

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

SUPPLEMENTAL SPECIFICATION

Section 939—Communication and Electronic Equipment

939.1 General Description

This work includes installation, acceptance testing, warranty, and guaranty of items that are either components of several NaviGator subsystems or elements of the communication network.

Provide all equipment and materials of like kind and function to be of the exact same manufacture, model, revision, firmware, etc.

Provide all equipment, materials, and work in accordance with all manufacturers' recommendations.

939.1.01 Definitions

Type A Cabinet – The Type A cabinet housing is a standard Model 336 stretch (336S) housing with approximate exterior dimensions of 46 in. (1.2 m) (H) x 24 in. (0.61 m) (W) x 23 in. (0.58 m) (D).

Type B Cabinet - The Type B cabinet housing is a standard Model 337 housing with approximate exterior dimensions of 35 in. (0.89 m) (H) x 20 in. (0.5 m) (W) x 17 in. (0.43 m) (D).

Type C Cabinet - The Type C cabinet housing is a standard Model 332 housing with approximate exterior dimensions of 64 in. (1.6 m) (H) x 24 in. (0.61 m) (W) x 30 in. (0.76 m) (D).

Type D Cabinet – The Type D cabinet housing is a standard Model 336 stretch (336S) housing with approximate exterior dimensions of 46 in. (1.2 m) (H) x 24 in. (0.61 m) (W) x 23 in. (0.58 m) (D). The difference between a Type D and Type A cabinet is the difference in interior cabinet configuration.

Type F Cabinet - The Type F cabinet housing shall be a standard ITS Cabinet Housing #3 with approximate exterior dimensions of 67 in. (1.7 m) (H) x 44 in. (1.2 m) (W) x 26 in. (0.66 m) (D).

GBIC, Type LX: GBIC is a fiber interface module to the network switches and the LX type is for shorter distances on single mode fiber of up to 10 km in length.

GBIC, Type EX: GBIC is a fiber interface module to the network switches and the EX type is for medium distances on single mode fiber of up to 40 km in length.

GBIC, Type ZX: GBIC is a fiber interface module to the network switches and the LX type is for longer distances on single mode fiber of up to 70 km in length.

Field Switch, Type A – is a hardened network field cabinet switch with a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets used in a typical drop and insert over fiber link.

Field Switch, Type B – is a hardened network field cabinet switch with a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets used in a drop and insert over fiber link when two links come together or split.

Field Switch, Type C – is a hardened network field cabinet switch with a minimum of eight (8) Gigabit-Ethernet SFP GBIC sockets used where multiple drop and insert links come together.

Field Switch, Type D – is a hardened network field cabinet switch with a minimum of eight (8) ports, four (4) ports are Dual-Purpose Uplink or Downlink Ports that can be used for 10/100/1000BASE-T ports or 100/1000 Mb/s SFP-modules. The other 4 ports are 10/100/1000BASE-T ports. The hardened switch should be layer 3 capable or have the ability to load a layer 3 OS onto it. The switch should have an SD card slot for loading and swapping configurations in the field.

Field Switch, Type E – is a hardened network field cabinet switch with a minimum of twelve (12) ports, four (4) ports are Dual-Purpose Uplink or Downlink Ports that can be used for 10/100/1000BASE-T ports or 100/1000 Mb/s SFP-modules. The other 8 ports are 10/100/1000BASE-T ports. The hardened switch should be layer 3 capable or have the ability to load a layer 3 OS onto it. The switch should have an SD card slot for loading and swapping configurations in the field.

Field Switch (POE), Type A – is a hardened network field cabinet switch with a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets used in a typical drop and insert over fiber link and where Power Over Ethernet capability from the switch is needed for POE devices.

Field Switch (POE), Type B – is a hardened network field cabinet switch with a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets used in a drop and insert over fiber link when two links come together or split and where Power Over Ethernet capability from the switch is needed for POE devices.

Field Switch (POE), Type C – is a hardened network field cabinet switch with a minimum of eight (8) Gigabit-Ethernet SFP GBIC sockets used where multiple drop and insert links come together and where Power Over Ethernet capability from the switch is needed for POE devices.

939.1.02 Related References

A. Georgia Standard Specifications

Section 631 – Permanent Changeable Message Sign

Section 682 – Electrical Wire, Cable and Conduit

Section 797 – Buildings

Section 922 – Electrical Wire and Cable

Section 923 – Electrical Conduit

Section 925 – Traffic Signal Equipment

Section 935 – Fiber Optic System

Section 936 – Closed Circuit Television System (CCTV)

Section 937 – Detection Systems

Section 940 – NaviGator Advanced Transportation Management System Integration

B. Referenced Documents

American Society of Testing and Materials (ASTM)

American National Standards Institute (ANSI)

Caltrans TEES – Caltrans Transportation Electrical Equipment Specifications, as published by the State of California Business, Transportation & Housing Agency; Department of Transportation, Current Edition, and all current addenda.

Caltrans TSCES – Caltrans Traffic Signal Control Equipment Specifications, as published by the State of California Business, Transportation & Housing Agency; Department of Transportation, Current Edition, and all current addenda

Canadian Standards Association (CSA)

Deutsches Institut für Normung {German Institute for Standardization} (DIN)

Electronics Industry Association (EIA)

Standards of the European Committee for Standardization (EN)

ICEA Table K.2/Method 1

Institute of Electrical and Electronics Engineers (IEEE)

International Electrotechnical Commission (IEC)

International Standards Organization (ISO)

International Telecommunications Union (ITU)

Motion Pictures Expert Group (MPEG)

National Electric Code (NEC)

National Electric Safety Code (NESC)

National Electrical Manufacturers Association (NEMA)

National Television System Committee (NTSC)

National Transportation Communications for ITS Protocol (NTCIP)

Telecommunications Industry Association (TIA)

Underwriter's Laboratory Incorporated (UL)

Association for Electrical, Electronic & Information Technologies [Germany] (VDE)

939.1.03 Submittals

Use only equipment and components that meet the requirements of these minimum specifications and that are approved on the Department's Qualified Products List. Products appearing on the Qualified Products List (QPL) are exempt from normal submittal requirements. These products have been evaluated by the Office of Traffic Operations and have proven their capability of meeting the applicable Georgia Department of Transportation Specification. Any of these products may be used without submitting catalogue cuts, sampling or pre-testing. The Contractor shall submit a letter to the Engineer, stating which QPL items they will use. The Engineer and/or department designee must ascertain that the construction item is the same material identified on the QPL and will acknowledge receipt of these items in the project diary or as required by the Construction manual.

The following chart provides the Contractor with an outline of the submittal requirements for the equipment and components not on the Qualified Products Lists for this pay item. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

Section 939 Submittal Requirements								
Item	Specification Subsection	Catalog Cuts	Factory Specifications	Independent Test Lab Certification	Installation Procedure	Test Plans	Maintenance Procedures	Submittal Due Date (Cal. Days after NTP)
Serial Data Terminal Server (All Types)	939.2.02				X	X	X	60 Days
Patch Cords	939.2.03							60 Days
Hub UPS	939.2.04				X	X	X	60 Days
Network Switch, Layer 3 Gig-E (All Types)	939.2.05				X	X	X	60 Days
GBIC Routing Switch Module (All Types)	939.2.06				X	X	X	60 Days
GBICs (All Types)	939.2.07				X	X	X	60 Days
Field Switch (All Types)	939.2.08				X	X	X	60 Days
Equipment Rack	939.2.11				X			60 Days
Equipment Cabinet Assembly (All Types)	939.2.13.A				X	X	X	60 Days
Training Plan	939.3.08				X		X	60 Days

Submit submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items within sixty (60) calendar days after the Notice To Proceed and prior to any installation, unless noted otherwise in the Contract Documents.

