behind a secure police panel door and shall perform the following function:

- Allow operator to power the electronic security lock sub-system from the police panel using a back-up power supply cable (automobile cigarette lighter adapter) operating with 12VDC voltage supply.

**4. Cabinet door locks with electromechanical release control.** This electromechanical release control shall be mounted in its normal cabinet door position and shall perform the following functions:

- Cabinet door locks shall include an electromechanical key lock blocker that allows the manual door key to unlock the cabinet door lock after the releasing of the blocking mechanism following receipt of a validated access code at the LCU.

- The electronic security lock sub-system shall check 1) door closure and 2) the position of the sub-system key lock blocker. This information should be adequate to determine proper closure and locking of the cabinet. Note that the subsystem lock blocker cannot physically engage until after the key lock is properly engaged. This means the door is already locked before the blocker can engage. The electronic sub-system shall not record the cabinet closure until both doors have been closed and locked.

**5. Annunciator (Beeper).** This unit shall be mounted behind the police panel and shall perform the following functions:

- When the electronic security lock sub-system releases the blocking mechanism, a distinct audible sound shall be produced that is capable of being heard by the user in the controller cabinet field environment (over the sound of passing vehicles, etc).
- When electronic security lock sub-system is put into the block position (locked) after both cabinet doors are in the closed position, a distinct audible sound different from the release sound shall be produced capable of being heard by the user from a range of 24 inches or less in the controller cabinet field environment (over the sound of passing vehicles, etc.).

**(F) FUNCTIONAL REQUIREMENTS.**

**1. Lock Dependence and Control Requirements**

- The electronic security lock sub-system shall be integrated with the physical lock mechanism (called a key lock blocker) to prevent the key lock from properly engaging unless authorized by the electronic sub-system.
- The electronic security lock sub-system shall remain in the locked condition (fail-secure) until validation of an authorized access code supports release of the key lock blocker mechanism.
- If both the physical door(s) are closed and the key locks for the doors are in the proper locked condition, the electronic security lock sub-system shall engage. The LCU shall not record the cabinet closure until both cabinet doors have been closed and locked.
- This sub-system shall provide electronic lock self-diagnostics.
- Should the electromechanical key lock blocker fail, it shall not prevent the mechanical lock from being positioned in the proper lock condition.
- The electromechanical key lock blocker shall be able to be opened/closed from a central location by an operator via a computer workstation; for any individual LCU, a select group of LCUs or all LCUs.
- One LCU shall release both key lock blocker mechanisms at the same time so they can be physically opened.
- The electronic security lock sub-system shall remain in a locked condition when power is removed from the sub-system, unless externally powered and validation of an authorized access code or released from central location.

**2. Central Security Management Software Requirements.** The software shall have the following functions:

- Software shall reside on a security management server located at a central location and be able to communicate (read/write) with all cabinet security lock sub-systems individually and globally.
- Central shall read/write all LCUs, up to 2500 cabinet LCUs and these shall transmit back to central.
- Central Software shall provide multi-level addressing capability to uniquely communicate with each LCU, based upon the LCUs addressing capability and the serial communications channel provided. Multi-level addressing shall be able to support an addressing scheme that communicates to each LCU using the DC ITMS serial communications channel provided. Each LCU will be provided a Permanent Virtual Circuit (PVC) over the ATM fiber network. Communication shall include reading/writing to memory locations within the LCU for the storage and retrieval of LCU data. For example, an address scheme could combine an LCU Station Address with an IP Port address and a Local LCU Group ID (group of security locks) to identify the delivery address for data to an LCU.

- Central shall be able to write data to each LCU to synchronize lock time and store authorized access codes, both individually and on a broadcast basis.
- Display alarms shall be able to be prioritized by cabinet and alarm type by central.
- Software shall run on in a Microsoft Windows operating system environment or platform compatible with the DC ITMS software environment.
- Central shall be able to open/close the Key Lock Blocker for any individual LCU, a select group of LCUs or all LCUs.
- Password(configurable) shall be required for operation of this software.
- Central shall be able to assign Access Codes to specific users
- Central shall maintain a database of Access Codes assigned to users.
- Central shall communicate to all field Lock Control Units (LCU) via serial communications located at central location.
- Central shall be able to generate status reports of event logs for each LCU.
- Reports shall be subject to Engineer's approval and shall include at a minimum:
  - Code Administrator name on each report
  - All currently Authorized and Retired codes
  - LCU event log (contains local status logged)
    - Unauthorized Access (Alarm)
    - Unsuccessful Access (Lock Picking) attempts (Alarm)
    - Power Failure (AC) (Alarm) and duration
    - Low Battery (Alarm)
    - Excessive open door status; various time duration thresholds (configurable from central) (Alarm)
  - Date and time stamps for each event log entry
  - Lock status open/closed (Alarm)
  - Alphanumeric Intersection Location identification obtained from ACISA number lookup table
- Supervisor Control shall be able to perform administration on all related cabinet security databases, reports, access code data, lock time clock and electronic lock control. The Supervisor Control shall be set up with a unique password code, given only to authorized individuals. The Supervisor Code shall be used to release the electronic lock local components in the event that the sub-system has encountered an error.

**3. Code Structure and Storage Requirements.** Code shall have the following characteristics:

- Code shall have eight (8) digit identifier assigned to only one person requiring access to the controller cabinet. First four (4) digits uniquely identify the person assigned the code, and the second four (4) digits is a cabinet access identifier. The cabinet identifier can serve as a common number to all cabinets for a specified period of time. If an eight (8) digit code shall cause too much memory to be used, a four (4) digit code may be considered, subject to the approval of the Chief Engineer.
- Valid time period for a specific cabinet access identifier is configurable from central location for all LCUs in the system.
- Electronic security lock sub-system shall be able to store valid access codes.
- Codes shall be downloaded, edited, and deleted from a central location.

**4. LCU Requirements.** The required features of the LCU shall be compatible with the Central Security Management Software Requirements.

The software/firmware shall perform the following functions with 30 events being recorded and retained in the local memory for polling:

- LCU event log shall be provided containing the following local status information:
  - Authorized Access Code of field personnel opening cabinet
  - Unauthorized Access
  - Unsuccessful Access Attempts (and Code Sequences)
  - Power Failure (AC) and duration
  - Low Battery
  - Excessive open door status (configurable from central)
  - Date and time stamps for logged events
  - Supervisor Access Code Change event
  - Door open/closed, with code, date and time stamp.
  - Identity of controller cabinet using 4-digit ACISA number, which shall be supplied by the Contracting Officer's Technical Representative (COTR). ACISA number shall be used at central to look up intersection location name.
  - Verification of lock closure (reset in locked position)
- The LCU shall be uniquely addressable from central over ITMS communications network using serial communications protocol.
- This sub-system shall include software/firmware that facilitates data to be read from and written to the LCU.
- This sub-system shall be capable of immediate notification to central location of all authorized and unauthorized entries.
- In the event that communications to central is off-line, the cabinet security lock sub-system shall allow access based on its internal authorized list and shall store an audit trail of at least 30 events.
- When communication is restored, the cabinet electronic security lock sub-system shall report, on request, all events to the central security management software database, and shall receive, on request all security sub-system related changes made at the central location.

##### **5. LCU Status Indicator Requirements.**

- Transmit and receive indicators for serial communications ports
- Power indicator to show LCU is being powered
- Program Run indicator to show current software/firmware is running.
- Other diagnostic indicators and self-test buttons shall be located internal to the cabinet, available on the LCU.

##### **6. Data and Event Requirements.**

- Unique LCU Serial Number for each LCU that is stored in the LCU and addressable from central server
- Cabinet ACISA number, identifying unique intersection location for each LCU
- Last valid Access Code used, date and time of access
- List of recent valid Access Codes used, date and time of access
- Current date and time of lock clock upon event
- Event status report from lock
- Attempted Code Picking Events and Attempted Codes (3 strike lockout for configurable period of time)
- Last 30 events
- Low Clock and Data Storage Backup Battery Event
- AC Power failure

**7. Diagnostic Requirements.** The Electronic Security Lock sub-system shall perform the following diagnostics initiated locally or from central location:

- Lock open (Unlock)/Lock closed (Lock)
- Communicate with central location
- Exercise electronic security lock sub-system annunciator (beeper)

**8. Maintenance Scenario Requirements.**

**Scenario 1: Electronic Lock not powered**

An external power supply terminal (PST) shall be provided at each cabinet. External power supply connections are protected and cannot be used to damage internal cabinet components. External power can be supplied through protected external power connections.

The Electronic Security Lock Sub-system shall perform in a normal operating manner once external power to the lock is applied.

**Scenario 2: Electronic Lock malfunctions**

If an Electronic Security Lock Sub-system malfunctions and is not controllable from central or locally at the cabinet, the key lock blocker shall be able to be released by an already established key lock maintenance procedure.

The maintenance procedure to release the security sub-system key lock blocker and key lock shall be accomplished by drilling the mechanical key cylinder. The drilling location for release of the cabinet lock, minimal cabinet intrusion, and effective removal and replacement of the cabinet lock and key lock shall be confirmed by the Chief Engineer.

**Scenario 3: TMC Lockouts**

Three (3) unsuccessful attempts to access the Electronic Security Lock cause an automatic lockout to last by default 15 minutes (configurable from central location). Electronic security lock sub-system can be released from central during this period.

**9. Communications Requirements.**

- Two (2) built-in serial ports
  - Port 1 is RS-232C, fixed at 9600 baud, used for programming the PLC.
  - Port 2 is multi-function RS-232C, RS-422, RS-485 with selective baud rates (300-38,400bps) for central communication
- Parity – Odd, Even, None
- Start Bits-1
- Stop Bits-1
- Data Bits-8
- Protocol: Asynchronous, Half or Full Duplex (2-way communication)

**10. Cabinet Installation/Mounting Requirements.**

- This sub-system shall be modular in design to allow for field installation in an existing cabinet
- This sub-system shall be mounted internally to the cabinet, except for external components, where noted, using the available cabinet space to the approval of the Chief Engineer. Consideration shall be given first to a LCU rack mount option (See LCU Rack Mount Option below). An interior side panel in the back of the controller cabinet may be considered only upon approval by the Chief Engineer.
- Keypad shall be weather proofed, sealed keyboard with a panel seal gasket to protect it. No additional weather proofing or protection shall be required to protect it. All fasteners for removal of keypad shall be internal to the cabinet and shall not be accessible from external to the cabinet or from behind police panel door.

- Keypad, Back-up External Power Supply Terminal and Annunciator required for electronic access to the cabinet shall be installed on the police panel, behind the police panel door. The Back-up External Power Supply Terminal and Annunciator may be recommended for integration with the Keypad, if the integration will result in reducing the cost and simplifying the production installation. This integration shall not cause any performance problems and is subject to approval by the Contracting Officer's Technical Representative and the Chief Engineer.
- a. **LCU Rack Mount Option.** This option specifies the basic size, orientation and location for mounting the LCU within a standard 19-inch controller cabinet equipment rack.

The LCU will be enclosed within a metal box from formed sheet metal. The enclosure shall be approximately 5.25 inches high by 5 inches deep by 12 inches wide. The enclosure shall be mounted on a standard 5.25 inch (3U) by 19 inches rack mount faceplate. The faceplate will be full width (19 inches) but the actual box enclosure on the back shall be approximately 12 inches wide and set off center to the left. This leaves room on the right side for wiring harness connectors.

The unit shall be mounted so any wire routing or cable harness will not obstruct air flow to the LCU, will be able to provide for loops of excess cable/wiring for door opening, and allow for easy storage and removal when necessary.

## 11. Electrical Requirements.

**Discrete Output Points (12VDC).** The security sub-system shall have at least 4 output points available for custom functions. These points can be used to send signals to external devices or to engage relay contacts. The Electronic Security Lock sub-system outputs shall be to points to engage:

- Output 1: Solenoid Key Lock Blocker
- Output 2: Annunciator (Beeper)
- Outputs 3 and 4: Spares

**Discrete Input Points (12 VDC Sinking).** The security sub-system shall have at least 6 input points available for customs functions. These points can be used to send signals to the LCU electronics for use in triggering lock functions. The Electronic Security Lock sub-system inputs shall be to points to engage:

- Input 1: Keypad inputs
- Input 2: Cabinet Door Switches (one input for front and rear doors)
- Input 3: Solenoid Key Lock Blocker
- Input 4: Back-up External Power Supply Terminal (PST)

**Contact Closures Outputs (Capable of Handling 24 VDC Signals).** The electronic security lock subsystem shall provide for 2 relay contacts for switching logic ground of 24 VDC referenced signals. In the absence of other requirements, relay contacts are driven by LCU special functions outputs. These contacts may be used for traffic signal controller interfaces via the C1 or C11 connector.

**Ground True Inputs (referenced to Traffic Signal Controller 23 VDC Supply).** The electronic security lock sub-system shall accommodate 2 traffic signal controller control signals provided to the LCU as ground true referenced signals. In the absence of other requirements, the LCU shall process these inputs as Special Function Alarms to be communicated to Central. These contacts may be used for traffic signal controller interface via the C1 or C11 connector.

**Electrical Isolation.** The Electronic Security Lock Sub-systems shall not be interrupted or caused to operate abnormally due to Electromagnetic Interference (EMI) or Extraneous Power Signals. The sub-system shall be subjected to the same requirements provisioned in the Cabinet and Controller specification that this specification is attached to.

**Power Failure Recovery.** The electronic lock security sub-system shall recover from power outages transparently to the user, Recovery may be permanent, as in the case of PEPCO grid power restoration, or temporary, as in the case of externally applied power terminal. Under all power outage circumstances, electronic security lock sub-system shall operate as if power had never gone out.

**12. Power Requirements.**

12VDC shall be supplied by LCU internal power source; 120VAC converted.

- Output Voltage Range: 6-27VDC
- Maximum Output Voltage: 30VDC
- Maximum Output Current: 2A/point; 6A/common
- Smallest Recommended Load: 5mA@5VDC
- Off to On Response Time: < 15ms
- On to Off Response Time: <10 ms

Power Fuses – include for LCU unit; removable fuse holder mounted for LCU outside enclosure access.

Real Time Clock shall be backed up by battery. The battery shall be good for 3 years of clock operation in the event of a power failure to the cabinet.

**13. Environmental Testing Requirements.** The Electronic Security Lock Sub-system shall be subject to the level of testing specified in the Controller and Cabinet Specification.

**14. Software/Firmware Licensing.** There shall be no software/firmware license fee for each LCU. The firmware for the LCU shall be provided by the supplier and installed at the factory as part of the electronic lock security sub-system.

**(G) MATERIALS REQUIREMENTS.**

Basic parts list for Cabinet Electronic Security Lock Sub-system for each cabinet. Each cabinet has dual door controls.

- One (1) each – Lock Control Unit (LCU)- Rack mountable or Side Panel mountable battery-backed real time clock (3 year life after power loss to LCU). Includes Programmable Logic Controller, DC power supply, LCU power cable to 120VAC, and internal cooling fan.
  - Two (2) built-in serial ports. Port 1: RS-232C; Port 2: Multi-function RS-232C, RS-422, RS-485
  - Keypad – 12 Key telephone type keypad, environmentally sealed, tactile and tone feedback.
- One (1) each – Electromechanical key lock blocker for release/blocking control as part of each cabinet key door lock
- One (1) each – Keypad shall be installed behind Police Panel Door. Sealed keyboard, audible contact, 1 million push button operations per button, and panel seal gasket to protect keypad. Gasketing to also seal cabinet innards.
- Wiring harnesses/wire as necessary for such interfaces as: Keypad, Annunciator (Beeper) and Power Supply Terminal (PST) for LCU external power capability and one (1) input from front and back door open contacts.
- One (1) each – Back-up Power Supply Terminal (PST) shall be installed behind Police Panel.
- Forty (40) each – Back-up Power Supply Cable for PST. Shall be 30 feet in length and able to plug into an automobile cigarette lighter. Cable shall be properly labeled.
- One (1) each – Serial Communications Cable RS-485 for communications from LCU to internal cabinet communications channel (Data Bridge or Integrated Encoder contains Serial Port for Electronic Cabinet Lock supplied with communications equipment ). Cable type and connectors shall be available at the time of purchase.
- Twenty-five (25) each – Serial Communications Cable RS-232C for communications to LCU from local laptop or similar technology. Cable type and connections shall be available at the time of purchase.

