

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

SPECIAL PROVISION

**P.I. No.: 0010782
DISTRICT 7**

Section 939—Communication and Electronic Equipment

Delete Section 939 and substitute the following:

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

- 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.
- 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 as shown in the Detail Drawings in this section.
- 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).

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 – Video Detection System

Section 938 – Detection

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

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

The following chart provides the Contractor with an outline of the submittal requirements for the equipment and components 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	X	X	60 Days
Patch Cords	939.2.03	X	X					60 Days
Hub UPS	939.2.04	X	X		X	X	X	60 Days
Network Switch, Layer 3 Gig-E (All Types)	939.2.05	X	X	X	X	X	X	60 Days
GBIC Routing Switch Module (All Types)	939.2.06	X	X	X	X	X	X	60 Days
GBICs (All Types)	939.2.07	X	X	X	X	X	X	60 Days
Field Switch (All Types)	939.2.08	X	X	X	X	X	X	60 Days
Video Encoder (All Types)	939.2.09	X	X	X	X	X	X	60 Days
Video Decoder (All Types)	939.2.10	X	X	X	X	X	X	60 Days
Equipment Rack	939.2.11	X	X	X	X			60 Days
Equipment Frame	939.2.12	X	X	X	X			60 Days
Dial-up modem	939.2.13	X	X		X	X	X	60 Days
Equipment Cabinet Assembly (All Types)	939.2.13.A	X	X		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 Special Provisions, 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

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, equipment racks, equipment frames, and dial-up modems.

Submittal Review Demonstration Test Set

Submit demonstration test set(s) for Department evaluation after the Engineer approves the submittal materials for the equipment and materials listed below. The demonstration test sets shall be connected to and operated through the NaviGator system by the Engineer. Deliver the test set to the Department at the location specified by the Engineer. Request a delivery and test time a minimum of 30 days in advance. Provide demonstration test sets of the materials, types and quantities as shown below:

- Serial Data Terminal Server, all types (quantity 2 of each type)
- Network Switch, Layer 3 Gig-E, all types (quantity 1 of each type)
- Field Switch, all types (quantity 4 of each type)
- Video Encoder, all types (quantity 2 of each type)
- Video Decoder, all types (quantity 2 of each type)

A demonstration test set shall include all materials, components, assemblies, control software and documentation of the equipment and shall be complete and fully functional for communications with the NaviGator system. All equipment shall be configured for locating on a benchtop, or else provide a desktop stand to secure the equipment. Provide a high-density chassis cage for video encoders and decoders when the cage is required on a project. Provide an RS232 serial cable for console connection for each type of equipment item. Provide a NEMA 5-15 cord for power service to all equipment.

Review of the demonstration test set submittal shall be conducted in two parts. The first part of the review shall be performed by the Contractor in the presence of the Engineer and shall include the setup and configuration of the demonstration test set on the NaviGator system. The first part of the review shall be conducted during normal Department weekday business hours and shall be conducted for the period of time necessary to the satisfaction of the Engineer. The second part of the review shall be a 60-day period during which the Engineer shall operate and evaluate the demonstration test set with the NaviGator system. The second part of the review shall commence only upon the Engineer's approval of the first part of the review. Retrieve the demonstration test set upon completion of the second part of the review as notified by the Engineer.

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.

C. Equipment Cabinet Assembly

Submit materials submittal data for the equipment cabinet and all individual component and hardware items that make up the complete assembly. These items shall include, but are not limited to, cabinet shell specifications, electrical component description and performance specifications, wiring and cabling equipment and materials, electrical/power specifications, and all documentary items.

Submit materials submittal data for all materials and hardware necessary for the patch and electrical cabling, conduit and power service. These items include but are not limited to cabling, wire and conduit materials, service disconnect breaker/surge suppression/termination/housing description and performance specifications, ground rod and conductor, proposed conduit route from service point to equipment cabinet, and all miscellaneous hardware and accessories.

Submit and provide all equipment cabinet assemblies and corresponding ancillary and incidental materials of a like kind from 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, cabinet housings, internal cabinet assembly components, and electrical components including surge suppressors, terminal blocks, rack-mount equipment outlets, and side and support panels.

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.