Submit to the Engineer for approval, two (2) copies of the manufacturer's descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation and all other materials required within these specifications. An electronic copy, which includes all the aforementioned documents, shall be placed on a CD as pdf documents and delivered to the Engineer.

Provide submittal data that is neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item. Use the "Materials Certification Package Index and Transmittal Form", contained in Section 105.02 of the Specifications, for each pay item to document and list all material and components that are included in the submittal package. Any submittal data submitted without the Index/Transmittal form or that is incomplete will be rejected.

A. Equipment

Materials submittal data for items specified herein shall include, but not be limited, equipment performance and technical specifications, electrical/power specifications, size/weight/mounting configuration requirements, and environmental operating conditions.

Provide a diagram showing the location of all equipment within the TCC, Hub and/or Equipment Cabinet, 30 days prior to any installation activities at the site. Include in this diagram the dimensions, power requirements, power service materials and heat dissipation specifications for all of the equipment.

Submit and provide all equipment and corresponding ancillary and incidental materials of a like kind to be the exact same manufacturer, model, revision, firmware, etc. for the entire quantity in the project. Like kind equipment shall include, but is not limited to, serial data terminal servers, uninterruptible power supplies, network switches, GBIC routing switch modules, GBICs, field switches, video encoders and decoders, and equipment racks.

B. Testing

Provide test equipment and system set-up and diagnostic software required for the testing, operation, maintenance and troubleshooting of the equipment, along with Operations, Installation and Maintenance manuals for these software packages. Submit all testing plans and procedures for Department approval in accordance with the chart above.

939.2 Materials

939.2.01

Not Applicable

939.2.02 Serial Data Terminal Server

Provide multiport Serial Data Terminal Servers (terminal servers) that are compatible with the existing NaviGator serial port control system. The existing serial port control system consists of serial data terminal servers (Digiboard PortServer II) addressed with the Digiboard RealPort system interface.

A. Ensure all terminal servers meet the following requirements:

1. Compatible with the existing NaviGator serial port control system
2. IP addressable supporting Ethernet 10/100Base-T/TX with RJ45 port
3. RS-232 serial ports with RJ45 ports
4. Management access by HTTP, telnet, and console ports, all password protected
5. SNMP read/write management of terminal server and individual serial ports
6. Each serial port individually configurable comm. settings and TCP/UDP socket support
7. RS-232/422/485 selectable serial connections
8. Each serial port with minimum 230Kbs throughput with 64Kbps buffering and data capture
9. Firmware upgradeable by FTP/TFTP
10. Upload/download of configuration settings
11. Diagnostic LEDs for Ethernet connection and unit status
12. UL approval

B. Ensure Serial Data Terminal Server, 16 Port, meet the following additional requirements:

1. EIA 19-inch rack-mounted units with maximum vertical height of 1.75 inch (44.4 mm).
2. 16 RS-232 ports mounted on the front of the unit.
3. Internal 120VAC power supply.

C. Ensure Serial Data Terminal Server, Type B, meet the following additional requirements:

1. Operating temperature of unit and power supply of -31°F to 165°F (-35°C to 74°C).
2. Conformal-coated circuit boards.
3. Capable of being panel-mounted, rack-mounted and shelf-mounted in equipment cabinets.
4. Minimum of two (2) RS-232 ports mounted on the front of the unit.

5. Internal or external 120VAC power supply.

939.2.03 Patch Cords

A. General Requirements

Provide all necessary patch cords with all electronic equipment for interconnection. Verify that patch cords consist of a length of cable that is connectorized on both ends, primarily used for interconnecting termination or patching facilities and/or equipment.

1. All patch cords shall be factory assembled and connectorized and be certified by the patch cord manufacturer to meet the relevant performance standards required below. All connectors shall incorporate mechanical cable strain relief and protective boots.
2. Coaxial Video Patch Cords: Ensure that coaxial video patch cords are 75-ohm precision double-shielded cables with tinned copper braid shield and minimum #22AWG solid copper stranded center conductor. Use BNC connectors with gold-plated center pins at both ends. Connectorized coaxial video patch cords shall be 100% sweep tested. Provide only adapters with gold-plated pins.
3. Network/Field Switch/Data Patch Cords: Verify that network//field/data patch cords meet all ANSI/EIA/TIA requirements for Category-5e 4-pair unshielded twisted pair cabling with stranded conductors and RJ45 connectors.
4. Voice/Telephone Patch Cords: Provide voice/telephone patch cords that meet all ANSI/EIA/TIA requirements for Category 3 unshielded twisted pair cabling with stranded conductors, unless otherwise required by the voice/telephone equipment manufacturer.
5. Fiber Optic Patch Cords: Provide fiber optic patch cords that meet all requirements of Section 935.

939.2.04 Hub Uninterruptible Power Supply

Ensure the Hub UPS provides AC back-up power for network electronics and other equipment as shown in the contract documents.

A. Provide a Hub UPS meeting the following requirements:

1. 19" rack mounted, maximum height of six (6) rack units (10.5").
2. 120 VAC single phase 60 HZ output
3. Input line cord plug type NEMA L5-30P
4. 8 output receptacles type NEMA5-15R
5. Pure sine wave output at 115 VAC +/- 5%
6. Transfer time of 4 ms or less
7. Capacity of 2200 VA/1900 W
8. Load factor range of 0.5 to 1.0
9. Peak current capability of 6.5 KVA
10. Software adjustable high and low voltage buck/boost function
11. SNMP manageable hardware and software with 10Base-T connection (RJ-45)
12. Addressable SNMP command set shall minimally include: UPS state, battery condition (capacity, age, internal temperature); current AC input conditions (voltage, phase, frequency, failure condition); current AC output conditions (voltage, frequency, load); and diagnostic/self-test control and status.
13. Remote environmental sensing hardware and software integrated with SNMP minimally capable of temperature and humidity monitoring and 4 dry contact closures
14. Network connection to Ethernet port on Hub Network Switch, Layer 3 GigE

15. Printed and electronic user documentation for all management, configuration and operation hardware and firmware settings, installation procedures, and the MIB.
16. Sealed maintenance-free lead-acid batteries
17. Maximum audible noise of <53 dBA at 3 ft (0.9 m).
18. Upgradeable for increased runtime capacity (minimum 2.5X) with additional battery packs
19. Expansion battery pack that is 19" rack mounted, with maximum height of five (5) rack units (8.75").

939.2.05 Network Switch, Layer 3 GigE

Furnish a Gigabit Ethernet Layer 3 network routing switch that is compatible with the existing GDOT Ethernet switching network. The existing network consists of Cisco Networks 3750 Layer 3 routing switches. The network switches shall be managed by the department's existing network management software. Furnish and configure the network switches as complete compatible assemblies. Switches shall be modular, stackable and the modules configurable to be operated as a single switch. Configure the network switch (es) at the locations shown in the Plans, as applicable, to the following minimum requirements:

Minimum 12 port 1000 Base SFP GBIC Routing Switch.

One (1) 24-port auto-sensing 10/100/1000 Base-T/TX Ethernet Layer 3 switching interface.

Three (3) 100-240VAC power supplies including North American power cables, configured for 120VAC service
EIA 19" rack mounted

All modules shall be hot-swappable.

Meet the IEEE 802.3u (Fast Ethernet 100 Mbps) standard.

Meet the IEEE 802.3x (Full Duplex with Flow Control) standard.

Meet the IEEE 802.1p (Priority Queuing) standard.

Meet the IEEE 802.1q (VLAN) standard per port for up to 255 VLAN's.

Meet the IEEE 802.1w (Rapid Spanning Tree Protocol) standard.

Meet the IEEE 802.1d (Virtual Bridge) standard.

Meet the IEEE 802.1x (authentication) standard.

Meet the IEEE 802.3ad (Port Trunking) standard for a minimum of two groups of four ports.