**H. DOCUMENTATION REQUIREMENTS.** Twenty-five (25) complete sets of operation and maintenance manuals in hard copy format shall be provided. Format and text style shall replicate that

described in the controller and cabinet specifications. In addition, at least five (5) copies of CD-ROM electronic manuals shall be delivered.

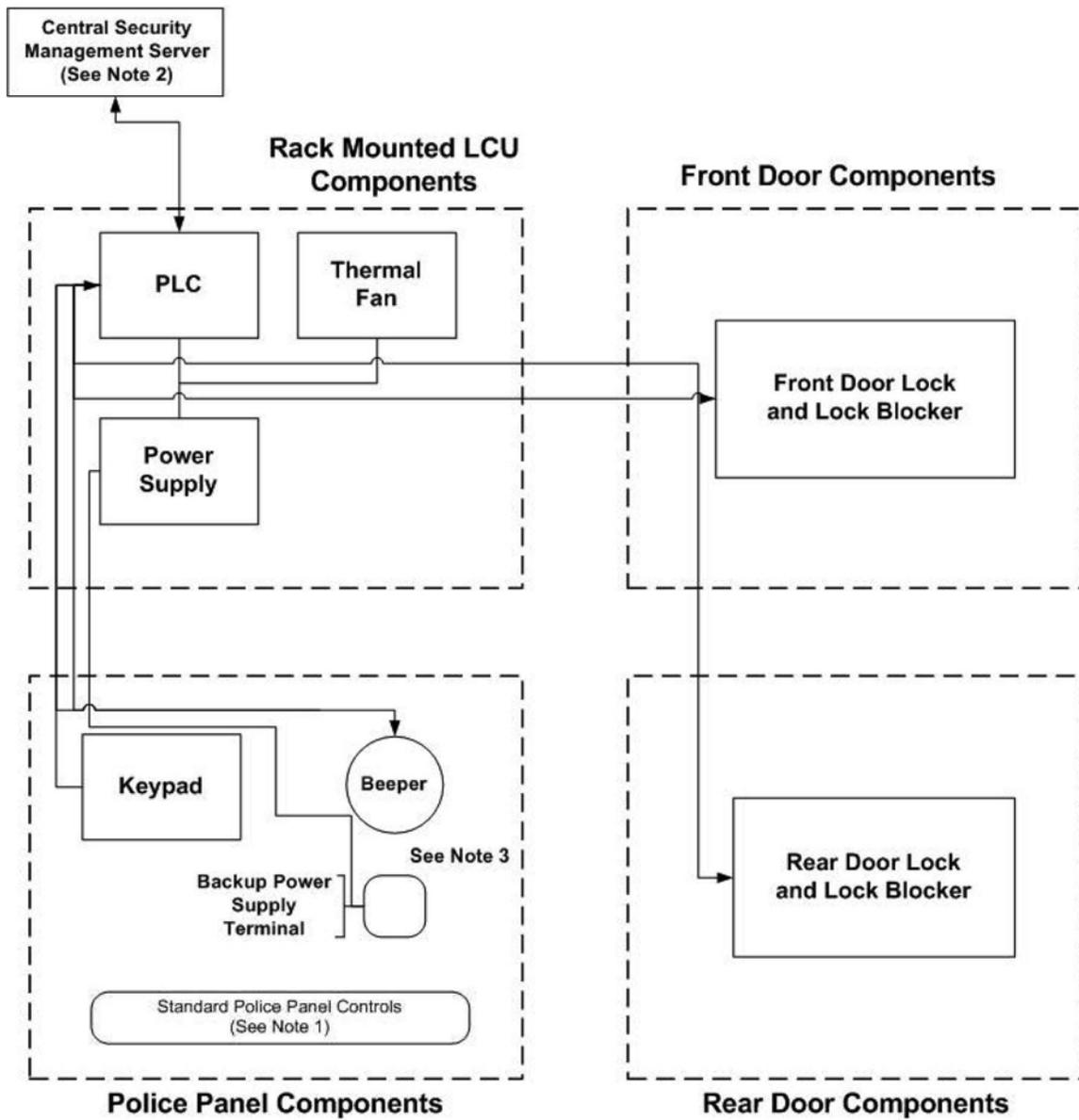
The manuals shall, as a minimum, include the following:

- Equipment operation
- Complete installation procedures
- Complete performance specifications (functional, electrical, mechanical, and environmental)
- Complete and accurate troubleshooting, diagnostic and maintenance procedures, including cabinet lock drilling and removal procedures.

Complete source code documentation shall also be provided in hard copy (two copies) and electronic (two copies) formats.

- I. TESTING REQUIREMENTS.** Electronic Security Lock Sub-system shall be subjected to the levels of testing for the described Environmental Requirements above. In addition, a self test diagnostics shall be cycled during the cabinet/controller burn-in period to ensure operational performance. Production test to exercise all LCU inputs and outputs logic shall be conducted. All test results shall be recorded and provided to the Contracting Officer's Technical Representative for approval.

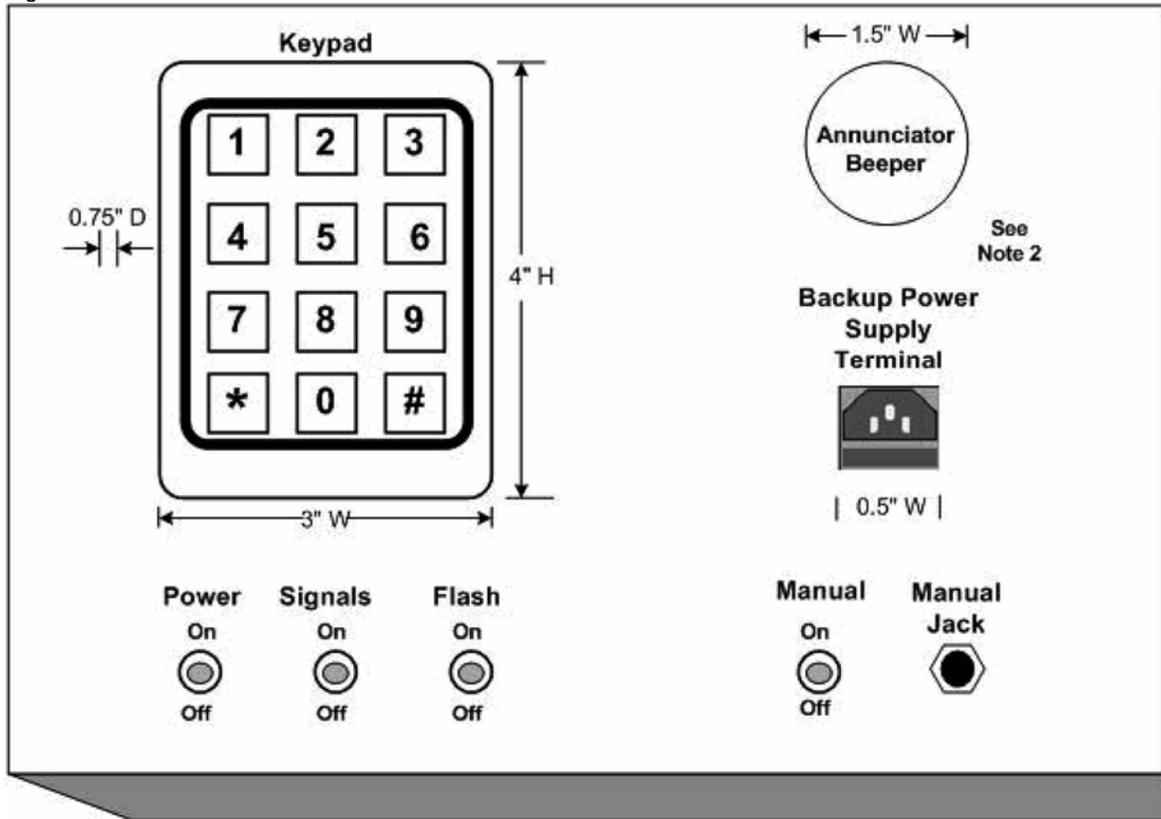
Figure 1 ELECTRONIC SECURITY LOCK SUBSYSTEM COMPONENTS



LCU - Lock Control Unit  
 Opt. - Optional  
 PLC - Programmable Logic Controller  
 Note 1 - Not part of Lock Sub-system.  
 Shown for completeness.  
 Note 2 - Central Security Management Server/  
 Workstation connected to its own serial channel that  
 sends/receives data to/from the PLC.

Note 3 - Annunciator (beeper) and  
 Backup Power Supply Terminal  
 (PST) may have the option to be  
 integrated with the Keypad. See  
 section F-10 for detailed  
 requirements.

Figure 2 POLICE PANEL ELECTRONIC SECURITY LOCK SUBSYSTEM



Notes:

1) All dimensions shown are approximate. Final sizes will be determined by the subcontractor.

2) Annunciator (Beeper) and Backup External Power Supply Terminal may be integrated with the Keypad at the discretion and approval of the COTR/engineer. See section F-10 for detailed requirements.



## 2007-TS-003

### 336SS TRAFFIC CONTROLLER AUTOMATIC TRANSFER SWITCH

#### 1.0 GENERAL

1.1 All 336SS controller cabinets supplied to DC Department of Transportation shall include an Automatic Transfer Switch assembly including:

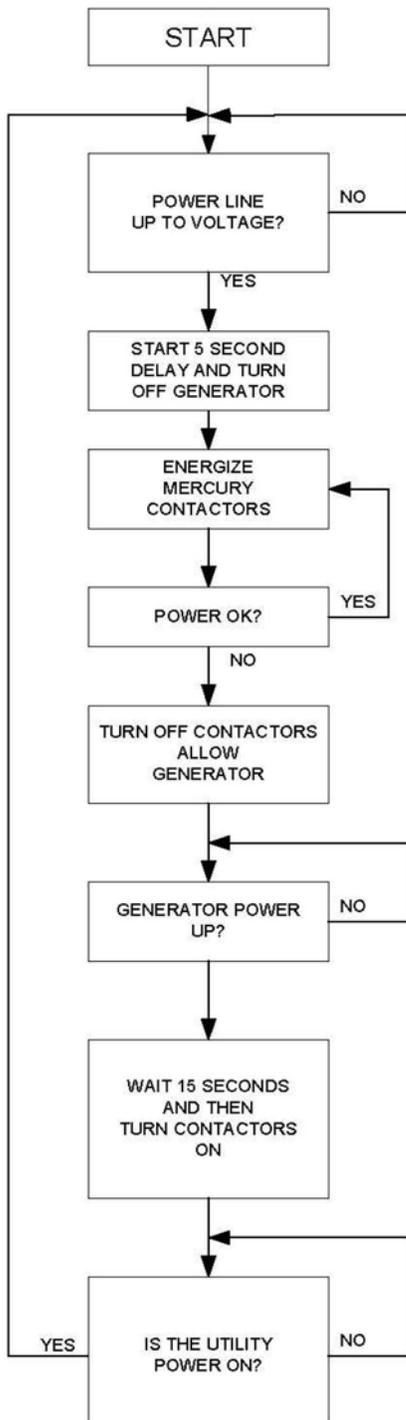
- Mating connector for DDOT traffic cabinet back-up generator.
- Mating connector shall be installed in secure interface compartment with locking access door.
- The Transfer Switch shall automatically transfer to the Input power, which is available with preference given to the standard AC Power Line over the generator power. Upon loss of power line voltage the transfer switch shall disconnect cabinet AC service from the utility power grid and connect to the input from the generator port.
- The Transfer Switch shall monitor the voltage level of the utility AC Power Line and automatically switch back to utility power when utility power is restored, disconnecting the generator input connection. The voltage sense level shall be adjustable with the pick-up voltage and dropout voltage being individually adjusted.
- The Transfer Switch shall not allow the generator input port to be connected to the electrical utility power grid. Short line permutations shall not affect the operation of the Transfer Switch. The Transfer Switch design shall prevent chattering of the relays as the power goes up and down.
- The Transfer Switch shall mount on the 19" rails of the cabinet and connect to the TBS terminal lock for the AC Line Power. The front panel shall be hinged so that the unit can be swung out of the way to allow access to cabinet components and wiring behind the Transfer Switch.
- The generator connector shall mount to a metal box, which can be mounted on either sidewall of the cabinet. A door, similar to the police door, shall provide access to the generator connector.
- The generator connector and cable shall be capable of handling 50 Amps.
- The automatic Transfer switch shall be covered by a manufacturer's 36 month warranty.

#### 2.0 SPECIFICATIONS

2.1	Power-Handling Capability	50 Amps @ 120 VAC
2.2	Turn-on Voltage	90-140 VAC (Set to 103VAC)
2.3	Turn-off Voltage	90-140 VAC (Set to 98 VAC)
2.4	Turn-on Delay AC Line	3-60 Seconds (Set to 5 seconds)
2.5	Turn-on Delay Generator	3-60 Seconds (Set to 15 Seconds)
2.6	Size	17.95" W x 6.25"H x 2.5" D
2.7	Indicators	NORMAL (AC Line Power) GENERATOR (Generator Power)
2.8	Environmental	-37° to + 74° C 5 to 95% humidity non-condensing
2.9	Connector	Amp Circular Plastic Connector #213889 with #213841 Pins (3) Pin 1.....AC+ Pin 2.....AC Pin Pin 3.....Equip. Ground