Full implementation of RIP protocol

Full implementation of OSPF protocol

Capable of mirroring any port to any other port within the switch.

Full implementation of SNMPv1, SNMPv2c, and SNMPv3.

Full implementation of GMRP (Generic Multicast Registration Protocol).

Full implementation of GVRP (Generic VLAN Registration Protocol).

Full implementation of IGMP, IGMPv2 and IGMP snooping.

Full implementation of PIM-SM and PIM-DM.

Full implementation of DVMRPv3.

Full implementation of VRRP.

Additionally configure each Network Switch, Layer 3 GigE, Type E, with four (4) Type E GBICs. Include four (4) duplex fiber optic single-mode patch cords, 30 ft. (9 m) in length, in accordance with Section 935 and with LC - connectors on one end (at the FDC) and an LC-connector on the other end (at the network switch.)

Additionally configure each Network Switch, Layer 3 GigE, Type F, with four (4) Type E GBICs and four (4) Type F GBICs. Include eight (8) duplex fiber optic single-mode patch cords, 30 ft. (9 m) in length, in accordance with Section 935 and with LC-connectors on one end (at the FDC) and an LC-connector on the other end (at the network switch.)

939.2.06 GBIC Routing Switch Module

Provide a GBIC Routing Switch Module, Type B, which consists of 30-1000Base SFP GBIC ports populated with GBICs as called-out on the Plans and as specified herein. All Modules and GBICs provided shall be compatible with the Network Switch, Layer 3 GigE.

939.2.07 GBIC (Gigabit interface converter)

A. The GBICs shall meet the following minimum requirements:

1. Support single-mode operation
2. Fully compliant with IEEE 802.3z standards
3. Small Form Factor Plug-in module that Operates at 1000Mbps and full-duplex two fiber operation supporting the following types:
4. GBIC, Type LX
5. GBIC, Type EX
6. GBIC, Type ZX
7. Allow for hot swapping failed components.
8. Operate as its own switched port.
9. Support detecting and shutting down one-way link failures, using auto-negotiation.
10. The GBIC optical receiver saturation level shall be greater or equal to the maximum optical output of the mating transmitter minus 5db. Where required for manufacturer's recommended operations, provide fiber optic patch cords in accordance with Section 935 with integral optical attenuators for optical power control in accordance with the Ethernet switch (network switch, field switch, etc.) manufacturer's recommendations.
11. GBICs, all types, furnished with field switches shall meet the same environmental operating requirements as the field switch.

939.2.08 Field Switch

A. Requirements

Provide a hardened network field cabinet switch with a minimum number of ports according to the Field Switch Type. The Field Switch SFP GBIC sockets shall be populated as indicated on the Plans and shall be of SFP GBIC Type compatible with the devices it shall interface to as indicated on the Plans.

B. Functional Requirements for Field Switches (ALL TYPES)

This section defines the minimally required functional aspects for field switches. All field switch types shall meet the following minimum requirements:

1. General:
 - a. Meet the IEEE 802.3 (10Mbps Ethernet) standard
 - b. Meet the IEEE 802.3u (Fast Ethernet 100 Mbps) standard
 - c. Provide Gigabit-Ethernet SFP GBIC sockets as specified
 - d. Bit Error Ratio (number of erroneous bits divided by the total number of bits transmitted, received, or processed) shall not increase over the optical channel when two units are connected with a fiber optic jumper having total optical losses of 6dB, including connector losses
 - e. Operate with non-blocking store and forward switching at full wire speed
 - f. Minimum MTBF of 100,000 hours using Bellcore TS-332 standard.
 - g. The temperature and humidity limits of the field switch, interface modules, power supply and all other associated hardware shall adhere to NEMA TS2-2003 requirements
 - h. Switches must provide LED status indicators for the following:

- i. Power: On, Off
 - ii. Network Status per port: Transmit, Receive, Link, Speed
2. Network Capabilities and Features:
 - a. Provide full implementation of IGMPv2 and IGMP snooping
 - b. Meet the IEEE 802.3x (Full Duplex with Flow Control) standard
 - c. Meet the IEEE 802.1p (Priority Queuing) standard
 - d. Meet the IEEE 802.1Q (VLAN) standard per port for up to four VLAN's
 - e. The switch shall meet the IEEE 802.1D (Spanning Tree Protocol) and IEEE 802.1w (Rapid Spanning Tree) standards
 - f. Meet the IEEE 802.3ad (Link Aggregation) standard for a minimum of two groups of four ports
3. Port Security:
 - a. Ability to configure static MAC addresses access
 - b. Ability to disable automatic address learning per ports; known hereafter as Secure Port. Secure Ports only forward statically configured Mac addresses
 - c. Trap and alarm upon any unauthorized MAC address and shutdown. Port shutdown requires administrator to manually reset the port before communications are allowed
4. Network Management Functions:
 - a. Password manageable
 - b. Full implementation of SNMPv1 and SNMPv2c and SNMPv3c.
 - c. Full implementation of RMON I statistics, history, alarms, and events objects.
 - d. Capable of mirroring any port to any other port within the switch.
 - e. Capable of being managed remotely by an enterprise software application/program for configuration, reporting, updates, etc.
 - f. TACACS+ compatible
 - g. Environment monitoring
 - h. SNMP
 - i. Telnet/CLI/SSH
 - j. HTTP (Embedded Web Server) with Secure Sockets Layer (SSL).
 - k. Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.
5. Remote Management and Configuration
 - a. SNMP
 - b. Telnet/CLI/SSH
 - c. HTTP (Embedded Web Server) with Secure Sockets Layer (SSL).
 - d. Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.
 - e. Password manageable
 - f. Full implementation of SNMPv1 and SNMPv2c and SNMPv3c.

- g. Full implementation of RMON I statistics, history, alarms, and events objects.
- h. Capable of mirroring any port to any other port within the switch.
- i. Capable of being managed remotely by GDOT's enterprise network management system, Cisco Prime Infrastructure, for configuration, reporting, updates, etc.
- j. TACACS+ compatible
- k. Environment monitoring

Note: We are currently using Cisco Prime centralized enterprise management tool/software for remote management.

C. Additional Requirements for Field Switch Types A, B and C

Field Switch Types A, B and C shall meet the following requirements:

1. Field Switch Type A – Provide a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets.
2. Field Switch Type B – Provide a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets.
3. Field Switch Type C – Provide a minimum of eight (8) Gigabit-Ethernet SFP GBIC sockets and one 10/100 Base-T/TX port.

D. Additional Requirements for Field Switch Types D and E

Field Switch Types D and E shall meet the following requirements:

1. Provide, in the quantity specified, Gigabit-Ethernet Combo ports, where each Gigabit-Ethernet Combo port is defined as a single interface that can be used as a 10/100/1000Base-T/TX ports or 100/1000Base SFP GBIC socket.
2. Provide a card slot for a field removable SD read-write memory card (included) capable of storing all switch operating system modules and all switch configuration modules, and addressable/manageable from the switch's management interface and built-in memory system. The switch shall be capable of booting from and loading configuration from the removable memory card slot or from the built-in memory, as defined by the user.
3. Capable of global push/pull of switch operating system modules and/or switch configuration settings from the GDIT network management system.
4. Capable of operating with Layer 3 switch and routing protocols, as specified in 939.2.05, with only a change in the switch operating system.
5. Field Switch Type D – Provide a minimum of four (4) Gigabit-Ethernet Combo ports and four (4) 10/100 Base-T/TX ports.
6. Field Switch Type E – Provide a minimum of four (4) Gigabit-Ethernet Combo ports and eight (8) 10/100 Base-T/TX ports.

E. Mounting

All necessary hardware and adaptors for mounting shall be included. Provide a perforated shelf and secure with rack mounting hardware for a Field Switch that is not rack mountable with integral "rack ears."

Provide a sufficient quantity of fiber optic patch cords to match the populated optical ports on the Field Switch. Include duplex fiber optic single-mode patch cords, 3 ft. (1 m) in length, in accordance with Section 935 and with ST-connectors on one end (at the FDC) and an LC-connector on the other end (at the Field Switch.)

F. Electrical/Safety

The Field Switch shall support/comply with the following:

1. Operate from 100 VAC to 200 VAC (120VAC nominal, 60Hz) as shown on the Detail Drawings in this section.
2. Include UL approval

Provide rubber dust caps/covers with insertion/removal handles that completely seal the port opening for all unused copper and optical ports.

939.2.09 Field Switch (POE)

Field Switch (POE) is a Power Over Ethernet capable Field Switch that is to be used where POE field devices are installed and shall meet all the requirements of Field Switch as indicated in section 939.2.08 except as indicated by the following requirements:

1. Each 10/100Base-T/TX port shall be capable of providing Power Over Ethernet (POE) with each port 802.3af / 802.3at compliant.
2. Each port shall be Auto-sensing that provide power only to PoE end devices or shall be able to turn POE capability on or off on a per port basis.

A. Field Switch (POE) Types

In addition to meeting all the requirements specified herein, the Field Switch (POE) SFP GBIC sockets shall be populated as indicated on the Plans. The Field Switch types are defined as follows:

1. Field Switch (POE), Type A – provide a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets.
2. Field Switch (POE), Type B – provide a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets.
3. Field Switch (POE), Type C – provide a minimum of eight (8) Gigabit-Ethernet SFP GBIC sockets

939.2.10 Equipment Rack

Provide equipment racks as applicable and required within the equipment cabinets as specified herein.

939.2.11 Equipment Cabinet Assembly

Provide Equipment Cabinet Assemblies as show on the plans and as specified herein.

Ensure that all cabinets exhibit a smooth, uniform natural aluminum finish.

All bolts, nuts, washers, screws, hinges and hinge pins shall be stainless steel.

Manufacture the exterior mounting bracket and fixtures of aluminum or galvanized steel, and manufacture all fastening and mounting hardware of stainless steel. Verify that the bottom of the pole-mounted cabinet is fully enclosed. Where base-mounting of equipment cabinets is specified, the cabinet bottom shall be open.

Verify that all electrical cables between the cabinet and the device are UL-listed tray cable with #18 AWG 16-strand copper conductors with PVC/nylon insulation and a UV-resistant PVC outer jacket rated for 600V, 190 F (90 C) dry, 170 F (75 C) wet and wet/dry direct burial use. Conductor color-coding shall be in accordance with ICEA Table K.2/Method 1.

A. General

1. Standard Cabinet Housing
 - a. General Requirements: Unless otherwise specified, furnish cabinet housings that conform to the Cabinet Housing Details as defined in Chapter 6, Sections 2, 3 and 5 and the Cabinet Housing Details of the Caltrans Traffic Signal Control Equipment Specification, latest version (TSCES). The police panel and associated wiring circuits are not required as part of this cabinet assembly. All cabinets shall have hooks, welded to the inside of the front cabinet door, for hanging the plastic documentation pouch.
 - b. Unless otherwise specified in these Specifications or in the Plans, configure all equipment cabinet assemblies for pole mounting. The holes for pole mounting shall be properly reinforced with metal plates of adequate size and strength welded longitudinally across the inside depth of the cabinet. Where base-mounting of equipment cabinets is specified, make the cabinet bottom open and provide an approved base mounting adapter, in accordance with the Department's Standard Specification for Traffic Signal Equipment.
2. Type A Standard Cabinet Housing – Not Applicable
3. Type B Standard Cabinet Housing – Not Applicable
4. Type C Standard Cabinet Housing:

- a. The Type C cabinet housing is a standard Model 332 housing with approximate exterior dimensions of 64 in. (1.6 m) (H) x 24 in. (0.61 m) (W) x 30 in. (0.76 m) (D).
 - b. Equip all Type C cabinet housings with the standard EIA 19-inch rack cabinet cage as described in Section 3 of the Caltrans specification. Install side panels within the two sides of the cabinet cage. Each side panel shall be fabricated from 5052 sheet aluminum alloy with a minimum thickness of 0.125 in (3.175 mm).
 - c. Equip Type C cabinet housings with a cabinet sliding drawer. Follow the drawer specifications given in Subsection 939.2.11.B.1
 - d. Provide a ground fault interrupt 15A duplex receptacle (NEMA 5-15R) in the cabinet as an accessory outlet. Install two (2) non-ground fault protected 15A equipment outlet strips, each with ten (10) receptacles. Mount the strip outlets vertically near the top of the cabinet.
5. Type D Standard Cabinet Housing:
- a. The Type D cabinet housing shall be a standard Model 336 stretch (336S) housing with approximate exterior dimensions of 46 in. (1.2 m) (H) x 24 in. (0.61 m) (W) x 23 in. (0.58 m) (D). The minimum door opening dimensions shall be 40.5 in. (1.03 m) (H) x 22 in. (0.56 m) (W).
 - b. Equip all Type D cabinet housings with the standard EIA 19-inch rack cabinet cage as described in Section 3 of the Caltrans specifications. The minimum clear vertical inside dimension of the rack for equipment mounting shall be 39.5 in. (1.00 m). Install side panels within the two sides of the cabinet cage. Use side panels fabricated from 5052 sheet aluminum alloy with a minimum thickness of 0.125 in (3.175 mm).
 - c. Equip the Type D cabinet housing with a cabinet-sliding drawer. Follow the drawer specifications given in Subsection 939.2.11.B.1.
 - d. Provide a ground fault interrupt 15A duplex receptacle (NEMA 5-15R) in the cabinet as an accessory outlet. Provide rack mounted power strip outlets near the top of the cabinet. The power strip shall incorporate eight (8) NEMA 5-15R receptacles. The power strip receptacle shall face the back of the cabinet and shall be recessed within the cabinet rack to provide a minimum spacing of three (3) inches between the outlet's face and the cabinet door when the door is closed.
6. Type F Standard Cabinet Housing:
- a. The Type F cabinet housing shall be a standard ITS Cabinet Housing #3 with approximate exterior dimensions of 67 in. (1.7 m) (H) x 44 in. (1.2 m) (W) x 26 in. (0.66 m) (D) as specified in the Caltrans Transportation Electrical Equipment Specifications, latest version and all addenda (TEES). The minimum door opening dimensions shall be 56 in. (1.4 m) (H) x 20 in. (0.51 m) (W).
 - b. Equip all Type F cabinet housings with two standard EIA 19-inch rack cabinet cages as described in the Caltrans TEES. Equip all Type F cabinet housing with four (4) side mounting panels in the rack cabinet cages; side mounting panels shall mount from inside the rack cabinet cage only. The minimum clear vertical inside dimension of the rack for equipment mounting shall be 54.5 in. (1.4 m). Use side panels fabricated from 5052 sheet aluminum alloy with a minimum thickness of 0.125 in (3.175 mm) with minimum dimensions of 50 in (1.3 m) (H) x 21 in. (0.53 m) (W).
 - c. Provide a minimum of four (4) wiring pass-through holes on the inside mounting panels to permit patch cords to pass between the two cabinet sides. Each pass-through hole shall be 5 in. (127 mm) in diameter and shall be fully grommetted for patch cord protection, with the holes positioned with two (2) in the cabinet front and two (2) in the cabinet rear and aligning horizontally between the two side panels.
 - d. Provide a minimum of 16 plastic- or rubber-coated J-hooks or D-rings, minimum 1 in. (25 mm) depth and height, on the inside rails of the rack cabinet cages, to organize patch cords passing between the two cabinet sides. Install the J-hooks in horizontally-aligned pairs on the inside rails, with four (4) pairs in the cabinet front and four (4) pairs in the cabinet rear.