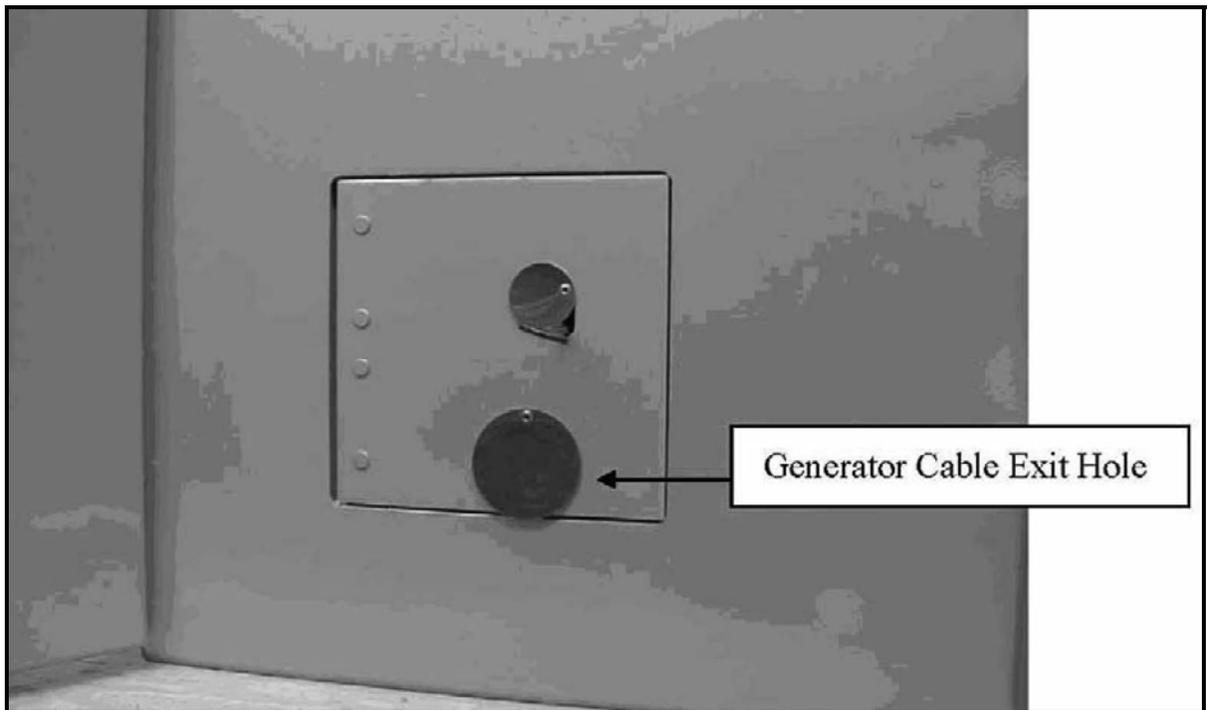
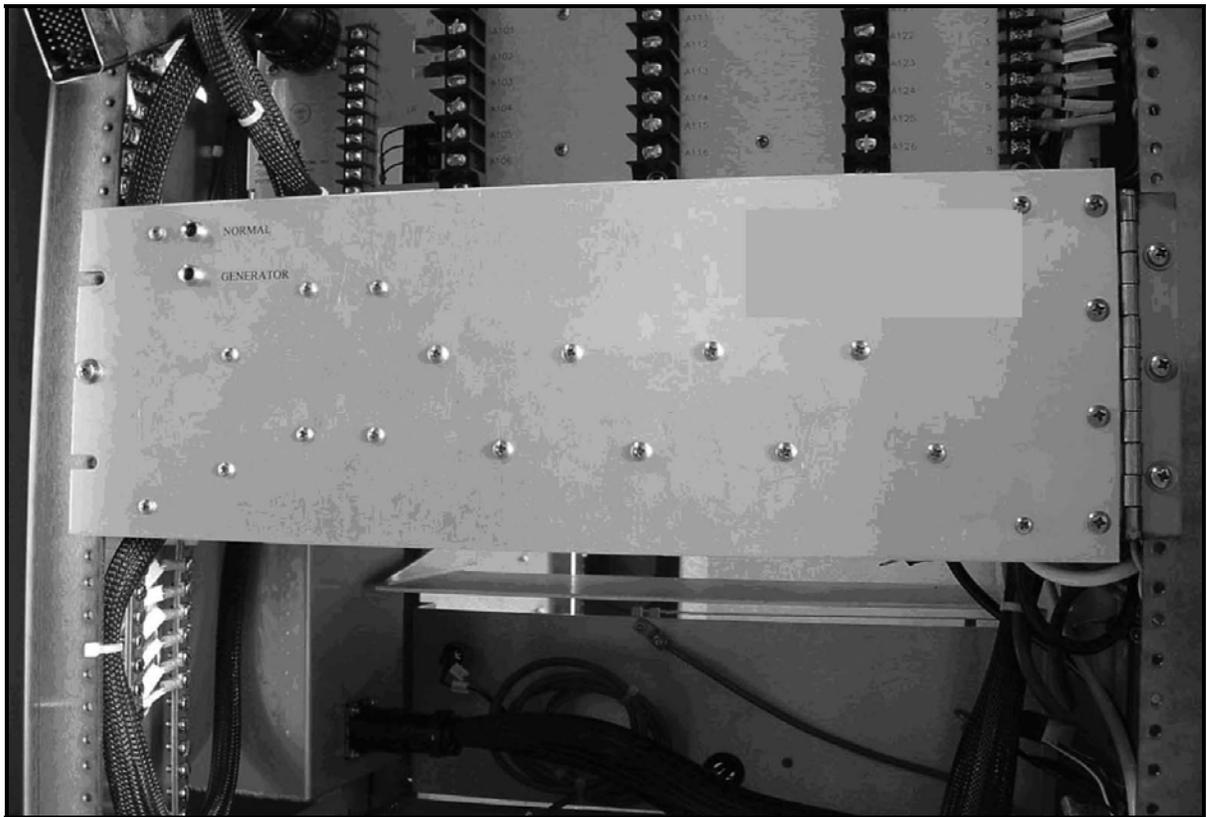
### 3.0 TRANSFER SWITCH OPERATION

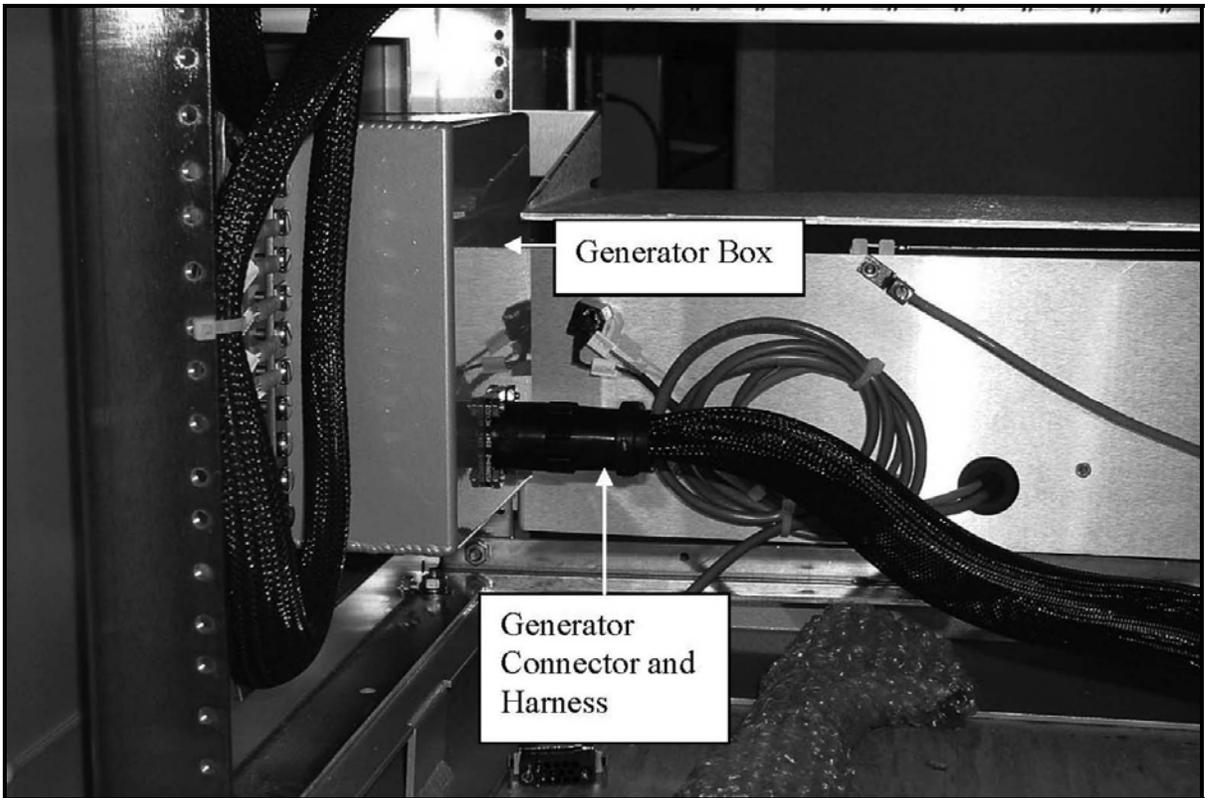
The following diagram summarizes the Transfer Switch operation:



#### 4.0 TRANSFER SWITCH INSTALLATION

Transfer switch assembly mounting example





## 2007-TS-004

### 336SS TRAFFIC CONTROLLER CABINET UPS UNIT

#### A. GENERAL

All 336SS controller cabinet assemblies shall include an uninterrupted power supply (UPS) unit with the following specifications:

1. UPS unit shall be rack-mountable to the DC Department of Transportation 336SS Traffic Control Cabinet
2. UPS unit shall occupy a maximum of 2 rack units
3. UPS unit shall be supplied with four (4) 12V/7Ah internal batteries, which are maintenance-free and user-replaceable. UPS unit shall provide surge suppression up to 1796 Joule rating, and the device is fully SNMP/HTTP manageable with the addition of an external card. It is also equipped with two (2) serial communications ports that allow for the control of two (2) PCs or servers.
4. UPS unit shall include the full SNMP/HTTP manageable option.
5. UPS unit shall carry a 3-year unlimited warranty.
6. UPS unit shall produce Pure Sine Wave operation with built-in EMI, RFI.
7. UPS unit shall incorporate full AVR-Boost/Buck-Boost/Buck topology.
8. UPS units shall include compatible management software which allows users to view detailed information about their electrical power and the vitals of the UPS including:
  - Configurable system notifications
  - Automatic self-tests
  - Adjustable high/low voltage warnings
  - Event/data logging
  - Scheduled shut downs
9. UPS unit shall be field-hardened
10. UPS unit shall include LED status lights that indicate Power-On, Wiring faults, AVR and Battery level.
11. Audible Alarms- audible tones shall identify when the unit is running off battery power, unit overloads and low battery.
12. UPS unit shall include Re-settable Circuit Breaker-Convenient unit reset switch in case of overload.
13. UPS unit shall be manufactured under ISO-9000 standards, and products shall be certified by the FCC, cUI and UL.

#### B. TECHNICAL SPECIFICATIONS

##### 1. Technical Information

- |                                     |                                         |
|-------------------------------------|-----------------------------------------|
| a. Product Type Plug/Connector Type | Pure Sinewave UPS NEMA 5-15P            |
| b. Receptacles                      | 6 A x NEM 5-15R-Back-up/Surge-protected |
| c. Switching Time                   | 4 ms                                    |
| d. Dataline Protection              | 1 x RJ45 (One-in/One-out)               |
| e. Automatic Voltage Regulation     | Yes                                     |

##### 2. Power Description

- |                        |                                                               |
|------------------------|---------------------------------------------------------------|
| a. Load Capacity       | 1500VA/ 1000W                                                 |
| b. Input Voltage       | 110V AC                                                       |
| c. Input Voltage Range | 85V AC to 15 V AC Single-phase 0                              |
| d. Output Voltage      | 1 hase 20V AC Single-p                                        |
| e. Frequency           | 47 to 63 Hz Input<br>47 to 53 Hz Output<br>57 to 63 Hz Output |
| f. Voltage Handling    | 5 %                                                           |
| g. Waveform Type       | Sine Wave                                                     |

h. Surge Energy Rating	1780J
i. Filtering	EMI/RFI
j. Circuit Breaker	1 x 15A
3. Management	
a. Network Manageability	SNMP Manageable           Optional via RMCARD 100
b. Overload Protection	On Utility: Circuit Breaker On Battery: Internal Current Limiting
c. Audible Alarms	Low Battery On Battery Overload
d. Bypass Switch	Not Provided
4. Controls/Indicators	
a. Status Indicators	Power On Battery In Use AVR Load Level Battery Level
5. Interfaces/Ports	
a. Interfaces/Ports	2 x Serial/USB (Combo) DB9
6. Battery Information	
a. Batteries	4 x 12V/7Ah Maintenance Free Sealed Lead-acid User-replaceable Hot-swappable
b. Backup/Run Time	5 Minute(s) 1000W Full-load 15 Minute(s) 500W Half-Load Server & Router (750W) – 10 minutes
c. Battery Life	3 Year(s) to 6
d. Battery Recharge Time	8 Hour (s)
7. Environmental Conditions	
a. Temperature	32° F (0° C) to 95° F (35° C) Operating 5° F (-15° C) to 113° F (45° C) Non-operating
b. Humidity	0 to 95% Non-condensing Operating Humidity 0 to 95% Non-condensing Non-operating
c. Altitude	0 ft to 10,000 ft Operating 0 ft to 50,000 ft Non-operating
8. Physical Characteristics	
a. Color	Black
b. Form Factor	2U Tower/Rack Mountable
c. Power Cord/Cable	10 ft
d. Dimensions	3.5" Height x 17.25" Width x 15.75" Depth
e. Shipping Dimensions	18.5" Height X 20" Width x 10.25" Depth – Display Case
f. Weight	56 lbs
g. Shipping Weight	64 lbs – Display Box
9. Miscellaneous	
a. Package Contents	UPS Unit User Manual Rack Mount Kit Power Management Software Warranty Card Serial Cable Phone Cable Serial-to-USB Adapter

b. Certifications & Standards

FCC Class B certified  
cUL  
UL 1778



**2007-TS-005(a)**

**FURNISH AND INSTALL 336SS TRAFFIC SIGNAL CABINET WITH  
CLASSIFIER/COUNTER AND RADIO FREQUENCY MODEM**

Pay Item No.: 800 001

**A. GENERAL**

This Special Provision will MODIFY the Specification Section 617.16 as well as to DDOT Standard Drawings No. 617.10 and 167.11 as defined below.

The contractor shall furnish and install all required equipment in accordance with the provisions of the technical specifications and in compliance with the procedures outlined in this section and on the project drawings. Individual plans specific to each intersection will specify the type and physical orientation of the cabinet.

The contractor shall furnish all necessary labor, equipment, and materials to procure and install the cabinet, classifier/counter and radio frequency (RF) modem. Individuals tasked with wiring the cabinet must possess at least IMSA Level 2 certification and experience in working with inductive loop and piezoelectric sensors, microwave detectors, acoustic detectors, video detectors and infrared detectors. No other contractor employee will be permitted access to the cabinet or electronic components within the cabinet.

**B. SPECIFICATIONS**

This section and the Appendix contains the technical specifications for the Model 336-SS Controller Cabinet, counter/classifiers and detectors, and all peripheral electronic components within the cabinet. The contractor shall procure equipment in strict conformance with those specifications. The contractor must submit and the District must approve catalogs cuts from individual vendors before procurement is undertaken.

**1. 336SS Controller Cabinet** – The controller cabinet shall conform to Specification Section 617.16 as well as to DDOT Standard Drawings No. 617.10 and 167.11. All references to Traffic Signal Controller in Specification 617.16 shall be DELETED for this Special Provision.

The Contractor shall include rustproof mounting brackets, and all miscellaneous fittings, connectors, terminal strips, power switches, indicator lights. The cabinet shall be large enough to accommodate:

- a. Power distribution assembly
- b. Terminal block
- c. Mounting rack
- d. A 15-watt shatterproof fluorescent strip-light
- e. Power strip
- f. Two (2) Radio Frequency (RF) modems (RS232 to Wireless)
- g. Two (2) RF modem antenna (Minimum 3 dB Gain)
- h. One of the following per cabinet:
  - i. One (1) Traffic Counter/Classifier unit
  - ii. Video processing unit
  - iii. Infrared processing unit
  - iv. Microwave data storage unit
  - v. Acoustic data storage unit

The Contractor shall submit the layout of the cabinet to the Engineer for review and approval. The layout should be similar to the layout provided in the project drawings. A rustproof lock shall be provided with two (2) keys of the pattern approved by the Department.

**FURNISH AND INSTALL 336S TRAFFIC SIGNAL CABINET WITH CLASSIFIER/COUNTER AND RADIO FREQUENCY MODEM**

The Contractor shall provide all accessory equipment necessary to mount and operate the traffic classifier/counter equipment to be stored within each cabinet, including a power distribution assembly, counter/classifier, RF modem, mounting hardware, cabinet wiring, and wiring harnesses. The contractor shall provide a RF modem with power and antenna connection in each cabinet. The modem shall be as described in this Section of these Special Provisions and will be paid for under this bid item.

The Contractor shall provide full I/O surge protection, with additional devices to protect the equipment and cables from surges and over-voltages. The Contractor shall include detector cable terminals and power service connections.

The Contractor shall provide all mounting racks for all equipment.

Door locks and keying shall be electronic security lock that follow the standard contained within the Appendix.

The Contractor shall provide surge protected power strip to accommodate all DC power supplies, or piezoelectric or loop sensor counting equipment for each station location.

A 15-watt shatterproof fluorescent strip-light fixture shall be provided mounted to the top front portion of the cabinet, as far forward as possible, in order to illuminate the front face equipment placed on the shelves. A door-actuated switch shall be installed to turn on the cabinet light when the door is opened, and to turn out the light when the door is closed.

The Contractor shall provide screened and louvered vents designed to keep out rain, insects, and rodents. The cabinet shall be equipped with intake vents with a 14 inch by 20 inch by 1-inch standard furnace-type vent filter. The filter tray shall be sized to adequately house and secure the filter in place. There shall be no obstructions on the interior face of the door to interfere with easy removal and replacement of the filter.

The equipment and terminal blocks shall be arranged within the cabinet such that they do not interfere with the entrance, tracing, and connection of electrical conductors or communication cables. All conductors and cables shall be neatly arranged in the cabinet and bundled in groups with cable ties, vinyl labels, or vinyl tape. The Contractor shall label all conductors and cables with indelible ink.

The Contractor shall permanently mark all parts with the Manufacturer's Name, Serial Number, and Model or Part Number.

A block diagram of all components illustrating all connectors and connections used to interconnect the components, wiring diagrams and schematic drawings of all circuits shall be inserted in a re-sealable weather-resistant pocket that is permanently mounted on the inside of an accessible door in the ground-mounted controller cabinet.

The component name and model number shall be inscribed using a permanent label or laminoid name plate in a position adjacent to the location of each major or replaceable component on the inside of the cabinet and enclosure.

All devices, components, cables and wires shall be indelibly identified on permanently attached labels designed for use in the intended environment using labels approved by the Engineer, and inscribed in accordance with the approved schematic shop drawings showing the component layout.