- e. Equip the Type F cabinet housing with two cabinet-sliding drawers. Follow the drawer specifications given in Subsection 939.2.11.B.1.
- f. Provide a ground fault interrupt 15A duplex receptacle (NEMA 5-15R) in the cabinet as an accessory outlet. Provide rack mounted power strip outlets near the top of the cabinet. The power strip shall incorporate eight (8) NEMA 5-15R receptacles. The power strip receptacle shall face the back of the cabinet and shall be recessed within the cabinet rack to provide a minimum spacing of 3 in. (76 mm) between the outlet's face and the cabinet door when the door is closed.

B. Internal Cabinet Assembly Components

1. Unless otherwise specified in the Plans or approved by the Engineer, construct all cabinet assemblies in conformance with this Subsection 939.2.11.B, all applicable provisions of the Georgia DOT Standard Specifications for Traffic Signal Equipment, and applicable provisions of the Caltrans TSCES or TEES. Do not include with the cabinet assembly the power supply assembly, power distribution assembly, input file, output file, monitor unit assembly, field terminal hookup blocks, modular/serial/control bus, AC/DC power assembly and extension, and related wiring assemblies as described in the Caltrans TSCES or TEES.
2. Provide a plastic documentation pouch to store the cabinet and equipment documentation. Use a pouch that is side-opening, re-sealable, opaque, and of a heavy-duty plastic material. Use a pouch that has metal or hard-plastic reinforced holes for hanging from hooks included on the cabinet door. The pouch shall be of the size and strength to easily hold all wiring diagrams, equipment documentation and the maintenance logbook

3. Wiring, Conductors and Terminal Blocks

All 120VAC service entrance, power distribution, grounding and protection shall be provided by components mounted on 35mm DIN standard rails. Devices include, terminal blocks, circuit breakers and surge protection devices. All DIN rail mounted components will be certified to meet or exceed UL-94, UL-467, UL-489, UL-1449, IEC-947-7-1, IEC-60947-2, CSA-22.2 or as specified in the Details or special provisions.

DIN rail mounted power distribution devices supplied shall be configured as shown in the Details and shall meet or exceed the specifications and certifications listed below.

a. Mounting Rail

Use DIN rail with pre-punched holes for mounting and certified to meet EN 50022, EN 60715 and DIN 46277-3. DIN mounting rail shall be 35mm wide, 7.5 mm high, 1 mm thick, perforated for flexible mounting and cut to length. Rail will cut between mounting holes to allow mounting at both ends of the rail section. Rail shall be provided burr free with no sharp edges or deformation from the standard profile. The portion of the rail at the mounting bolt holes shall be cleaned of any coating to expose the underlying steel. The area under the bolt hole and the aluminum power panel mounting point shall be covered with an anti corrosion paste to provide a solid and long lasting electrical connection between the DIN Rail and the power panel. DIN Rail shall be attached to the power panel by nut and bolt with star washers to provide a low resistance electrical connection between the rail and the power panel.

b. Terminal Blocks

Use DIN terminal blocks with voltage and current ratings greater than the voltage and current ratings of the wires that are terminated on the blocks. Metallic terminal block connection hardware and components shall be non-ferrous copper or nickel/tin-plated copper alloy or equivalent. All terminal blocks and wire shall be supplied in the colors listed below.

- Black – Line
- White – Neutral
- Green or Green/Yellow – Ground

c. Service Entrance Terminal Blocks

Make the terminal block for the 120VAC cabinet service entrance (SE) a 10 mm single level screw type device. The terminal block shall accommodate #20 - 6 AWG wiring and shall be provided in colors as specified herein. The Ground terminal shall be the same size and pitch as the power terminals and shall provide positive electrical and mechanical connection to the mounting rail. Ground terminals may be provided in the color green or the international green and yellow style. Provide the quantity of terminals as shown in the Details.

d. Distribution Terminal Blocks

Terminal blocks for distribution of 120 VAC (TB2) and ground located on the protected side of the power distribution assembly shall be a 6 mm single level screw type device. The terminal block shall accommodate #24-8 AWG wiring and shall be provided in colors as specified herein. The Ground terminal shall be the same size and pitch as the power terminals and shall provide positive electrical and mechanical connection to the mounting rail. Ground terminals may be provided in the color green or the international green and yellow style. Provide the quantity of terminals as shown in the Details.

e. Cross Connection Bridge

Cross connection bridge strips shall be provided to connect a number of terminal blocks to create the specified power distribution design. The bridge strips shall match the pitch and construction of the terminals to be connected and shall be certified by the terminal block manufacturer to be compatible with the connected terminal blocks. Cross connection bridge strips shall be fully insulated to prevent operator contact. Connected terminal blocks of any number shall be connected by a single cross connection bridge strip.

f. Circuit Breaker

Provide circuit breakers as shown in the Detail Drawings in this section. Use only circuit breakers that are UL-489 and CSA 22.2 approved and plainly marked with trip, frame sizes and ampere rating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Ensure that contacts are silver alloy and enclosed in an arc-quenching chamber. Overload tripping shall not be influenced by an ambient air temperature range from -18 degrees C to 50 degrees C. Minimum interrupting capacity shall be 5,000 amperes RMS. Use only circuit breakers that are 35 mm DIN rail mounted.

g. End Brackets

Provide screw-clamped end brackets to positively lock all DIN rail mounted devices to the rail.

h. Spacer

Spacers or dividers shall be placed between terminal blocks and other components as shown in the Details for visual separation. Spacers shall snap on to DIN rail be approximately 5-18 mm thick and match the size of the terminals they separate.

i. Safety Cover

A safety covers shall be provided on terminal blocks to prevent contact with exposed conductors or any metallic components. This cover will provide electrical and visual separation between terminal blocks and other rail mounted devices. Covers shall be approximately 2mm thick and sized to match the terminal blocks they protect or separate.

j. Surge Suppressor

Provide a DIN rail mounted TVSS (Transient Voltage Surge Suppressor) with RFI/EMI filtering for AC power service to the cabinet housing. The TVSS shall provide protection from all conductors to ground and meet or exceed the following requirements and levels of protection.

1. Nominal operating Voltage 120 V
2. Max. Continuous Operating Voltage 150V
3. Max. Surge Current Rating 20 kA
4. Nominal Surge Current Rating for 8x20µs surge 20 kA
5. Internal Thermal Fuses
6. Failure/ replacement indication
7. Operating Temperature: -40C to 80C
8. Meet UL1449 2nd Ed., VDE0675-6, CSA-22.2, and CE marked

k. Wiring

Use a minimum #12 AWG grounding of each surge suppression device, or larger if recommended by the surge suppression device manufacturer or indicated in the Details. Use insulated green wire and connect the ground wire directly to the ground terminals. Do not "daisy chain" with the grounding wires of other devices including other surge suppressors. Terminate all ground wiring between cabinet surge suppressor devices on the DIN rail

mounted ground terminal blocks. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the suppressor and the ground terminals. Label all surge suppressors with silk-screened lettering on the mounting panel. Use minimum #12 AWG insulated THHN-THWN conductors between the surge suppression device and the power distribution terminal.

1. Sliding Drawer

Install drawer that is an aluminum storage compartment mounted in the rack assembly with the approximate following dimensions: 1.75 in (44.4 mm) (H) x 16 in (410 mm) (W) x 14 in (360 mm) (D). Ensure the compartment has telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartment shall open to provide storage space for cabinet documentation and other miscellaneous items. Install a storage compartment that is of adequate construction to support a weight of 25 lb (11 kg) when extended. The top of the storage compartment shall have a non-slip plastic laminate attached which covers a minimum of 90% of the surface area of the top.

939.2.020 Delivery, Storage and Handling

Not applicable

939.3 Construction Requirements

939.3.01 Personnel

Have trained personnel available for troubleshooting and problem solving until all equipment is fully functional and ready to start the acceptance phase.