All internal connectors and wire terminations shall be labeled with sufficient information to locate its connection point without recourse to any other documentation located outside the controller cabinet or enclosure.

2. **Counter/Classifier** – At a minimum, the Contractor shall provide the classifier/counter with the following functionality:
  - a. Provide one (1) counter/controller for every controller cabinet identified for the project. Some sites will not require a counter/classifiers, in this case, the contractor shall deliver the counter/classifier to the COTR at the traffic counter branch at 1338 G Street SE. Sites that require more than one (1) counter/classifiers will request additional counter/classifiers from COTR. COTR will provide additional counter/classifiers from those extra units delivered by the contractor.
  - b. Count one (1) to 16 lanes.

- c. Classify one (1) to 8 lanes using 13 classification bins
  - d. Input Capabilities per counter:
    - i. Up to 16 presence inductive loop sensors
    - ii. Up to eight (8) piezo sensor inputs.
  - e. Record Intervals
    - i. 1 minute to 24 hours
    - ii. Ability to program counter for different intervals throughout the day
  - f. Two counting modes
    - i. Time interval count mode
    - ii. Time stamped count mode
  - g. Three modes of classification (1 to 8 lanes)
    - i. Binning with default and user definable vehicle and speed classes meeting Section 22 and 27 requirements
    - ii. Time stamped sensor events
    - iii. Individual vehicle records (RAW) containing lane number, time of day, speed, number of axles, axle spacing, and type of vehicle.
  - h. Memory
    - i. Provide sufficient memory to store up to a week of data for each count location (minimum 1 MB RAM without TAM card).
  - i. 16 key watertight keyboard with complete alphabet and numbers on a liquid crystal display
  - j. Programmable from counter keyboard and display and IBM compatible PC.
  - k. Data collection and download, command, control, and calibration locally by an IBM compatible PC and remotely through a telephone modem
  - l. English and metric unit capability for speed, distance and weight measurements.
  - m. Hardwire power capability
  - n. Able to be mounted within the 336-SS cabinet
  - o. Adjustable and automatic baud rates ranging from 300 to 19,600 kbs
  - p. Environmental operating range: -40 degrees F to 165 degrees F  
0-95 % non-condensing relative humidity
- 3. RF Modem** – At a minimum, the Contractor shall provide 900 MHz RF modems with the following functionality:
- a. The Contractor shall provide two (2) RF modems (RS232 to Wireless) for every controller cabinet identified for the project. Some sites will not require two (2) RF modems (RS232 to Wireless), in this case, the contractor shall deliver extra RF (RS232 to Wireless) modems to the COTR at the end of the site installation.
  - b. Performance
    - i. Power Output: 1 mW – 1 Watt (0 - 20 dBm)
    - ii. Indoor/Urban Range: up to 3000' (900m)
    - iii. Outdoor/RF Line-of-sight Range: up to 40 miles (64 km)
    - iv. Receiver Sensitivity: -110 dBm (@ 9600 bps)

- v. RF Data Rate: 9.6 or 19.2 Kbps
- vi. Interface Data Rate: up to 230.4 Kbps
- c. Networking
  - i. Spread Spectrum Type: FHSS (Frequency Hopping Spread Spectrum)
  - ii. Supported Network Topologies: Peer-to-peer, point-to-point, point-to-multipoint & multidrop
  - iii. Error Handling: Retries & acknowledgements
  - iv. Filtration Options: VID (Vendor ID Number), channels and addressing
  - v. Channel Capacity: 7 hop sequences share 25 frequencies
  - vi. Addressing: 65,000 network addresses available for each channel
  - vii. Encryption: 256-bit AES
- d. Power
  - i. Supply Voltage: 7 - 28 V
  - ii. Transmit Current: 900 mA
  - iii. Receive Current: 110 mA
  - iv. Power-down Sleep Current: 17 mA
- e. General
  - i. Frequency Band: 902 - 928 MHz
  - ii. Data Connection: DB-9
- f. Certifications
  - i. FCC: OUR9XSTREAM
  - ii. IC: 4214A-9XSTREAM 4214A 12008
  - iii. Class 1 Division 2: Approved
- g. Antenna:
  - i. Minimum Gain: 3dB
  - ii. Type: Yagi Directional

**C. PROCUREMENT, ACCEPTANCE AND PROGRAMMING**

The contractor shall accept delivery of the counter/classifier, detectors, cabinet, and component parts from the vendor. Storage of the materials shall be in accordance with DDOT Standard Specifications. All material will be stored in an approved location until delivered to the specific site location.

**D. FIELD INSTALLATION PROCEDURES**

The contractor shall set the controller cabinet assembly on the permanent foundation ensuring that the foundation anchor bolts penetrate the designated holes in the base of the cabinet. The contractor shall ensure that the front and rear cabinet doors are oriented properly in accordance with instructions on the project plans. The contractor shall level the cabinet, if necessary, using stainless steel shims placed where appropriate between the base of the cabinet and the foundation. The contractor shall utilize stainless steel washers and bolts to affix the leveled cabinet securely to the foundation. All four bolts shall be tightened to ensure a secure and stable fit on the concrete foundation.

The contractor shall pull all cables through the conduits into the controller cabinet allowing a minimum of 10 feet of slack cable inside the cabinet. The contractor shall attach an identifying, waterproof tag onto each cable identifying the specific field equipment being serviced by that particular cable run. The contractor shall

furnish and install a new No. 6 bare solid copper ground cable from the appropriate terminal in the controller cabinet to the ground rod extending above the top of the controller cabinet foundation.

The contractor shall schedule and ensure the completion of the installation of secondary electrical service cable into the controller cabinet by the Potomac Electric Power Company, following the procedures outlined in Special Provisions. The contractor shall maintain constant communications with counterparts in PEPCO to ensure that PEPCO officials are apprised of the project schedule for the purpose of avoiding project delays attributable to secondary electrical service installation.

The contractor shall terminate all loop detector lead-in, piezoelectric lead-in, microwave detector, acoustic detector, infrared detector, closed circuit television, and communications cables at their appropriate place on the terminal block of the controller cabinet. The contractor shall cut the cables pulled into the controller cabinet at the appropriate length, strip the conductors, and affix terminal lugs at the end of the conductors. All cables shall be dressed arranged using cable ties in a neat, orderly manner in accordance with accepted industry standards.

The contractor shall apply a generous quantity of duct seal into each conduit entering the cabinet to help regulate cabinet humidity and to impede the flow of moisture or other matter between the cabinet and the underground conduit/manhole network. The duct seal shall penetrate at least 4 inches into each conduit entering the cabinet and shall totally encapsulate the conduit and cables. The duct seal shall be installed after all cable is terminated and dressed.

The contractor shall apply a generous bead of waterproof sealant inside and outside the controller cabinet at all points where the cabinet is in physical contact with the concrete controller cabinet foundation to preclude the flow of moisture and debris between the inside of the cabinet and the outside environment.

**E. MEASURE AND PAYMENT**

Each cabinet assembly will be paid for at the contract unit price of each. The price will include the cost of the counter/classifier, cabinet, RF modem, modem antenna and all peripheral electronic components and mounting hardware and all required labor equipment and materials to install the cabinet in the field and render the traffic count station operational in accordance with the operation including testing, and furnishing documentation to complete the work. The cost associated with arranging and providing secondary electrical service to the cabinet is not included in this payment.

## 2007-TS-005(b)

### FURNISH AND INSTALL SOLAR POWER SYSTEM

Pay Item No.: 800 003.

#### A. GENERAL

Furnish and install a solar power system as denoted on the plan set or in the specifications for either the microwave or acoustic traffic counting system. The solar power system with inverter option will include inverter in addition to other items as detailed below.

#### B. MATERIAL

At a minimum, the Contractor shall provide the solar power system with the following functionality:

The system shall have the capacity of producing electricity directly from the Sun i.e., Solar Power.

The solar system shall provide power to run one (1) or two (2) detector unit(s).

The system shall provide stored power for full operations for a minimum of five (5) sun-less days.

The system shall fully restore battery charge in 8 hours of sunshine.

The system shall include complete equipment with all individual units, array combiner box, cables, fuses, switches, circuit breakers, and meters for reliable operation of the detector.

The system shall have solar power assemblies made up of the following interconnected components, each with a specific function.

##### 1. Solar Array Panel

- a. Solar array shall consist of one or more Photovoltaic modules, which generate DC electricity from the sunlight and convert it into usable electric energy.
- b. The size of the array panel shall be designed based upon the power requirement for the system, geographical location of the detector sites and storage capability of the solar battery bank.
- c. The modules shall be connected in series and/or parallel to provide the required voltage and current levels.
- d. The arrays shall be mounted on same pole with detector, if applicable, at a downward angle of 34 degrees from horizontal.
- e. The photovoltaic arrays shall be arranged in rugged weatherproof steel or aluminum anodized frame, using code approved components and wired to US NEC Standards.
- f. The panels shall have high mechanical strength capable of withstanding extreme wind (110 mph), snow load, hailstorm/ hailstones protected from airborne particles and exposure to moisture.
- g. Each solar array shall be refined and treated with special oxides to passivate the surface.
- h. The panels shall have an anti-reflective coating to optimize the cells optical properties for maximum absorption of Photons from the sunlight.
- i. The arrays shall have the capability of high light absorption, even at low light level or cloudy conditions.
- j. Each solar cell shall be laminated in ethylene-vinyl acetate (EVA) between multi-layer rear film and front glass.
- k. The arrays shall have an operating temperature range of -37 to +74 degrees C.
- l. The arrays shall have an operating humidity range of 5% to 95% relative humidity, non-condensing.

- m. The system shall avoid any power loss of any type or reason especially, during shadowing.
  - n. The system shall have an output voltage of 12-24 VDC supplying a minimum of 6W, or by adding an Inverter, supply 120 VAC @ 60 Hz.
  - o. The solar array panel shall have a warranty of at least 15 years.
  - p. Each solar panel shall have a typical maximum power ( $P_{max}$ ) of 120 Watts.
2. Mounting Bracket
- a. Provide stainless steel clamps or bands for mounting on metal poles, or provide stainless steel lag-bolt or through bolts for mounting on wood poles. Design must be submitted for review and approved by the manufacturer and the Engineer.
  - b. The elevation adjustable angle shall be 25 to 65 degrees in 5 degrees increments.
  - c. Provide heavy gauge steel pole clamps, strong back, and support arm to withstand self load, loads of all equipment, wind load, snow load and also associated moments and torsion.
  - d. Provide components having rust-proof/rust-resistant properties against all weather conditions.
3. Solar Charge Controller
- a. A charge controller shall be provided for each solar array panel to maintain a battery at the proper charge level, and to protect from overcharging.
  - b. The charge controller shall be 100% solid state unit completely sealed against any harsh environment conditions.
  - c. The charge controller shall have the following features: lighting protection, reverse leakage protection – blocking diode, low power consumption, simple rugged circuitry, No. 12 AWG terminal, charging light and Low Voltage Disconnect (LVD) activated light.
  - d. The charge controller shall be a maintenance free unit.
  - e. The charge controller shall have a temperature sensor capable of adjusting the charging thresholds according to battery temperature.
  - f. The charge controller shall have a Low Voltage Disconnect (LVD) relay to protect battery from low voltage damage.
  - g. The solar charge controller shall have an operating temperature range of  $-37$  to  $+74$  C degrees C.
  - h. The solar charge controller shall have an operating humidity range of 5% to 95% relative humidity, non-condensing.
  - i. The solar charge controller shall have at least 3 years of warranty
4. Battery Bank
- a. The Battery Bank shall contain one or more 12-Volt (minimum) deep cycle batteries, connected in series and/or parallel depending on voltage and current need for TFDS.
  - b. Size and number of batteries shall be “sized” to match the System.
  - c. The Battery shall be capable of storing and discharging energy, when and as required.
  - d. Battery Bank System shall be approved by the manufacturer of the solar array panel.
    - i. The battery shall have a deep cell, sealed gel battery, with a minimum of 5 days of autonomy.
    - ii. The Battery shall be maintenance free.
    - iii. The battery shall have an operating temperature range of  $-37$  to  $+74$  degrees C.
    - iv. The battery shall have an operating humidity range of 5% to 95% relative humidity, non-condensing.
    - v. The battery shall have a warranty period of at least 3 years

## 5. Inverter

- a. When required by the System or when stated in these Special Provisions, the Solar Power Assembly shall include an Inverter capable of converting 12-24 VDC power from the solar array into 120 VAC power.
- b. The inverter shall have an automatic thermal protection.
  - i. The inverter shall have efficiency greater than 95%.
  - ii. The inverter shall have a low input voltage alarm.
  - iii. The inverter shall have dual AC Outlets.
  - iv. The inverter shall have plug in Protection.
  - v. The inverter shall have full Input and Output Protection.
  - vi. The inverter shall have reverse polarity protection.
  - vii. The inverter shall be capable of providing maximum continuous output power, as required for running the detector without any obstruction.
  - viii. The inverter shall have surge protection.
  - ix. The inverter shall be maintenance free.
  - x. The inverter shall have an operating temperature range of -37 to +74 degrees C.
  - xi. The inverter shall have an operating humidity range of 5% to 95% relative humidity, non-condensing.
  - xii. The inverter shall have a warranty of at least 3 years.

All components must be approved by the Engineer before installation.

**C. CONSTRUCTION**

The solar power assembly shall be constructed and installed in accordance with the requirements of the Plans, the manufacturer, applicable codes, regulations, and applicable Standards. The assembly shall be mounted on poles as indicated on the plans. Consider the geographical location (latitude) of the detector sites in the design. Provide manufacturer recommendations including mounting angle and azimuth for the solar array panel for location revisions to the Engineer for review and approval. All conduits, cables, wires, clamps required for a complete installation shall be associated with this item.

**D. MEASUREMENT AND PAYMENT**

Furnish and Install Solar Power System Side will be measured and paid for at the Contract unit price per each. The payments will be full compensations for furnishing and installing, solar array panels, mounting bracket, solar charge controller, battery bank, and inverter (if applicable), all associated cables and wiring, manuals, setup and testing for the equipment necessary to complete the work.

## 2007-TS-005(c)

### FURNISH AND INSTALL SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEM

Pay Item No.: 800 005.

#### A. GENERAL

Furnish and install a Spread Spectrum Wireless Radio Frequency (RF) receiving modem within an existing Traffic Signal Controller Cabinet according to the plans. Install the corresponding antenna to the nearest traffic signal pole. Antenna cable shall be run from through existing traffic signal pole to the Traffic Signal Controller Cabinet utilizing existing conduit traffic signal cable conduit. Program the modem to receive signals from adjacent traffic counter cabinet signals spread spectrum wireless communication system as denoted on the plan set or in the specifications and convert the signal into Ethernet ready protocol to be conveyed through DDOT's Traffic Signal Communications Network.

#### B. MATERIAL

At a minimum, the Contractor shall provide the spread spectrum wireless communication system with the following requirements:

1. The Spread Spectrum wireless communication system (The System) shall include a wireless transceiver package, a Yagi directional antenna, plus the mounting brackets, cabling, wiring harnesses, and any software required to provide a fully functioning Vehicle count/classification Data Gathering System.
2. The system shall have the following features:
  - a. The Contractor shall provide one (1) RF modem (Wireless to Ethernet) for every existing Traffic Signal Controller Cabinet identified for the project.
  - b. Performance
    - i. Power Output: 1 mW – 1 Watt (0 - 20 dBm)
    - ii. Indoor/Urban Range: up to 3000' (900m)
    - iii. Outdoor/RF Line-of-sight Range: up to 40 miles (64 km)
    - iv. Receiver Sensitivity: -110 dBm (@ 9600 bps)
    - v. RF Data Rate: 9.6 or 19.2 Kbps
    - vi. Interface Data Rate: up to 230.4 Kbps
  - c. Networking
    - i. Spread Spectrum Type: FHSS (Frequency Hopping Spread Spectrum)
    - ii. Supported Network Topologies: Peer-to-peer, point-to-point, point-to-multipoint & multidrop
    - iii. Error Handling: Retries & acknowledgements, multitransmission
    - iv. Filtration Options: VID (Vendor ID Number), channels and addressing
    - v. Channel Capacity: 10 hop sequences share 50 frequencies
    - vi. Addressing: 65,000 network addresses available for each channel
    - vii. Encryption: 256-bit AES
  - d. Power
    - i. Supply Voltage: 7 - 28 V

- ii. Transmit Current: 800 mA (@ 1W TX Power Output)
- iii. Receive Current: 110 mA
- iv. Power-down Sleep Current: 17 mA
- e. General
  - i. Frequency Band: 902 - 928 MHz
  - ii. Data Connection: RJ-45
- f. Certifications:
  - i. FCC: OUR-9XTEND
  - ii. IC: 4214A-9XTEND
  - iii. Class 1 Division 2: Approved
- g. Antenna
  - i. Minimum Gain: 3dB
  - ii. Type: Yagi Directional

**C. CONSTRUCTION**

Construct and install the spread spectrum wireless communication in accordance with the requirements of the Plans, the manufacturer, applicable codes, regulations, and applicable Standards. At the Control Cabinet location, install a transceiver assembly and the yagi antenna. At the Traffic Signal control cabinet, install the Spread Spectrum Data Transceiver Assembly. Antenna to be mounted on the nearest traffic signal pole (minimum height of 25-feet) and the RF Modem shall be installed within the existing Traffic Signal Controller Cabinet. Connect a cable linking the Spread Spectrum Data Transceiver to the antenna utilizing the existing traffic signal conduit and through the existing traffic signal pole. Adjust the height of the antenna, adjust/aim all antennas and tune radio equipment for maximum performance. Use a VSWR meter if recommended by the manufacturer. If recommended by the manufacturer, provide a Lightning Arrestor Assembly for the Antenna and Spread Spectrum Data Transceiver, with the ground wire bonded to the rooftop grounding system. Provide surge protection for all electronic and radio equipment. Ground and bond all metallic parts.

**D. MEASURE AND PAYMENT**

Each spread spectrum assembly will be measured and paid for at the contract unit price per each. The payments will be full compensation for furnishing, installing the RF modem, modem antenna and all peripheral electronic components and mounting hardware and all required labor equipment and materials to install the modem in the field cabinet and antenna on the nearest adjacent traffic signal pole, including testing, and furnishing documentation to complete the work.

**2007-TS-005(d)**

**FURNISH AND INSTALL MICROWAVE TRAFFIC  
FLOW DETECTION SYSTEM (MTFDS)**

Pay Item No.: 800 007.

**A. GENERAL**

This work shall consist of furnishing and installing side-fired, radar based vehicle detectors, as specified and as approved by the Engineer. This work shall include all necessary hardware and electrical connections to install the units on a traffic pole (paid for separately) and to convey the data to a traffic counter control cabinet (paid for separately).

All component parts shall be designed, manufactured, tested, and installed in compliance with the following codes and standards:

1. National Electrical Manufacturers Association (NEMA LS-1, 1992)
2. National Fire Protections Association (NFPA 20, 70, 75, & 780)
3. Underwriters Laboratories (UL 1283 and UL 1499)
4. International Standard Organization (ISO) – The Manufacturers shall be certified ISO 9001 for manufacturing design and service.
5. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)

Side-fired radar-based vehicle detectors shall be easy to install and remove, and shall be fully programmable to support a variety of applications. In general:

- 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 and installation.
- All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturers recommendations and standard practices.
- The design shall be such as to prevent reversed assemble or improper installation of connectors, fasteners, etc.
- Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments and maintenance.
- The designed Mean Time Between Failures (MTBF) of the MTFDS unit, operating continuously in their application, shall be 10 years or longer.

Area of Coverage. The MTFDS's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall be as follows:

- Elevation Beam Width      45 degrees
- Azimuth Beam Width      15 degrees
- Range                              10 to 200 feet

The MTFDS shall be a true presence detector which can provide presence, volume, lane occupancy, speed information and a minimum of three (3) vehicle classifications on up to six (6) discreet detection zones. The contractor shall furnish and install the unit which captures the maximum number of vehicle classes available in the market at the time of purchase.

1. The information from the detector(s) shall be conveyed via spread spectrum radio available to existing controller via contact closure pairs and to other systems via serial communications lines.

2. The minimum number of detection zones defines shall be than six (6). The range limits of each zone shall be user defines in 7 ft. resolution.
  - a. The detector shall identify vehicles presence within each detection zone with a 95% accuracy or graters, independent of the vehicle's direction of travel through the detection zone.
  - b. The maximum permissible error shall be 5% in the detection of the direction and magnitude of radial speed and 10% in the case of transverse speed.

**B. Electrical Requirements**

Equipment Cabinet. Shall be a Type 332, or Pole-Mounted NEMA TS-2 Size 4 or 5 Cabinet, as shown on the Plans.

Communications: RF Wireless Modem to the nearest Traffic Signal Control cabinet.

Input Power:

1. 12 – 24 VAC/DC
2. 95 – 135 VAC @ 60Hz.
3. Power Consumption: 6 Watts

Other Power Sources: Power shall be obtained from the power distribution assembly, or from a 15-20 amp branch circuit from an existing cabinet, or from a solar power assembly as shown on the plans.

MTFDS Interface. The interface at the MTFDS shall consists of a single MS connector which shall provide:

1. Power to the unit
2. Output contact closure wire pairs for each of the required detection zones, and
3. Serial communication lines for programming, testing or modem interface at 9600 Baud rate. The data format of the serial port shall be standard binary NRZ 8 bits data, 1 stop bit, no parity.

Cable: A UV-resistant cable of multiple twisted pairs of stranded AWG 20 wires with a common shield rated at 300V with a temperature rating of 105°C shall be used to provide a connection between the MTFDS and the cabinet equipment.

**C. Environmental**

Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any of the following environmental conditions:

1. Ambient temperature range or -37 to +74 degrees C
2. Relative humidity from 5 to 95 percent, non-condensing
3. Except as mat be otherwise stated herein for a particular item, no item, component, or sub-assembly shall emit a noise level exceeding the peak level of 55 dBA when measured at a distances of one meter away from its surface.
4. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcomes adverse effects due to temperature in the specified environmental range.

**D. Installation**

The MTFDS shall be mounted in the side-fired configuration, as directed by the Engineer.

It shall be mounted on poles or sign structures at the specified locations, using the supplied mounting brackets.

The brackets shall be attached with approved ¾ inch wide, .025 inch thick, stainless steel bands or to a concrete wall/bridge using 2 stainless steel expansion bolts of sufficient length and diameter to support 100 pounds.

The contractor shall install the detector unity on a pole at a height of between 17-23 feet above the road surface, or as per manufacturers recommendation, so that the masking of vehicles is minimized and that all detection zones are contained within the specified evaluation angle as suggested by the manufacturers.

The MTFDS detection zones shall be setup using the provided software and Notebook PC.

**E. Mechanical**

The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 MPH, dust and airborne particles, and exposure to moisture (NEMA type 3R enclosure)

The mounting assembly shall have all painted steel, stainless steel, or aluminum construction, and shall support a load of 20 pounds.

The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be titled in both axes then locked into place.

The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent.

The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test Ea), NEMA TS-1 (Section 2.1.13).

**F. Circuitry Protection**

All conduit connections to the MTFDS enclosure shall be watertight and allow for adjustment of the MTFDS for optimum viewing. Methods and materials used shall be approved by the Engineer, prior to installation of the signs.

Where a cable or wire passes through a hole or runs along a surface at any point through or on a completed assembly, such holes and/or surfaces shall be deburred and void of any sharp edges that may damage the cable or wire passing through or along the surface. All deburred holes shall be equipped with a rubber or plastic grommet.

The Contractor shall install all connections between the microwave unit and the controller cabinet in accordance with the recommendations of the MTFDS manufacturer.

All terminal blocks and strips located within the control cabinets shall be accessible to the extent that it shall not be necessary to remove any equipment from the housing to make an inspection or connection.

All wires shall be cut to their proper length before assembly. No wire shall be doubled back to make up for unnecessary slack. However, sufficient slack shall be provided such that any wire end can be cut back, re-stripped and connected at least twice.

All electrical connections in the MTFDS enclosures and cabinets shall have sufficient clearance between each terminal and the housing so as to prevent a leakage path or physical contact under stress. The lay of the interconnect cables between components shall be such that when the housing door is closed, it will not press against the cables or force the cables against various components inside the housing.

The ground side of service shall be carried throughout all MTFDS enclosures and control cabinets without a break. All equipment grounds shall run directly and independently to the ground bus. The grounding strip shall be connected directly to the housing wall.

**G. Labeling**

A block diagram of all components illustrating all connectors and connections used to interconnect the components, wiring diagrams and schematic drawings of all circuits shall be inserted in a re-sealable weather-resistant pocket that is permanently mounted on the inside of an accessible door in the ground-mounted controller cabinet.

The component name and model number shall be inscribed using a permanent label or laminoid name plate in a position adjacent to the location of each major or replaceable component on the inside of the cabinet and enclosure.

All devices, components, cables and wires shall be indelibly identified on permanently attached labels designed for use in the intended environment using labels approved by the Engineer, and inscribed in accordance with the approved schematic shop drawings showing the component layout.

All internal connectors and wire terminations shall be labeled with sufficient information to locate its connection point without recourse to any other documentation located outside the controller cabinet or enclosure.

**H. MEASUREMENT AND PAYMENT**

Microwave Traffic Flow Detection System (MTFDS) will be measured and paid for at the Contract unit price per each. The payments will be full compensations for furnishing, installing the detector on a pole (paid for separately), configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from DDOT's TMC and furnishing documentation to complete the work.

2007-TS-005(e)

**FURNISH AND INSTALL INFRARED TRAFFIC  
FLOW DETECTION SYSTEM (ITFDS)**

Pay Item No.: 800 009.

**A. GENERAL**

Work under this item will consist of furnishing, and installing an infrared non-intrusive traffic flow detection system at locations denoted on the plan set. The system shall consist of all mounting equipment, conduit, cabling, and power and communications equipment for a fully functional infrared detection station. The data from this device will be conveyed to a traffic count control cabinet. This data will be conveyed, via the existing DDOT traffic signal system, to a data base located at the TMC.

**B. MATERIAL**

At a minimum, the Contractor shall provide an infrared non intrusive traffic flow detection system with the following functionality:

1. Data Collection and Storage Requirements

- a. The system shall provide the following information:
  - i. Speed (Mph)
  - ii. Volume
  - iii. Occupancy
  - iv. Lane of Travel
  - v. Vehicle Classification description
  - vi. Vehicle Classification - 13 classifications
  - vii. End-to-end axle separation
- b. A single system shall be capable of continuously counting vehicle axle classification for multilane highways up to four (4) lanes of traffic in each direction for a total of eight (8) lanes.
- c. The system shall have a detection range of 10 to 330 feet.
- d. The system shall have user-definable detection zones, which are programmable with an external personal computer or a handheld palm.
- e. The system shall be able to collect and store the collected data in 15 minute increments for a minimum of 30 days. Data collection duration shall be configurable from 1 minute to 15 minutes.
- f. The system shall have an internal memory to store data for 30 continuous days.
- g. Accuracy: Between 90% to 100% for vehicle volume and classification, per lane

2. Installation Requirements

- a. The system shall be non intrusive, mounted on the ground (either on the curbside or in concrete barrier) by the roadside providing a low profile. The system shall be enclosed in a durable, NEMA 4X rated enclosure as to not allow water or other corrosive materials interfere with the operations of the units. When the units are installed in curb or barrier applications, the enclosure shall not impede the operations of vehicles or pedestrians by creating an unsafe situation.
- b. The contractor shall verify that the infrared beams are leveled, as per the manufacturer's recommendations, to promote 95% accuracy in volumes speed and classifications.

- c. The system shall be deployable for permanent application.
  - d. The system shall not obstruct the vehicle or pedestrian traffic
  - e. The system shall be secured against vandalism
  - f. The system shall be safe for operation and maintenance
3. Power Requirements
- a. The system shall be able to accept power via the following options:
    - i. 12 VDC internal power using cell batteries
    - ii. 12 VDC external power using a single 12 V battery
    - iii. 12 VDC solar power with battery
    - iv. AC 110V power stepped down to 12 VDC. The DC Power Supply shall be a UL Listed Class 2 Power Supply
    - v. When a DC Power Supply, it shall be a UL Listed Class 2 Power Supply and it shall plugged into a surge protected power strip.
  - b. The system shall be able to operate with 12 VDC internal batteries for up to seven (7) days or 168 hours without replacements
  - c. The system shall be able to operate with 12 VDC external batteries for up to 20 days without replacement
  - d. The system shall be able to operate with a single power supply of 4 W
  - e. Dissipate power surge of not more than 6 KV – 10,000 amps.
  - f. Provide surge protection to protect the device.
4. Communication Requirements
- a. The system shall be able to transmit the daily data from the traffic counter control cabinet to a traffic signal control cabinet via spread spectrum wireless communications. From the traffic signal control cabinet, the data will be conveyed through DDOT's traffic signal network to a central controlling server and software at the DDOT administration building through a CDMA or a hard line telephone modem.
  - b. The system shall be suitable for polled operation using multi-point EIA-232 communication at 9600 bits per second.
  - c. The system shall meet FCC Part 15 requirements for interface.
5. ITFDS Software
- The Contractor shall provide ITFDS software to configure the system, as well as to access and manipulate data from the ITFDS.
6. ITFDS Hardware
- The system software will be installed in the hardware provided as part of other pay item as defined in these Special Provisions.
- Environmental Requirements:
- a. The system shall operate within the temperature range of -40 to +185 degrees F.
  - b. Operating humidity range: 5% to 95% relative humidity, non-condensing.
  - c. The system shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture.

**C. CONSTRUCTION**

1. Installation

Construct and install all the equipment necessary for a fully functional ITFDS, in accordance with the requirements of the Plans, the manufacturer, applicable codes, regulations, and applicable Standards. All conduits, cables, wires, clamps required for a complete installation shall be associated with these items. Field verify the suitability of the proposed locations, and device installation with ITFDS manufacturer. Provide manufacturer recommendations for location revisions to the Engineer for review and approval.

2. Functional Output Protocol

ITFDS software from the DDOT administrative building shall be able to open up connection to receive polled data from the ITFDS. Ensure that ITFDS can process polling requests to maintain a minimum 30 seconds polling cycle.

3. Testing

Complete testing as identified in these Special Provisions.

4. Warranty and Maintenance

Provide warranty and Maintenance as identified in these Special Provisions.

5. Training

Provide Training as identified in these Special Provisions.

**D. MEASUREMENT AND PAYMENT**

Infrared Traffic Flow Detection System (ITFDS) will be measured and paid for at the contract unit price per each. The payments will be full compensations for furnishing, installing the detector in a manufacturers and DDOT approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from DDOT's TMC, training, and furnishing documentation to complete the work including the following:

1. All the hardware and material necessary including unit enclosure and mounting assembly to provide a fully functional ITFDS.
2. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any ITFDS component.
3. ITFDS Software
4. All hardware and material necessary to provide electrical power services to the ITFDS field location as shown in the Plans.

The central hardware and RF modem, if applicable shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate pay item. However, the contractor is responsible under this item to ensure that the ITFDS work including complete installation, setup and configuration, and acceptance of the ITFDS.

**2007-TS-005(f)**

**FURNISH AND INSTALL ACOUSTIC TRAFFIC  
FLOW DETECTION SYSTEM (ATFDS)**

Pay Item No.: 800 011.

**A. GENERAL**

The work to be performed under this section consists of procuring, furnishing, installing and wiring of the complete Acoustic Traffic Flow Detection System (ATFDS) at the locations shown on the plans and in accordance with the conditions set forth. The work also includes testing, training, warranties, and guarantees as designated in the specifications.

The ATFDS shall have the following general high level requirements:

1. The system shall be non-intrusive.
2. The system shall use acoustic technology.
3. The system shall at a minimum collect classification (3 or 4 types), volume, speed, and occupancy.
4. A single system shall be capable of continuously collecting data for up to five (5) lanes of traffic.
5. The detector shall be mountable from a side-fired location
6. The collected data shall be stored in the field equipment for at least 30 continuous days.
7. The system shall enable data collection through a spread spectrum wireless communication modem to DDOT traffic signal network.

The ATFDS shall consist of:

1. A self-contained Roadway Traffic Sensor which detects and monitors roadway traffic.
2. Cabinet termination circuit card
3. Mounting Bracket
4. Sensor lead-in cable
5. PC Monitoring and Set-Up software, for installation and subsequent maintenance tasks.
6. ATFDS Software

The pole for mounting the sensor and the cabinet, the hardware for installing software, and power and communication to the field cabinet will be considered as separate items.