939.3.02 Equipment

Not applicable

939.3.03 Preparation

A. Network Equipment Programming

Perform network equipment programming and testing in accordance with the Network Equipment Programming Procedure below and as directed by the Engineer. Network equipment is defined as any traffic control and monitoring equipment with an Ethernet interface and includes equipment from these and the following GDOT Specifications and Special Provisions:

1. Section 631—Changeable Message Signs
2. Section 925—Traffic Signal Equipment
3. Section 936 – CCTV System
4. Section 937—Detection System
5. Section 938—Detection
6. Section 940—NaviGator System Integration

The Contractor is responsible for all steps, work and activities in the procedure below except when Department responsibility is expressly indicated. At all times, the Contractor is responsible for all equipment and materials, including while being programmed by the Department, and including operation, warranties, and technical support.

Coordinate all aspects of the procedure through the Engineer.

Perform all network equipment programming for a complete project at one time. The Contractor may request in writing for a staged equipment programming; provide a plan with schedule for the complete project that details all of the proposed stages and identifies all network equipment and field sites for each stage. If approved by the Department, the procedure below applies independently and fully to each individual stage. Field sites will always be programmed concurrently for all of the equipment at that site.

Materials submittal reviews for all network equipment, and related equipment, shall be successfully completed prior to beginning the Network Equipment Programming Procedure.

Step 1

Request in writing for GDOT to prepare and provide the basic equipment programming data. The request shall clearly identify the project. If the Contractor desires a staged equipment programming, that request must be identified at this time and the staging plan must be submitted.

Step 2

Once the Contractor's request is complete, the Department will provide the basic equipment programming data within 45 days from the Department's acceptance of the Contractor's request. Basic equipment programming data will include the IP address, subnet, and gateway for each network device. The programming data will be provided in spreadsheet form.

Step 3

Complete installation of all field equipment, including but not limited to support poles, equipment cabinets, power service, field and network devices, and fiber communications infrastructure. Complete all basic equipment programming. Furnish Network Switch GBICs to GDOT. Furnish all fiber patch cords in the hub(s) but make no connections to the Network Switch. Provide in spreadsheet form the equipment model numbers, serial numbers, MAC addresses, and firmware revision numbers for each network equipment device in its installed location. Complete all field testing required prior to the Interim Field Subnet (IFS) test, and conduct an IFS test dry-run.

Step 4

Request in writing to begin the IFS test a minimum of 30 days in advance of the desired start date. Conduct IFS test in the presence of the Engineer. If the IFS test fails, identify the defects and make corrections, provide a written report on the diagnosis and corrections made, and request in writing an IFS retest a minimum of 14 days in advance of the desired start date.

Step 5

Upon successful and accepted completion of IFS testing, the Department will have 45 days to complete all network and system programming and NaviGator integration of the field devices and hub equipment. Continue with all remaining field construction that has no impact on any equipment or communications infrastructure associated with the network programming. Any disruption of the equipment or communications infrastructure shall result in stopping the 45 day period for Department programming.

Step 6

The Department will notify the Contractor when network programming is successfully completed, at which time the Network Equipment Programming Procedure will be considered completed. Continue with all remaining project activities, including remaining acceptance testing.

939.3.04 Fabrication

Not applicable

939.3.05 Construction

A. Equipment

1. Installation

Install all equipment in new and/or existing equipment racks and equipment frames in accordance with the equipment manufacturer's recommendations, including mounting, interconnection wiring, and electrical service. Furnish and install all mounting hardware and incidental materials, including fasteners and auxiliary supporting frames/brackets, as recommended by the manufacturer. Furnish and install all miscellaneous hardware, materials, wiring/cabling, configuration, and any other incidental items necessary for fully operational components and subsystems shown in the Contract Documents and Section 940 of the Standard Specifications, except when specifically identified as existing or as work to be performed by the Department.

Work in this project may require access to various Department buildings and Hubs requiring coordination of all work activities in these locations with the Engineer before access is needed. Work in this project requires system configuration tasks to be performed by the Department before some Contractor-installed items can be brought online and completely system tested. Coordinate all work activities needing system configuration with the Engineer a minimum of 14 days prior to any testing.

Install all Hub and control center equipment in the presence of the Engineer. Locate new equipment in new or existing equipment racks or equipment frames as shown in the Plans.

Provide proper electrical service, including grounding and current rating, in the equipment racks and equipment frames for all hardware installed under this project. This requirement includes existing and new equipment racks and equipment frames. Obtain Engineer approval prior to installation of all electrical service for hardware in control centers. Furnish and install additional power outlet strips in new and existing equipment racks and equipment frames if needed for the new equipment.

For any equipment that is not rack mountable with “rack ears”, provide perforated shelves and secure all shelf-mounted equipment with rack mounting hardware.

Label all wiring and cabling, including building entrance cables, jumper and patch cords, and power supply cables, using cable identification numbers as shown in the Plans or provided by the Engineer. Apply cable labels at each end and in the center of the cable. Cable labels shall consist of permanent ink printed or legibly written on self-laminating and over-wrapping label material.

Protect cable ends at all times with acceptable end caps. Never subject any coaxial cable to a bend radius of less than six (6) inches. Provide grommets, guides and/or strain relief material where necessary to avoid abrasion of or excess tension on wire and cable.

2. Serial Data Terminal Server

For Hubs, install the Serial Data Terminal Servers, 16 Port, in equipment frames as shown in the Plans and in accordance with the Manufacturer’s recommendations. For equipment cabinets and as required, install the Serial Data Terminal Servers, Type B, as shown in the Plans and in accordance with the Manufacturer’s recommendations. Furnish and install all interconnection wiring and power service connections.

3. Patch Cords

a. General Requirements:

- i. Use patch cords only within control center buildings, communication Hubs, and equipment cabinets.
- ii. Label all patch cords using cable identification numbers as shown in the Plans or provided by the Engineer. Apply cable labels at each end and in the center of the cable. Use printer-generated adhesive overlapping cable labels.
- iii. Neatly route, dress and secure patch cords in the equipment racks or frames and at both ends. Use all available cable management devices and/or trays. Route patch cords only vertically on the sides of the equipment racks and frames or horizontally across the bottom or top of the racks and frames; no diagonal routing is permitted. Follow all manufacturer’s recommendations including bend radius requirements during all patch cord installation.

b. Fiber Optic Patch Cords: Furnish and install fiber optic patch cords in accordance with Section 935 and this section.

c. Coaxial Video Patch Cords: Where an equipment or termination facility has a connector other than BNC (such as an RCA), furnish and install a BNC adapter to connect the patch cord to the equipment or termination facility.

d. Data Patch Cords: Use data patch cords to connect all local area network and RS-standard (e.g., RS-232, RS-422/485) serial data termination facilities and equipment.

Where an equipment or termination facility has a connector other than an RJ45 outlet (such as a “D-shell” connector), furnish and install RJ45 adapters between the connectors and the network/data patch cords as approved by the Department. For any type of RJ45 adapter, provide the proper pin-out of the adapter as part of the documentation.

e. Network Switch / Field Switch Patch Cables: Furnish and install Category-5e unshielded twisted pair (UTP)/shielded twisted pair (STP) patch cables that comply with EIA/TIA-568 (current edition) for all network to device interconnects (device to switch). The maximum length of Category-5e cable should not exceed 250 feet. In no case shall the total cable distance (device to switch) including risers, connectors, and connecting patch cables exceed 300 feet (90 meters). All cables over 250 feet shall be tested for transmission capability and cable certification using a Network Tester. All tests shall be performed with the Engineer present.

- f. Voice/Telephone Patch Cords: Use voice/telephone patch cords to connect all voice or telephone communications facilities and equipment. Furnish and install the voice/telephone patch cords with the necessary pair sizing and connector for the equipment being connected.