All Acoustic Vehicle Detector Assembly sites shall be capable of allowing the straightforward integration of up to four additional Roadway Traffic Sensors in the future.

**B. MATERIALS**

All the materials shall contain all of the components described in the subsequent material specifications. All necessary incidental components, cables, and hardware, shall be supplied to accomplish a fully operational ATFDS installation. All equipment and component parts furnished shall be new, be of the latest design, and manufacture. 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.

1. Roadway Traffic Sensor
  - a. Functional Requirements

The Roadway Traffic Sensor shall be mountable from a side fire location or overhead structure, and shall comply with the following functional specifications:

- i. The unit shall be able to monitor a minimum of five (5) discrete detection zones
  - ii. Zone width and location can vary, as per the roadway's requirements, and shall be user definable.
  - iii. The Roadway Traffic Sensor shall be capable of detecting vehicles in a far zone that is a minimum of 70 feet (near edge of zone) from the Roadway Traffic Sensor.
  - iv. The Roadway Traffic Sensor shall be capable of detecting vehicles that are as close as 2 feet from the near travel lane.
  - v. The unit shall operate in all prevalent traffic conditions, from 0 to 80 mph. Over this range the unit shall be accurate to:
    - Volume - 5% of Actual Count (up to 4 lanes from the sensor), - 6% of Actual count in the 5th lane))
    - Occupancy- Within 10%
    - The unit shall be capable of storing data for 30 continuous days
    - The unit shall retain all changeable parameters and settings upon loss and subsequent restoration of power.
- b. Power Requirements
- i. The unit shall operate on 12 - 24 VDC dissipating 6W, derived from either a 12 VDC solar power assembly, or from a DC Power Supply. The DC Power Supply shall be a UL Listed Class 2 Power Supply; that is, a 120 VAC to 12 VDC adapter. Include a provision at the rear of the enclosure for waterproof connection of power and communication cables.
  - ii. When a DC Power Supply is used, plug it into a surge protected power strip. Both items are considered incidental to the ATFDS.
  - iii. Power shall be obtained from connections to a terminal block on the Cabinet Termination Circuit Card located within Field Cabinet.
  - iv. The Sensor Lead-In Cable connecting the unit to the Cabinet Termination Circuit Card shall supply power utilizing conductors whose minimum thickness is #22 AWG.
  - v. Each unit shall be able to recover automatically after a power failure.
- c. Communication Interface: The Roadway Traffic Sensor shall communicate to the field cabinet via RS-422 protocol.
- d. Enclosure: The enclosure shall be a weatherproof cabinet of cast aluminum, stainless steel, or polycarbonate meeting as a minimum the NEMA requirements for a 336SS Type enclosure, as specified in Section 47. (Paid for separately)
- e. Electromagnetic Interference (EMI): The unit and associated connected equipment in their installed condition shall comply with FCC Part 15 for interference.
- f. Weight: The unit shall not exceed 10 lbs
- g. Environmental Requirements: This equipment shall meet all its specified requirements during and after being subjected to any combination of the following conditions:
- i. The ambient temperature range shall be between -20° C and + 75° C.
  - ii. The storage temperature range shall be between -25° C and +85° C.
  - iii. Humidity: 5% to 95% per NEMA TS1 1989 (R1994), Section 2.1.5.2.
  - iv. Vibration – fulfill NEMA TS2-2.1.9, or equivalent, as approved by the Engineer.
  - v. Shock – fulfill NEMA TS2-2.1.10, or equivalent, as approved by the Engineer.

The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range. The unit shall not require programming changes to compensate for different environmental conditions encountered from season to season.

## 2. Cabinet Termination Circuit Card

### a. Functional Requirements

The Cabinet Termination Circuit Card shall be a mountable card located within the field equipment cabinet that connects to the Roadway Traffic Sensor via the combination of Sensor Lead-In Cable and Home Run Cable. The Cabinet Termination Circuit Card shall comply with the following functional specifications:

- i. The Cabinet Circuit Termination Card shall allow for a terminal block that shall be plugged into the Card subsequent to having been connected appropriately to the Roadway Traffic Sensor with the Sensor Lead-In Cable and Home Run Cable.
- ii. The Cabinet Circuit Termination Card shall provide electronic circuitry capable of converting traffic data streams sent from the Roadway Traffic Sensor via RS-422 protocol to RS-232 protocol suitable for input to a Terminal Server that is also located within the field equipment cabinet.

### b. Power Requirements

- i. The terminal block plugged into the Cabinet Termination Circuit Card serves as “the source” for the Roadway Traffic Sensor; however, the Cabinet Circuit Termination Card supplies the terminal block with power from a separate DC source within the cabinet.
- ii. Power shall be obtained by plugging a terminal block connector that connects from the DC Power Source (within the Cabinet) into the Cabinet Termination Circuit Card.
- iii. The Cabinet Termination Circuit Card shall provide a single stage of solid-state surge protection, and an additional stage of gas tube surge protection for all data and power lines. Surge protection shall comply with IEEE Standard 587-1980 Category C.

## 3. Mounting Bracket

The Roadway Traffic Sensor shall be supplied with a mounting bracket. The basic mounting bracket for the Roadway Traffic Sensor shall consist of a 51 mm diameter aluminum tube and a cast aluminum flange. The flange shall be matched to the structure the Roadway Traffic Sensor is mounted upon (e.g. curved to fit structures of differing diameters, or flat to fit rectangular structures or concrete walls). The flange shall be attached to the structure via stainless steel strapping or bolts. The aluminum tube shall screw into the flange, and be locked in place with set screw. The Roadway Traffic sensor itself slides over the tube before its stainless steel straps are tightened.

## 4. Sensor Lead-In Cable

A single composite interface cable (Sensor Lead-In Cable), of no less than 50 feet length and Home Run Cable of no less than 200 feet length, shall be provided with each Roadway traffic Sensor. This Sensor Lead-In Cable shall provide DC power to the top-of-pole sensor as well as the RS-422 data lines required to interface to the Cabinet Termination Circuit Card. The Sensor Lead-In Cable shall contain a minimum of six (6) pairs of stranded #22 AWG conductors – with foil shield running the length of the cable and ground strand in cable.

## 5. PC Monitoring and Setup Software

A PC based diagnostic software package shall be provided that can be utilized to set up the Roadway Traffic Sensor and monitor operation to verify the performance and settings of the Roadway Traffic Sensor. The Monitor and Setup software is designed to run under Windows. The software shall permit the Contractor to establish the detection zones and make all fine tuning adjustments necessary to ensure the accuracy and sanctity of the detection zones. The software shall also display presence, in real-time,

within the programmed detector zones and shall report the accumulated data over the user-defined reporting interval for all programmed zones including volume, average occupancy, and average speed.

6. ATFDS Central Software

The Contractor shall provide ATFDS system software with functionalities and capabilities as identified in these Special Provisions.

7. ATFDS Central Hardware

The system software will be installed in the hardware provided as part of other pay item as defined in these Special Provisions.

**C. CONSTRUCTION**

1. Installation

Furnish and install the Sensor as specified in the Contract Documents and adjust the Sensor and configure the lane detection zones.

Mount the Cabinet Termination Circuit Card inside the field cabinet to terminate the Sensor Lead-In Cable and convert RS-422 to RS-232.

Connect the sensor to the field cabinet via hard-wired Sensor Lead-In Cable and Home Run Cable with combined maximum run of 1500 feet. Sensor Lead-In Cable shall be connected to Home Run Cable at Junction Box located at the base of the pole on which the Sensor is mounted.

Connect all the cables as necessary within the cabinet to make the ATFDS functional.

2. Functional Output Protocol

ATFDS software from the DDOT administrative building shall be able to connect to receive polled data from the ATFDS. Ensure that ATFDS can process polling requests to maintain a minimum of 30 seconds polling cycle.

3. Cabinet Equipment

Install the cabinet equipment including wiring, conductors and terminal blocks, surge protectors, and other components as per provisions as identified for the NEMA Type 336S Classification/Count Cabinet. (Paid for separately)

5. Testing

Complete testing as identified in these Special Provisions.

6. Warranty and Maintenance

Provide warranty and Maintenance as identified in these Special Provisions.

7. Training

Provide Training as identified in these Special Provisions.

**D. MEASUREMENT AND PAYMENT**

Acoustic Traffic Flow Detection System (ATFDS) will be measured and paid for at the contract unit price per each. The payments will be full compensations for furnishing, installing the detector in a manufacturers and DDOT approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from DDOT's TMC and furnishing documentation to complete the work including the following:

1. Roadway traffic sensor, and mounting assembly with all associated hardware
2. All hardware and material necessary to provide electrical power services to the ATFDS field location as shown in the Plans.
3. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any ATFDS component.

4. AFTDS Software

The central hardware, the pole and its foundation for mounting the ATFDS and modem shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate pay item. However, the contractor is responsible under this item the complete installation, setup and configuration, and acceptance of the AFTDS.

All the items will be paid for only after the complete installation, setup and configuration, testing, and acceptance of the ATFDS.

## 2007-TS-005(g)

### FURNISH AND INSTALL VIDEO TRAFFIC FLOW DETECTION SYSTEM (VTFDS)

Pay Item No.: 800 013.

#### A. GENERAL

The work to be performed under this section consists of furnishing, installing and wiring of the complete Video Traffic Flow Detection System (VTFDS) at the locations shown on the plans and in accordance with the conditions set forth. The work also includes testing, training, warranties, and guarantees as designated in the specifications.

1. The VTFDS shall have the following general high level requirements:
  - a. The system shall be non-intrusive.
  - b. The system shall use vide image processing technology.
  - c. The system shall at a minimum collect volume, classification (3 or 4 types), speed, and occupancy.
  - d. A single system shall be capable of continuously collecting data for up to six (6) lanes of traffic.
  - e. The camera shall be mounted on an overhead structure directly over the travel lanes.
  - f. The collected data shall be stored in the field for at least 30 continuous days.
  - g. The system shall enable data collection through the Departments traffic signal communication network.
2. The VTFDS shall consist of:
  - a. A self-contained Video Traffic Sensor, camera lens, mounting equipment, all other associated hardware
  - b. 4" diameter GRS conduit, 4-foot extension pole.
  - c. Video Detection System Processor
  - d. Video Detection System Processor Software for installation and subsequent maintenance tasks
  - e. VTFDS Central Software
  - f. VTFDS Central Hardware

#### B. MATERIALS

All the materials shall contain all of the components described in the subsequent material specifications. All necessary incidental components, cables, and hardware, shall be supplied to accomplish a fully operational VTFDS installation. All equipment and component parts furnished shall be new, be of the latest design, and manufacture. 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.

##### 1. Video Camera Sensor

As a minimum, meet the following requirements for each camera installation. Use a camera sensor that is compatible with the video detection system processor and meets the following requirements:

- a. Lens: Equip the video camera sensor with an 8-48 mm motor driven variable focal length lens
- b. Input Power: 120 VAC, 60 Hz. Size power conductors from the power source to the camera input so that no more than a 3% drop is experienced (NEC 210-19a., FPN No.4). Include a provision at the rear of the camera enclosure for waterproof connection of power and video signal cables.

- c. Electromagnetic Interference (EMI): Apply FCC Part 15, Subpart J, Class A device requirements for the video camera sensor and associated connected equipment in their installed condition. .
- d. Video Camera Sensor Enclosure: Install the video camera sensor in a light colored enclosure to limit solar heating. Meet NEMA 250 Type 4 enclosure for the enclosure and pressurize the enclosure at least 5 psi  $\pm$  1 psi) to prevent sand, dirt, dust, salt, and water from entering. Provide a sun shield visor on the front of the enclosure which is sufficiently adjustable to divert water away from the video camera sensor lens and also prevent direct sunlight from entering the iris when mounted in its installed location. Install the sun shield so that it does not impede operation or performance accuracy of the video camera sensor or require removal of the video camera sensor enclosure for adjustment. Use an enclosure that allows the video camera sensor horizon to be rotated in the field during installation.
- e. Weight: 10 lbs maximum with mount, shield, and camera.
- f. Mounting: Ensure that video camera sensor assembly and associated enclosure and sun shield are capable of being mounted without special tools, fixtures, or holding devices. The video camera sensor horizon shall be adjustable without removing the camera, mounting bracket and enclosure, or sun shield.

## 2. Video Detection System Processor

- a. Mounting: Ensure that the video detection system processor is rack mountable in the DDOT 336SS Controller Cabinet.
- b. Electrical: Power the video detection system processor by 120 VAC, 60 HZ, single phase, and draw a maximum of 1.0A. Size power conductors from the power source for the video detection system processor input so that no more than 3% voltage drop is experienced (NEC 210-19a., FPN N0.4). The video detection system processor shall have transient protection that meets the requirements of NEMA TS1-1989 (R1989) and NEMA TS2-1992 (Standards). Power to the video detection system processor shall be from the cabinet equipment outlet.

Communicate to the traffic control center for downloading traffic data stored in non-volatile memory, via Spread Spectrum wireless communications to the Departments traffic signal communications network.

Ensure that the video detection system processor software is stored in non-volatile memory within the video detection system processor. Perform software updates through dial up port.

The video detection system processor front panel shall include a visual display of the status of each video input and the status of the video detection system processor in general. Indicators shall display, at a minimum, the status of video detection system processor communications, the status of the video detection system processor and whether or not video camera sensor is actively detecting.

Include an embedded HTTP server in the video detection system processor. The embedded HTTP server shall allow a remote user with a standard web browser to gain remote access, collect data, control, and configure the VTFDS. The server shall include multilevel password protection for a minimum of 10 users. The VTFDS shall also keep an access log that records MTFDS user and time of access.

Provide two (2) RS-170A black and white composite video inputs on the video detection system processor such that signals from up to two (2) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time. Use BNC connectors on the front or back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

- c. Remote Data Collection and Storage:
  - Detection Parameters: Provide a video detection system processor that independently computes the following traffic parameter data in each lane of detection:
    - i. Volume

- ii. Speed
- iii. Occupancy
- iv. Vehicle classification (three (3) or four (4) types)

Interval Duration: Provide a video detection system processor capable of computing and storing all traffic parameters by lanes in user selectable time intervals of 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes.

Memory: Store all traffic parameter data in non-volatile memory within the video detection system processor. This data shall be capable of being retrieved through a HTTP server or through a dial up connections. The memory shall have the capacity to store data for 30 continuous days.

Data Retrieval: Transfer traffic parameter data from the video detection system processor's non volatile memory to the DDOT administrative building through a dial up connection.

d. Detector Configuration:

Storage Format: Store collected traffic parameter data that is retrieved from the video detection system processor in readily accessible ASCII format.

Data Display Format: Allow for displaying the collected traffic parameter data in the numeric format.

Image Capture: Allow still image capture (snapshot) from all of the video detection system processor's active video inputs and provide for downloading the image for display or storage as a picture file. Capture and transmit the still image in JPEG format to transmit to the TMC.

Communications: Perform communications to video detection system processor for detector configuration through the dial up communication.

3. Cabinet Equipment

Wiring, Conductors and Terminal Blocks: Use terminal blocks and strips with voltage and current ratings greater than the voltage and current ratings or the wires that are terminated on the blocks or strips. Use Quick-clamp type wire terminals (Conch QC-1 or approved equivalent) optionally on TB 10. TB 10 shall have at least 8 terminal positions. Do not use compression-type or tubular clamp terminal blocks except for service entrance block SE. Do not use spade lug terminals for any terminal block.

Surge Protection: Provide full I/O surge protection, with additional devices to protect the equipment and cables from surges and over-voltages.

4. Functional Requirements

As a minimum, provide these features and capabilities that directly affect the overall operational performance.

a. Functional Detections: Provide a VTFDS that performs the following functions:

- i. Vehicle counting
- ii. Vehicle speed
- iii. Vehicle classification
- iv. Per vehicle data acquisition
- iv. Per lane data acquisition

b. Functional Output Parameters: Provide a VTFDS that outputs at least the following detections parameters on a per lane basis: Volume, speed, occupancy, and vehicle classification.

c. Video Detection System Processor Equipment and Software: Provide video detection system processor equipment that gives an operator the capability to define multiple detection zones within each individual camera sensor's field of video at the video detection system processor via the configuration software. Provide flexibility in definition of the zones and response and processing time of each zone.

5. VTFDS Central Software

The Contractor shall provide ATFDS system software with functionalities and capabilities as identified in these Special Provisions.

a. VTFDS Central Hardware

The system software will be installed in the hardware provided as part of other pay item as identified in these Special Provisions.

b. Environmental

**Video Detection System Processor:** Provide a video detection system processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA 1989 (R1994)

**Video Camera Sensor:** Operating ambient temperature range: -30°F to 140°F. Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interface with the operation of the video camera sensor electronics, or cause interference with the video signal.

**Humidity:** 5 – 95% per NEMA TS1-1984 (R1994), section 2.1.5.2

**Vibrations:** Provide a video camera sensor and enclosure that maintains its functional capability and physical integrity when subjected to a vibration of 5 to 30 Hz up to 0.5 gravity applied to each of three mutually perpendicular axes (NEMA TS1-1989 (R1994), section 2.2.12)

**Shock:** Ensure the video camera sensor and enclosure can withstand a 10G + 1 G shock. Neither permanent physical deformation nor inoperability of the video camera sensor and enclosure can be sustained as a result from this shock level.

**Acoustic Noise:** Provide a video camera sensor that can withstand 150 dB for 3 minutes continuously with no reduction in function or accuracy.

**C. CONSTRUCTION**

1. Installation

Install all video camera sensors, video detection system processors, and equipment at the locations specified in the plans. Install all rackmounted equipment with one rack unit space between adjacent equipment. Make all necessary adjustments and modifications to the total VTFDS system prior to obtaining DDOT recommendation for system acceptance.

2. Functional Output Protocol

TFDS software from the DDOT administrative building shall be able to open up connection to receive polled data from the TFDS. Ensure that TFDS can process polling requests to maintain a minimum 30 seconds polling cycle.

3. Camera Sensor Operating Locations

Adjust the video camera sensor lens to match the width of the road and minimize lane vehicle occlusion. Mount the camera at the top of the specified structure for that location as shown on the plans.

4. Cabinet Equipment

Install the cabinet equipment including wiring, conductors and terminal blocks, surge protectors, and other components as per provisions as identified for the NEMA Type 336S Classification/Count Cabinet.

5. Cables, Conduit, and Power Service

Furnish and install electrical cables used for the detector control, communications signaling and power supply as shown in the Detail Drawings. Do not splice any cable, shield or conductor used. Identify all conductors for all cables by color and number. Identify the conductor function in as-built documentation

(see next section). Terminate cable used for video signaling in BNC connectors. After terminating and dressing the cables in the cabinet, neatly coil and store a minimum of 2 ft of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back unused conductors over their outer jackets and individually tape them.

Provide electrical cables for the detector, communications signaling and power supply between the cabinet and the devices as required below and install them as shown in Detail Drawing.

Beginning at individual video camera sensors, carry video signal from the camera to the pole-mounted junction/splice cabinet via coaxial cable to the video detection system processor located in the field cabinet. Transmit the vehicle traffic data from the video detection system processor to the traffic control center via the dial up communications.

Install cabling inside new hollow metal or concrete support poles unless otherwise specified. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and changing against the pole device or bracket. Form a drip loop at the weather head and route cabling to minimize water entry into the cable connector.

6. As-Built Drawings: Provide As-built drawings as identified in these Special Provisions. Place all documentation in a weatherproof holder in the cabinet.
7. Training: Provide Training as identified in these Special Provisions.

**D. MEASUREMENT AND PAYMENT**

Video Traffic Flow Detection System (VTFDS) will be measured and paid for at the contract unit price per each system. Each system may contain one (1) or more cameras. The payments will be full compensations for furnishing, installing the detector in a manufacturers and DDOT approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from DDOT's TMC and furnishing documentation to complete the work including the following:

1. Camera Sensor, Sensor lens, and mounting assembly with all associated hardware
2. All weather heads, vertical conduit risers, and conduit hardware on the VTFDS support pole for power service, grounding, communication and control.
3. All hardware and material necessary to provide electrical power services to the VTFDS field location as shown in the Plans.
4. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any VTFDS component.
5. VTFDS Central System Software

The central hardware and modem shall also be paid as separate item. The power and communication to the field equipment cabinet will be established under a separate pay item. However, the contractor is responsible under this item to the complete installation, setup and configuration, and acceptance of the VTFDS.

All the items will be paid for only after the complete installation, setup and configuration, testing, and acceptance of the VTFDS.

## 2007-TS-005(h)

### FURNISH AND INSTALL ROADWAY WEATHER INFORMATION SYSTEM (RWIS)

Pay Item No.: 800 015.

#### A. GENERAL

The work to be performed under this section consists of procuring, furnishing, installing and wiring of the complete Road Weather Information System (RWIS) at the locations shown on the plans and in accordance with the conditions set forth.

1. The RWIS system shall have the following general high level requirements:
  - a. The system shall be specifically designed for monitoring and displaying pavement surface conditions, pavement temperature, freeze point temperature, chemical percent concentration, subsurface temperature, roadway video images, and atmospheric conditions from the location(s) as shown in the contract plans.
  - b. Both passive and active in-pavement sensors shall be installed at the RWIS site(s) to monitor roadway surface status conditions including dry, wet, frost, chemical wet, and snow/ice warning.
  - c. Atmospheric/meteorological conditions monitored may include any of the following; air temperature, relative humidity, dew point, precipitation classification, visibility, barometric pressure, and/or wind/speed direction.
  - d. The system shall provide color still frame video images of the roadway.
  - e. The information from the RWIS station shall be collected by, archived and displayed on the existing DOT RWIS server system.
2. The system shall include all hardware, software, and licenses to operate as follows:
  - a. Active and passive in-pavement surface sensors shall measure roadway pavement surface temperature, freeze point temperature, chemical concentration, surface conditions, and communicate these signals to the RPU.
  - b. Atmospheric sensors shall measure their respective weather parameters and communicate the signals from each to the RPU.
  - c. A Pan-Tilt-Zoom (PTZ), low light, color, snapshot video camera shall capture video images and transfer the images to the RPU.
  - d. Optionally, a wireless in-pavement or side-fire radar traffic counter shall measure the count, speed and length of passing vehicles, and transfer this data to the RPU.
  - e. Optionally, the RPU shall monitor and control a fixed anti-icing spray system to automatically apply anti-icing chemical to the bridge deck and roadway approaches.
  - f. The RPU shall process and temporarily store the output from the camera(s), pavement sensors and atmospheric sensors.
  - g. The RWIS server shall poll each RPU on a scheduled basis via communications telemetry as specified in the project plans. The RPU shall respond to the poll and transfer all of its data and images to the RWIS server.
  - h. All data transfers between the RWIS server and RPUs shall be compliant with the most current Federal standard NTCIP ESS protocols.

- i. The RWIS server system shall store the RWIS data and video images in a standard SQL Server database for access by DDOT users
  - j. Optionally, a 24-hour pavement specific weather forecast shall be provided by the RWIS vendor for display by the server as an advanced ice/snow control-planning tool for DOT maintenance personnel.
  - k. The RWIS user displays shall include all sensor, forecast and video data in a browser-based data display format.
3. The system shall consist of:
- a. Remote Processing Unit
  - b. Passive Pavement Sensor
  - c. Active Pavement Sensor
  - d. Subsurface Temperature Probe
  - e. Classifying Precipitation and Visibility Sensor
  - f. Precipitation Occurrence Sensor
  - g. Air Temperature/Relative Humidity Sensor
  - h. Wind Speed/Direction Sensor
  - i. PTZ Color Video Camera
  - j. RWIS Central Software
  - k. RWIS Central Hardware
4. The pole for mounting the sensors, the foundation and base, power and communication to the field unit will be considered as separate items.

**B. MATERIALS**

All the materials shall contain all of the components described in the subsequent material specifications. All necessary incidental components, cables, and hardware, shall be supplied to accomplish a fully operational RWIS installation. All equipment and component parts furnished shall be new, be of the latest design, and manufacture. 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.

1. Remote Processing Unit (RPU)

The contractor shall supply and install a tower mounted RPU electronics package with enclosure on a concrete foundation as shown in the project plans. The contractor shall install 110VAC service to the RPU power disconnects. Primary power should be installed to the RPU and fused for 20 amps, with voltage surge protection. The RPU shall operate in a range of 100-130 VAC at 50-60 Hz and shall use not more than approximately 50 Watts of continuous power (excluding options).

The RPU hardware and software supplied for the project should meet the following technical specifications:

- a. RPU software shall utilize a Linux based operating system, and be capable of multi-tasking operations to optimize data acquisition from all connected devices.
- b. The RPU shall gather data from all connected sensors and remote pavement sensors, and process, store and transmit this data to the RWIS server upon polled request. Each RPU shall be capable of collecting data from the following sensors:
  - i. 1 to 8 Passive surface sensors that are "hardwired"
  - ii. 1 to 8 Wireless outpost passive surface sensors
  - iii. 1 to 8 Subsurface sensors that are "hardwired"

- iv. 1 to 8 Wireless outpost subsurface sensors
  - v. 1 to 8 Active surface sensor heads that are “hardwired”
  - vi. 1 to 8 Thermal “pavement temperature only” sensors
  - vii. 1 Air temperature/relative humidity sensor
  - viii. 1 “Hardwired” mechanical wind speed/direction sensor or 1 heated ultrasonic wind speed/direction sensor
  - ix. 1 Wireless mechanical or ultrasonic wind speed/direction sensor
  - x. 1 Weather identifier and visibility sensor
  - xi. 1 to 2 Pan-Tilt-Zoom low light, color, still frame video cameras or 1 to 2 fixed, zoom, low light color video cameras
- c. RPU communication with the server shall utilize the most current published Federal Standard NTCIP-ESS protocol
  - d. The server shall poll the RPU via one of the following communications modes; Ethernet, PPP dial-up over telephone, PMPP leased line, PMPP VHF/UHF 2-way radio, PMPP spread spectrum radio, or PMPP serial fiber optic.
  - e. The RPU shall incorporate “watch-dog” circuitry and monitor its own operation and reset itself if the RPU software enters an indeterminate state.
  - f. The RPU shall also have the capability to be reset by a “user administrator” from the server.
  - g. There shall be a total of 10 serial ports available selectable to either EIA-232 or RS-422/485, half or full duplex. These serial ports are for system maintenance and device interfaces, using baud rates selectable from 300 to 115.2 Kbps.
  - h. For maximum reliability, the design shall utilize extensive lightning protection for all channels and serial ports including auto-reset circuit breakers for power, Tran sorbs and gas discharge tubes.
  - i. All RPU electronics shall provide stable operation over a temperature range of -40°C to 70°C (-40°F to 160°F) and 0-90% RH non-condensing.
  - j. The RPU shall have the capability of being modified to utilize solar power or other power sources in place of conventional commercial electric power. Solar powered RPU sites shall operate a minimum of 72 hours without sunlight or solar charging of the batteries.
  - k. The RPU shall be enclosed inside a NEMA 4 lockable aluminum enclosure that is resistant to damage by weather and vandals. It shall be mounted on a freestanding, non-climbable, corrosion resistant, steel tower. The 30-foot (3 meter) tower is to be equipped with a lockable fold-over device to facilitate servicing the atmospheric sensors.
  - l. RPU software configuration shall be performed by PC computer with browser connected to the RPU Ethernet port.
  - m. The RPU shall be capable of upgrade via software.
2. Passive Pavement Sensor
- a. The passive sensor supplied shall be a single solid-state electronic device that is installed in the roadway at the locations as shown on the plans. Exact sensor placement shall be as determined by the Project Engineer with guidance from the equipment supplier.
  - b. The sensor shall come with a limited lifetime warranty.
  - c. The sensor shall be constructed of materials that have thermal characteristics similar to common pavement materials.
  - d. The top of the sensor shall approximate the roadway pavement color and texture. It shall be installed with epoxy sealer so the top is flush with the surrounding roadway surface.

- e. The sensor shall be thermally passive, providing stable operation over a temperature range from -40°C to 80°C (-40°F to 176°F). Weather conditions, traffic, or ice control chemicals shall not degrade its performance.
  - f. The sensor shall be supplied with molded cable that is waterproofed and sealed as an integral part of the assembly
  - g. The sensor shall electronically sample the following pavement parameters:
    - i. Surface temperature at the sensor head.
    - ii. Dry pavement condition.
    - iii. Wet pavement condition above 0°C (32°F).
    - iv. Pavement status information.
  - h. The pavement sensors shall supply data for the RWIS to determine the following pavement surface conditions when sufficient water is present on the pavement, and atmospheric data from precipitation, RH, and air temperature sensors is available:
    - i. Water on the pavement at or below 0°C (32°F).
    - ii. Snowy or icy pavement at or below 0°C (32°F).
    - iii. Freezing point temperature of the water/ice-control-chemical solution present on the surface of the pavement sensor for selected ice-control-chemicals.
    - iv. Depth of the water/ice-control-chemical solution present on the surface of the pavement sensor up to a depth of 12 mm (0.5 inches).
    - v. Percentage of ice particles present in the water/ice-control-chemical solution resident on the surface of the pavement sensor.
3. Active Pavement Sensor
- a. The contractor shall supply and install an array of 2 or 4 active pavement surface sensor heads at the roadway locations as shown in the project plans. The Project Engineer shall determine exact sensor placement with guidance from the equipment supplier.
  - b. The sensor shall be installed with epoxy sealer so the top is flush with the surrounding roadway.
  - c. The sensor shall be thermally active to measure the freeze point temperature of solution on the road. At the point when the liquid/moisture changes state from liquid to solid, the temperature of the cell shall be measured and reported as the freeze point to the RPU. The freeze point temperature displayed to the user should be based on an average of the data points collected from the 2 or 4 head sensor array. The sensor must electronically measure the freeze point of the solution on its surface regardless of the type of anti-icing chemical mixtures or concentrations present.
  - d. The sensor shall operate in a temperature range of -40°C to 60°C (-40°F to 140°F). Sensor freeze point temperature detection range shall be -20°C to 0°C (-4°F to 32°F) with an accuracy of + or - .7°C.
  - e. Sensor performance shall not be degraded by weather conditions, traffic, or road contaminants.
4. Subsurface Temperature Probe
- a. The contractor shall supply and install the subsurface temperature probe(s) in the roadway near a surface sensor at a depth of 17 inches. The probe shall measure the ground temperature below the roadway pavement surface.
  - b. The temperature-sensing element of the probe shall operate over a temperature range of -40°C to 80°C (-40°F to 176°F).
  - c. The probe shall be supplied sufficient cable, which is waterproofed and sealed as an integral part of the assembly.