4. Network Switch, Layer 3 Gig-E

For Hubs, furnish and install Network Switches, Layer 3 GigE that are compatible with the existing NaviGator Ethernet network as shown in the Plans, as applicable. The existing network consists of Nortel Networks 8600 Layer 3 GigE switches.

Furnish and install the network switch and all fiber optic jumper cabling necessary to connect to the fiber optic cable FDC as shown in the Plans.

5. Hub Uninterruptible Power Supply

Furnish and install a dedicated electrical service branch circuit from the Hub main service panel for the UPS system. Ensure that the UPS system branch circuit is in accordance with all recommendation of the UPS manufacturer, including the provision of a locking plug/receptacle connection. Make all electrical conduit and fittings rigid EMT or approved equivalent. Locate the branch circuit receptacle as close as possible to the UPS mounting position to minimize the UPS input line cord and to minimize tripping hazards.

Configure the electrical service inputs for all network switches, serial data terminal servers, video encoders/decoders, and video switches to be supplied by the UPS. Furnish and install line cords, power strips, and all incidental materials to configure the UPS service to the above equipment.

B. Communications Subsystem

1. General

- a. Use Network Switches, Layer 3 Gig-E, Field Switches, Serial Data Terminal Servers, and Video Encoders/Decoders, as necessary or required to establish:

For Traffic Signals, digital data communications between local controllers and system masters and to and from Hubs and control centers

For Ramp Meters, digital data communications to and from equipment cabinets/Hubs/control centers

Digital camera video and control data communications to and from equipment cabinets/Hubs/control centers

Digital CMS control data communications to and from equipment cabinets/Hubs/control centers

Digital detector data communications to and from equipment cabinets/Hubs/control centers

Digital VDS processor control data communications to and from equipment cabinets/Hubs/control centers

- b. Furnish and install Network Switches, Layer 3 Gig-E, Field Switches, Serial Data Terminal Servers, and Video Encoders/Decoders, as necessary or required as specified in the Plans to ensure proper communications.

2. Installation Requirements

- a. Install all communications equipment and materials necessary for a complete communications path from the field site to the control center or communications Hub as shown in the Plans. Furnish and install all mounting and interconnection materials, including but not limited to card cages, mounting panels and rack hardware, fiber, patch/jumper cables, and power supply cables. Mount card cages and mounting panels as shown in the Plans and Detail Drawings in this section. Furnish and install the type and quantity of equipment shown in the Plans. Where the Plans show that new Field Switches, Video Encoders, VDS System Processors, Modems, and/or other devices are to be placed in existing cabinet space, furnish and install compatible mounting hardware, as required.
- b. Label all wiring and cabling, including entrance cables, jumper and patch cords, and power supply cables. Cable labels shall consist of permanent ink printed or legibly written on self-laminating and over-wrapping label material.
- c. Equipment Cabinet Mounting: All field equipment shall be mounted in a manner as to not restrict the replacement of other components in the cabinet housing.

- d. Hub/Control Center Mounting: Where data is transmitted to a receiving end such as a Hub, TCC or TMC, permanently mount the equipment as required within an equipment rack, frame.
3. Equipment Cabinet Assembly
 - a. General Requirements

Furnish and install the equipment cabinet assembly to include all devices/components, assembly, wiring and materials required in this Subsection 939.3.05.C and in Subsection 939.2.11.B.

The equipment cabinet assembly, as described below, shall conform to all applicable sections of the Caltrans specifications and Georgia DOT Standard Specifications.
 - b. Classification of Types
 4. Furnish and install equipment cabinet assemblies as called for in the Plans in accordance with the following requirements for each type.
 - a. Type A Cabinet – Not Applicable.
 - b. Type B Cabinet – Not Applicable.
 - c. Type C Cabinet: Furnish and install a Type C Cabinet that conforms with all materials and installation requirements of this Subsection 939.3.05.C and Subsection 939.2.11.B using a Type C Standard Cabinet Housing.
 - d. Type D Cabinet: Furnish and install a Type D cabinet assembly that conforms with all materials and installation requirements of this Subsection 939.3.05.C and Subsection 939.2.11.B using a Type D Standard Cabinet Housing.
 - e. Type F Cabinet: Furnish and install a Type F cabinet assembly that conforms with all materials and installation requirements of this Subsection 939.3.05.C and Subsection 939.2.11.B using a Type F Standard Cabinet Housing.

939.3.06 Quality Acceptance

The Engineer, based on justification of public interest, may order any completed or partially completed portions of the project placed in service. Such action is not an acceptance of the project in whole or in part, nor is it a waiver by the Engineer of any provision of the specifications. Assume no right to additional compensation or extension of time for completion of the work or any other concession because of the use of the project or any part thereof prior to final acceptance of the completed project. Fully maintain all equipment prior to final acceptance, which includes but is not limited to equipment configuration and communication systems.

Perform all acceptance testing in the presence of the Engineer. Notify the Engineer of a desired acceptance test schedule no less than 14 calendar days prior to beginning the testing except for testing using the NaviGator software and existing NaviGator control center and communications equipment. For acceptance testing using the NaviGator software and existing NaviGator control center and communications equipment, coordinate the testing schedule with the Engineer no less than 30 days prior to the start of this testing. Do not conduct any testing during any State or Federal holiday.

A. Equipment

1. General

Coordinate all work activities needing system configuration with the Engineer a minimum of 14 days prior to any testing.

Work in this project includes furnishing specific equipment to the Department for configuration and use by the Department during the course of the project. Operate this equipment and maintain the proper configuration until final acceptance of the project, including throughout the project duration after the Department has started using the equipment.

2. Start-up Testing

Provide start-up testing for the various devices supplied as described herein and as further detailed in the respective equipment specification section.

The Contractor shall provide a test plan and procedures for review and approval by the Engineer prior to any testing. The Contractor shall conduct a pre-test prior to contacting the Engineer prior to final inspection. Pretest shall be defined as all tests that are performed for the Engineer during inspection. The Contractor shall provide all test equipment and software necessary to perform the tests. Perform all tests in the presence of the Engineer unless otherwise specified.

Include in the test plan and procedures, as a minimum, the following tests:

- a. Device or system power-on self-test
- b. Conduct visual inspection of device or system to confirm presence of all components and features specified by the Contract specifications and otherwise customarily provided by the manufacturer
- c. Test using the built-in manufacturer's product or system diagnostics to confirm proper performance
- d. Test all input and output ports
- e. Demonstrate that all functional features of the device or system are operational
- f. An operational test demonstrating equipment performs as intended and as prescribed by the manufacturer and meets the requirements of the Contract specifications.
- g. Configure the components of the device, make necessary settings or adjustments, and power-on according to the manufacturer's instructions.

3. Serial Data Terminal Server

Prior to acceptance of any Serial Data Terminal Servers (all Types), the following shall be performed:

- a. Connect with serial cable to Serial Data Terminal Server with PC or laptop using HyperTerminal.
- b. Ensure that the Serial Data Terminal Server recognizes all ports and attached expansion modules.
- c. Input addressing for Serial Data Terminal Server and reset.
- d. Determine successful Ethernet connectivity (link light at Hub/switch).
- e. Successfully telnet from PC or laptop to Serial Data Terminal Server through Hub/switch.
- f. Print to screen configuration information that is consistent with addressing data previously entered into Serial Data Terminal Server.