5. Classifying Precipitation and Visibility Sensor
  - a. The contractor shall supply and install a classifying precipitation sensor approximately 8 feet above ground on the RWIS tower structure. This sensor shall function as a precipitation classifier, a precipitation rate meter, and a close range visibility sensor.
  - b. The sensor shall be able to differentiate between rain, snow, and drizzle as well as to measure actual precipitation rates as water equivalent.
  - c. The sensor shall have a rain dynamic range of 0.1 to 3000 mm/hr (0.005 to 118 in per hr). It shall measure rain accumulation from 0.1 to 999.999 mm (0.005 to 39 in), with a rain accumulation accuracy of 5%.
  - d. The sensor shall have a snow dynamic range of 0.01 to 300-mm/hr water equivalent (0.0004 to 11.8 in/hr). It shall measure snow accumulation from 0.001 to 999.999 mm water equivalent (0.00004 to 39 in), with a snow accumulation accuracy of 10%.
  - e. Sensor visibility range shall extend from 7.5m to 1600 m (25 ft to 1 mile).
  - f. Sensor housing shall be all weather and ice-proof with heated optics to prevent ice, dew or frost buildup.
  - g. Normal operating temperature range shall be from -40°C to 50°C (-40°F to 122°F).
6. Air Temperature/Relative Humidity Sensor
  - a. The Air Temperature/Relative Humidity Sensor shall have an air temperature-sensing element that operates over the temperature range of -40°C to 80°C (-40°F to 176°F).
  - b. The relative humidity sensing element shall be of the “human hair” type and have a measuring range of 10 to 100% RH. The operating temperature range shall be -35°C to 70°C (-31°F to 158°F).
  - c. System dew point temperature shall be calculated by the RPU from the air temperature and relative humidity.
  - d. Both atmospheric sensing elements shall be mounted on the RWIS tower at the standard meteorological height of approximately 2 m (6 ft) above ground level in a solar/wind-radiation shield.
7. Ultrasonic Wind Speed/Direction Sensor
  - a. The contractor shall supply and install an ultrasonic wind sensor at the standard meteorological height of approximately 10 m (30 ft) above ground level at the top of the RWIS tower. The sensor has no moving parts and is available with analog or digital outputs. Standard RWIS installations include an external heater unit that permits continuous operation during heavy ice and snow events.
  - b. The sensor shall have an operating range of 0 to 50m/sec, with a survival operation limit of 85 m/sec.
  - c. Accuracy shall be  $\pm 0.15$  m/sec or  $\pm 2\% \geq 5$  m/sec, with a resolution of 0.1 m/sec.
  - d. The operating azimuth shall be 0 to 360° with an accuracy of  $\pm 3^\circ$ , and resolution of 1°.
  - e. The temperature operating range shall be -30°C to 55°C or -50° to 55° with the external heater option installed.
8. PTZ Color Video Camera
  - a. The contractor shall supply and install the PTZ (pan-tilt-zoom) color video camera(s) at the RWIS tower locations as shown on the project plans and specifications. It shall be mounted to the RWIS tower approximately 27 feet above ground level. It shall be capable of grabbing up to 8 preset color video still frame images approximately every 5-10 minutes for display by the RWIS server.
  - b. It shall be fixed mounted, and positioned to take up to 8 views of the roadway to view traffic and weather conditions.
  - c. It shall be enclosed in an environmental video dome housing to operate in 100% humidity, -40°C to 60°C operating temperature, and withstand common air contaminants found along roadway locations.

- d. The small video dome shall provide dual mode, day (color) and night (monochrome) video camera with optical zoom lens and a high speed positioning system enclosed within a sealed and pressurized 7" optical dome.
- e. The lens has a focal length of 3.6mm to 82.8mm (23:1). It shall include auto/manual focus with focus control and variable speed zoom. A digital zoom range of up to 10X providing an effective zoom ratio of 230:1, and an effective focal length of 3.6mm to 828mm on a 1/4" format Progressive Scan CCD camera, resulting in an effective horizontal angle of view of 54° wide angle to 2.5° max. Telephoto.
- f. The camera shall provide Wide Dynamic Range (WDR) by use of dual shutter exposure technique. The pan function shall provide 360° of continuous rotation, with a variable speed from 0.5° per second to 225° per second. The tilt function shall provide 180° of movement (0° to 90° down to 0°, with video rotation), with a variable speed from 0.5° per second to 60° per second.
- g. Up to 64 preset shall be available for storing and recalling zoom, pan and tilt positions.
- h. It shall be capable of tour sequence defined using up to 64 preset positions.
- i. All camera and pan & tilt functions are operable via RS-422/RS-232 serial communications by maintenance terminal on-site or connection to the RPU.
- j. The camera shall follow DDOT standard drawings 617.28 through 617.30.

**9. RWIS Central Software**

DDOT has existing RWIS Software. The contractor shall ensure that the newly deployed RWIS field units are compatible with the existing software. The contractor shall update the database to access the deployed RWIS devices.

**10. RWIS Central Hardware**

The contractor shall upgrade the existing RWIS hardware, if necessary, to accommodate the new RWIS installation(s).

**C. CONSTRUCTION**

**1. Installation**

Construct and install the RWIS, including RPU, sensors, power units, modem, RPU Cabinet, Steel Pole (Paid for Separately) and Foundation (Paid for Separately), and all other materials in accordance with the requirements of the Plans, the manufacturer, applicable codes, regulations, and applicable Standards. All conduits, cables, wires, clamps required for a complete installation shall be associated with these items. Field verify the suitability of the proposed pole locations, and device installation heights with RWIS manufacturer. Provide manufacturer recommendations for location revisions to the Engineer for review and approval.

- a. Testing: Complete testing as identified in these Special Provisions.
- b. Warranty and Maintenance: Provide warranty and Maintenance as identified in these Special Provisions.
- c. Training: Provide Training as identified in these Special Provisions.

**D. MEASUREMENT AND PAYMENT**

Roadway Weather Information System (RWIS) will be measured and paid for at the contract unit price per each. The payments will be full compensations for furnishing, installing the detector in a manufacturers and DDOT approved enclosure, configuring, testing, and for all material, technical applications, labor, equipment, tools, and incidentals including testing, software to configure the units, software to access data from DDOT's TMC and furnishing documentation to complete the work including the following:

1. Remote Processing Unit and mounting assembly with all associated hardware.
2. Cabinet equipment, including but not limited to wiring, conductors, terminal blocks, surge protection and the sliding drawer.

3. All weather heads, vertical conduit risers, and conduit hardware for power service, grounding, communication and control.
4. All hardware and material necessary to provide electrical power services to the RWIS field location as shown in the Plans.
5. Passive Pavement Sensor
6. Active Pavement Sensor
7. Subsurface Temperature Probe
8. Classifying Precipitation and Visibility Sensor
9. Precipitation Occurrence Sensor
10. Air Temperature/Relative Humidity Sensor
11. Wind Speed/Direction Sensor
12. PTZ Color Video Camera
13. Updating RWIS Central Software
14. Upgrading RWIS Central Hardware, if applicable
15. All cables, connectors, hardware, interface, supplies, and any other items necessary for the proper operation and function of any/all RWIS component.

2007-TS-005(i)

**FURNISH AND INSTALL CLASS X  
PIEZOELECTRIC SENSORS (X')**

Item 800 017	Class I, 8'
Item 800 019	Class I, 9'
Item 800 021	Class I, 10'
Item 800 023	Class I, 11'
Item 800 025	Class I, 12'
Item 800 027	Class I, 13'
Item 800 029	Class I, 16'
Item 800 031	Class I, 17'
Item 800 033	Class I, 18'
Item 800 035	Class II, 8'

**A. GENERAL**

The Contractor shall develop a test and a range of electronic values to determine if the piezos installed are operating properly. The piezoelectric sensor placed in the roadway shall be physically small by design. Sensor element housing prior to installation shall be less than ½ inch in diameter, preferably smaller. Dynamic output voltage of piezos installed during this contract shall have a minimum of 300 milli volts of output voltage for all vehicle axles during the warranty period but should be significantly higher if possible. The piezo dynamic signal voltage will be measured according to standards outlined in these Special Provisions. The active sensor contact area should be less than 1/10 of the voltage magnitude of the true dynamic signal when compared to peak to peak voltages of the Bow Wave. Piezo output voltages shall not change significantly due to weather and temperature changes.

Static DC offset baseline voltages of the new piezo electric sensor shall not exceed +/- 100 milli volts during the life of the warranty with all external components disconnected. The resistance between the shield and the center conductor of the piezo element shall have greater than 20 Meg ohms of resistance during the warranty period. Resistance measured between the piezo shield and ground shall be greater than 20 Mega ohms of resistance during the warranty period.

The installation support holder used for positioning the piezosensor during installation shall be made of a material that will permanently bond with the grout material and develop a 100 percent encapsulated seal around the piezo electric sensor that will not crack or degrade over time. The use of plastic support holders during grouting operations will not be allowed. The installation depth of the piezo element shall be the depth recommended by the manufacturer, and the final installed height shall be exact without any variations across the length of the sensor.

For the typical installation, the first piezoelectric sensors shall be installed 3' from the back edge of the first loop and 1' from the front edge of the second loop and the second piezoelectric sensor shall be installed 1' from the back edge of the second loop and 3' from the front edge of the third loop. Both sensors shall be located from the left edge of the lane towards the middle, so that the left tire of vehicles will strike the sensor. If the AVC selected by the Contractor specifies a different type of layout, the contractor must notify the Project Engineer so that he may make the final decision as to the spatial installation. All installed Class II piezoelectric sensors shall be a minimum of 8 feet in length. The length of all Class I piezoelectric sensors shall be as shown on the plans.

For each newly installed piezoelectric sensor, the contractor shall provide the Project Engineer with the following:

1. Factory performance measures for each piezoelectric sensor.
2. Monitor traffic during normal operations for at least 30 minutes and capture five oscilloscope printout readings for each piezoelectric sensors that demonstrate the typical output signal for a typical sub compact, standard car, full size pickup, dump truck and a Class 9 truck. Vehicles monitored need to be traveling in the normal tire path. If vehicles are tracking in a different area because service vehicles are parked on the side of the roadway, the service shall be moved out of the area to allow for normal traffic flow.
3. Results of a DDOT approved drop test for each piezoelectric sensor (see test method in equipment section).
4. Sensor serial numbers.

When installing piezoelectric sensors, care shall be taken to insure coaxial lead-in cables installed in the roadway are protected from road movement and cracking. When the splice area of the piezo electric sensor falls in an area of the roadway that will not assure total protection to the sensor connection, the sensor shall be moved to a better location. Class II piezos shall normally be located on the left side of the lane, if vehicle tires track in areas outside this area the sensor shall be moved to a more ideal location. When pavement conditions or lack of a paved shoulder require the piezo to be reversed in the case of a full length piezo, it is recommended that the piezo placement be reversed and the lead-in cable run parallel with the sensor or the sensor moved. Under no circumstances will the connector between the piezo and the piezo lead wire be located in a pavement seam. The coaxial cable shall be inserted into tubing such as polybutylene, polyurethane or similar material that has been approved for use. A small 3" gap between the piezo and tubing will be sealed during the piezo grout pouring stage of the installation to prevent moisture from entering the sensor components. Duct tape shall be wrapped around end of the connection joint to prevent the grout material from traveling between the coaxial cable and tubing. The coaxial cable must be held in place with backer rod every 12 inches to prevent the conduit from floating up while the epoxy sealant is curing. Epoxy loop sealant shall totally encapsulate the coaxial cable conduit.

Static readings from the piezosensor will be recorded and submitted to the Project Engineer. These values will include capacitance, DC voltage offset, resistance and dissipation.

New sensors will require a finishing surface height procedure that is approved by the piezo, ATR, grout manufacture. The Project Engineer reserves the right to revise all installation guidelines.

Installation of piezoelectric sensors and the mixing of the piezo grout require the talents of the skilled craftsman and shall not be performed by an apprentice workman. The Project Engineer may request that individuals without the appropriate skills be removed from tasks that are beyond their skill levels.

## **B. MEASUREMENT AND PAYMENT**

Furnishing and installing polymer piezo sensors shall be measured and paid for by the unit each for the size indicated as specified in this Special Provision.

**2007-TS-005(j)**

**FURNISH AND INSTALL LEAD-IN CABLE  
FOR PIEZO P X (X FEET)**

Item 800 037	P1 (50 FEET)
Item 800 039	P2 (100 FEET)
Item 800 041	P3 (150 FEET)
Item 800 043	P4 (200 FEET)
Item 800 045	P5 (250 FEET)
Item 800 047	P6 (300 FEET)
Item 800 049	P7 (350 FEET)
Item 800 051	P8 (400 FEET)
Item 800 053	P9 (450 FEET)

**A. GENERAL**

Work under this item consists of providing a lead-in cable from the pullbox/handbox nearest the piezo to the traffic counter cabinet to complete the circuit of the instrument.

**B. MATERIALS**

Lead-in cable shall be comprised of the following materials:

Piezo detector lead shall consist of two THHN/THWN conductors twisted and covered with a polyvinyl chloride outer jacket. The lead-in cable shall conform to UL subject 1277. The cable shall be rated for 600 volts.

The conductor shall be bare soft annealed copper wire, seven wire (Class B) stranding conforming to ASTM B 3 and B 8.

The insulation shall be high dielectric polyvinyl chloride covered with an insulation armor of nylon conforming to UL 83 for type THHN/THWN insulation. The insulated conductors shall be twisted with a minimum of 3 turns per foot and covered with a helically or longitudinally applied suitable binding tape is optional.

Surface Printing: Ink Printed, "14 AWG No. Conductors - THHN/THWN"

**C. MEASUREMENT AND PAYMENT**

Furnishing, installing, piezo lead-in cable shall be measured and paid for at the contract unit price per each item as specified in this Special Provision.

2007-TS-005(j)

**FURNISH AND INSTALL LEAD-IN CABLE  
FOR PIEZO P X (X FEET)**

## 2007-TS-006

### IN-ROAD LIGHTING

#### A. GENERAL

This work shall consist of furnishing and installing in-road lighting at pedestrian cross walks as specified in the contract documents and as directed by the Engineer.

#### B. MATERIALS

Loop Sealant, as approved by the District Department of Transportation

1. In-road Warning Signals. In-road Warning Signals shall be comprised of an in-roadway light assembly with a snowplow protection base plate.

Each in-roadway light assembly shall use 12 amber light emitting diodes designed to emit light in a unidirectional manner that will be clearly visible to the motorist, and not visible to the pedestrians in the crosswalk.

The snow plow protection base plate shall be 14 in. diameter, and 1.875 in. high at its highest point with a pocket to hold the in-road light assembly. It shall be designed to be inset into the roadway and to protect the in-roadway light assembly from snowplow damage.

2. Power and Control Equipment. Power and Control Equipment shall be comprised of power and control equipment housed in a NEMA 3R cabinet and bollard activation unit.

The Power and Control Equipment shall be capable of being connected to a 120 volt power supply. It shall contain all the equipment necessary to monitor the bollard activation units and to activate the in-road Warning Signals to flash for a preset time. The preset timer for the warning signals shall be field adjustable from 11 to 44 seconds. The Power and Control equipment shall also record the number of times the in-road warning lights are activated.

A separate 120 volt tap shall be supplied that is energized whenever the in-road Warning Signals are flashing. This tap will provide a steady 120 volt AC suitable for operating a relay to control a hazard identification beacon.

A NEMA 3R, lockable enclosure of a suitable size shall be furnished to contain the Power and Control unit. The cabinet shall be formed of anodized aluminum, and have a natural finish.

The Bollard activation unit shall consist of four bollards arranged in pairs. Each pair shall be capable of detecting when a pedestrian passes between them, and with the power control equipment, determining if the pedestrian is entering or exiting the crosswalk. The Bollards shall be 42 in. high with an 8.5 in. diameter. The body of the bollard shall be formed of extruded aluminum.

#### C. CONSTRUCTION

1. In-road Warning Signals. In-road warning signals shall be installed so that the LED's are clearly visible to the oncoming traffic, but so that no part of the assembly projects more than 0.5 in. above the road. The installation shall not allow water to pool around the in-road warning signal. The snow plow protection base plate shall be secured to the road using an epoxy, and in a manner approved by the manufacturer. The in-roadway light assembly shall be fastened to the snowplow protection base plate with socket head stainless steel bolts.
2. Power and Control Equipment. Power and control equipment shall activate the in-road warning signals for a preset time only when a pedestrian passes between a pair of bollards entering the crosswalk. The in-road warning signals shall not be activated by pedestrian exiting the crosswalk. If another pedestrian

enters the crosswalk after the in-road warning signals have been activated, the preset time interval shall be restarted. Bollards shall be mounted to concrete pads as recommended by the manufacturer.

3. Bench Testing Manufacturers Certification. The Power and Control Equipment and in-road Warning Signals to be supplied shall be preassembled at the factory before delivery and tested to insure correct operation of the system and correct color of the in-road warning signals. A written certification of this bench test shall be provided by the manufacturer with the equipment.

#### **D. MEASUREMENT AND PAYMENT**

1. In-road Warning Signals shall be measured and paid for at the contract unit price per each. The payment shall be full compensation for furnishing and installing the in-roadway light assembly, the snowplow protection base plate, the saw cut necessary for installation of the inroad warning signals, cabling from the warning signal to the bollard activation units, epoxy, loop sealant, excavation of the road for installation of the snowplow protection base plate, and for all labor, tools, materials, and incidentals necessary to complete this work.
2. Power and Control Equipment shall be measured and paid for at the contract unit price per each. The payment shall be fully compensation for furnishing and installing Power and Control Equipment, enclosure cabinet, activation bollards, conduit and cables connecting the power control equipment, activation bollards, concrete for mounting the bollards, and for all labor, tools, materials, and incidentals necessary to complete this work.
3. Bench Testing and Manufactures Certification Bench Testing and Manufacturers Certification shall not be measured and paid for, but shall be incidental to other contract items.