4. Field Switches

Prior to acceptance of any Field Switch (all Types), the following shall be performed:

- a. Stand-alone Acceptance Test (SAT)
 - i. The Contractor shall provide the test plan and procedures for review and approval by the Department prior to any SAT activities. The test procedures shall provide comprehensive tests to verify and demonstrate full compliance with these specifications and device functionality. Pass and fail criteria shall be identified for each test for review and approval by the Department.
 - ii. The Contractor shall provide all test equipment and software necessary to perform the tests.
 - iii. The Department will perform the SAT in a test area provided by the Department. A Contractor representative shall be present during the SAT.
 - iv. The Field Switch will be assembled and connected to power in a stand-alone configuration.
 - v. The Field Switch will be powered up and allowed to initialize, boot and run self-diagnostic tests as defined in the Department-approved test procedures.
 - vi. After the Field Switch has started and initialized, test procedures will be executed.
 - vii. After the test procedures have been executed, the Field Switch will be allowed to run, uninterrupted, for period of seventy-two (72) hours and then rebooted. The switch shall hold all

settings and configurations through reboots and power failures. Once this is confirmed the 30 day burn-in period would then begin.

- viii. At the end of the burn-in period, the unit will be re-started and configuration verified.
- ix. Upon completion of all test procedures, the Contractor will be notified of SAT Field Switch acceptance or failure. If the unit fails the test, the Contractor shall replace it at no additional cost to the Department and the test procedure shall be re-started.

b. Operational Test

- i. The Contractor shall provide the test plan and procedures for review and approval by the Department prior to any Operational Test activities. The test procedures shall provide comprehensive tests to verify and demonstrate full compliance with these specifications in regards to device or subsystem network performance. Pass and fail criteria shall be identified for each tests for review and approval by the Department.
- ii. Upon completion of all test procedures, the Contractor will be notified of SAT Field Switch acceptance or failure. If the unit fails the test, the Contractor shall replace it at no additional cost to the Department and the test procedure shall be re-started.
- iii. The Contractor shall provide all test equipment and software necessary to perform the tests.
- iv. After successful completion of the SAT, the Department will configure and connect the Field Switch to the GDOT Network.
- v. Verify communications and network control from the Field Switch to/from the Hub and TMC.
- vi. Verify system integrity through comprehensive diagnostics.
- vii. Verify 10/100Base-T/TX interfaces and operations.
- viii. Verify 1000Base-X interfaces and operations.
- ix. Upon completion of all the tests, the Contractor will be notified of Operational Field Switch acceptance or failure. If the unit fails the test, the Contractor shall replace the unit at no additional cost to the Department and the test procedure shall be restarted.

5. Interim Field Subnet Test

Prior to acceptance of any network communications equipment or field device connected to the communications network, perform and successfully complete an Interim Field Subnet (IFS) test. All Start-Up and Standalone testing shall be successfully completed on all devices before an IFS test can begin. Include in the IFS test all network communications devices in the project, including but not limited to all field switches, video encoders and decoders, VDS processors, CMS controllers, microwave radar detectors, serial data terminal servers, ramp meter signal controllers, and traffic signal controllers.

- a. Provide the test plan and procedures for review and approval by the Department prior to any IFS activities. The test procedures shall provide comprehensive tests to verify and demonstrate full compliance with these specifications and device functionality. Pass and fail criteria shall be identified for each test for review and approval by the Department. The test procedures shall identify all field sites and devices in the project, as well as the field subnets the sites are attached to.
- b. Furnish all test equipment and software necessary to perform the tests, including but not limited to laptop PC with web browser and network analysis software, temporary field switch or other compatible media converter, and all necessary patch cords.
- c. Prior to conducting a scheduled IFS test, conduct a dry-run test to ensure all preparations for the IFS test are complete. The Engineer reserves the right to attend the dry-run test.
- d. An IFS test shall be conducted for each field subnet, which is typically a group of field sites connected to a fiber pair ring between two hubs. The test shall be conducted from one of the hubs. During the test, every network device shall be pinged, probed by SNMP or equivalent status queries, logged into, and connected to by other methods as needed to demonstrate that the equipment is functional, contains the proper base programming data, and is in the proper location.

939.3.07 Contractor Warranty and Maintenance

Provide a 3 year Manufacturer's support (usual and customary warranties) period for all equipment and materials furnished and installed as part of the Communications and Electronic Equipment System. Include in warranty and support all Contractor or Manufacturer activities related to maintenance, removal and replacement of parts and materials during the period of support. Begin the Manufacturer warranty support period upon successful completion of equipment cabling and component testing as outlined in Subsection 939.3.06. All Manufacturer warranties shall be continuous throughout the period and state that they are subject to transfer to the Department.

939.3.08 Training

Provide training as required herein. Include with training all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training. Furnish a training notebook in a labeled 3-ring binder to each trainee.

Provide installation, operations, and maintenance training on the equipment at a site near the project area. Personnel trained by the various equipment manufacturers and authorized by said manufacturers shall perform the training. Provide installation, operations and maintenance training for up to twelve (12) people. Include in this training both classroom training and hands-on training. Limit in-shop and in-field training to group sizes of four (4) people at a time. Conduct all training in half-day sessions. Two half-day sessions may be held on the same day. The total of the training shall consist of at least six (6) clock hours of training for each participant. Provide a course content of, at a minimum, the following:

A. Field Switches

1. Unit set-up and configuration
2. Diagnostic and maintenance
3. Performance tuning
4. Hands-on use of Field Switches for each trainee

939.4 Measurement

A. Equipment

For each equipment unit listed below, furnish and install all mounting and interconnection materials, including but not limited to card cages, mounting hardware, all patch cords of all types, and power strips and power supply cables at no separate cost to the Department. If software device drivers/communication protocols not currently incorporated into NaviGator software are needed, provide and integrate them at no separate cost to the Department.

1. Serial Data Terminal Server

Serial Data Terminal Servers (16 Port and all Types) are measured for payment by the number actually installed, complete, functional and accepted. For each unit provided, furnish and install any required Serial Data Terminal Servers and serial port concentrators as specified in Subsection 939.2.A.2 and in the Plans at no separate cost to the Department.

2. Hub Uninterruptible Power Supply

Hub Uninterruptible Power Supplies are measured for payment by the number actually installed, complete, functional and accepted.

3. Network Switch, Layer 3 Gig-E

Network Switches, Layer 3 GigE (all Types) are measured for payment by the number actually installed, complete, functional and accepted. For each unit provided, furnish and install any required switching Hubs, router and switching chassis as specified in Subsection 939.2.A.5 and in the Plans at no separate cost to the Department.

4. GBIC Routing Switch Module

GBIC Routing Switching Modules (all Types) are measured for payment by the number actually installed, complete, functional and accepted.

5. GBICs

GBICs (all Types) are measured for payment by the number actually installed, complete, functional and accepted.

6. Field Switches:

Field Switches (all Types) with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

7. Field Switches with Power Over Ethernet (POE)

Field Switches (POE) (all Types) with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

8. Equipment Frame

Equipment frames are measured for payment by the number actually installed, complete, functional and accepted.

B. Equipment Cabinet Assembly

Equipment cabinet assemblies are measured for payment by the number actually installed, complete, functional and accepted. For each unit installed, furnish all required items, including but not limited to identification and documentation, lighting, contact switch, fan, contact-closure sensor, patch cords, and cables at no separate cost to the Department.

C. Testing

Testing is to be included in the cost of the project and providing the devices.

D. Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training. Include in the lump sum bid price for training all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

939.4.01 Limits

Not applicable

939.5 Payment

Payment is full compensation for furnishing and installing the items complete in place according to this Specification. Payment for all items is as follows:

Item No. 939	Serial Data Terminal Server, 16 Port and Type _	Per Each
Item No. 939	Type__ Cabinet	Per Each
Item No. 939	Network Switch, Layer 3 Gig-E, Type _	Per Each
Item No. 939	GBIC Routing Switch Module, Type _	Per Each
Item No. 939	GBIC, Type _	Per Each
Item No. 939	Field Switch, Type _	Per Each
Item No. 939	Field Switch (POE), Type _	Per Each
Item No. 939	Hub Uninterruptible Power Supply	Per Each
Item No. 939	Equipment Frame	Per Each
Item No. 939	Training	Lump Sum

939.5.01 Adjustments

Not applicable