Ensure all terminal servers meet the following requirements:

- Compatible with the existing NaviGator serial port control system.
- IP addressable supporting Ethernet 10/100Base-T/TX with RJ45 port.
- RS-232 serial ports with RJ45 ports.
- Management access by HTTP, telnet, and console ports, all password protected.
- SNMP read/write management of terminal server and individual serial ports.
- Each serial port individually configurable comm. settings and TCP/UDP socket support.
- Each serial port with minimum 64kbps buffering and data capture.
- Firmware upgradeable by FTP/TFTP.
- Upload/download of configuration settings.
- Diagnostic LEDs for Ethernet connection and unit status.
- UL approval.

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

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

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

- Operating temperature of unit and power supply of -31°F to 165°F (-35°C to 74°C).
- Conformal-coated circuit boards.
- Capable of being panel-mounted, rack-mounted and shelf-mounted in equipment cabinets.
- Minimum of two (2) RS-232 ports mounted on the front of the unit.
- Internal or external 120VAC power supply.

939.2.03 Patch Cords

General Requirements:

- a. 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.
- b. 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.
- c. 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.

- d. Network/Field Switch/Data Patch Cords: Verify that network//field/data patch cords meet all ANSI/EIA/TIA requirements for Category-6 4-pair unshielded twisted pair cabling with stranded conductors and RJ45 connectors.
- e. 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.
- f. 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. Provide a Hub UPS meeting the following requirements:

- 19" rack mounted, maximum height of six (6) rack units (10.5").
- 120 VAC single phase 60 HZ output
- Input line cord plug type NEMA L5-30P
- 8 output receptacles type NEMA5-15R
- Pure sine wave output at 115 VAC +/- 5%
- Transfer time of 4 ms or less
- Capacity of 2200 VA/1600 W
- Load factor range of 0.5 to 1.0
- Peak current capability of 6.5 KVA
- Software adjustable high and low voltage buck/boost function
- SNMP manageable hardware and software with 10Base-T connection (RJ-45)
- 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.
- Remote environmental sensing hardware and software integrated with SNMP minimally capable of temperature and humidity monitoring and 4 dry contact closures
- Network connection to Ethernet port on Hub Network Switch, Layer 3 GigE
- Printed and electronic user documentation for all management, configuration and operation hardware and firmware settings, installation procedures, and the MIB.
- Sealed maintenance-free lead-acid batteries
- Maximum audible noise of <53 dBA at 3 ft (0.9 m).
- Upgradeable for increased runtime capacity (minimum 2.5X) with additional battery packs
- 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 Nortel Networks 8600 Layer 3 routing switches. The network switches shall be manageable using the Department's existing Device Manager network management software. Furnish and configure the network switches as complete compatible assemblies. Configure the network switch(es) at the locations shown in the Plans, as applicable, to the following minimum requirements:

- Minimum 6-slot chassis with hot-swappable card capability

- Two (2) Enterprise Routing Switch Module CPU/Switch Fabric Modules with PCMCIA flash memory card and a processing capability of 380 million packets-per-second
- One (1) 30-port 1000 Base SFP GBIC Routing Switch Module.
- One (1) 48-port auto-sensing 10/100/1000 Base-T/TX Ethernet Layer 3 switching interface Module.
- Three (3) 100-240VAC power supplies including North American power cables, configured for 120VAC service
- Ethernet Routing Switch 8600 software license, latest version, including license, agent software, management software, and all software documentation
- EIA 19" rack mounted

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 ST-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 ST-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)

The GBICs shall meet the following minimum requirements:

- a. Support single-mode operation
- b. Fully compliant with IEEE 802.3z standards
- c. Operate at 1000Mbps and full-duplex two fiber operation supporting the following types:
 - GBIC, Type A (LX): (SMFO at 1310nm); optical link budget: 10.5dB, typical
 - GBIC, Type B (XD): (SMFO at 1550nm); optical link budget: 17.0dB, typical
 - GBIC, Type C (ZX): (SMFO at 1550nm); optical link budget: 22.0dB, typical
 - GBIC, Type D (SFP LX): (SMFO at 1310nm); optical link budget: 10.5dB, typical
 - GBIC, Type E (SFP XD): (SMFO at 1550nm); optical link budget: 17.0dB, typical
 - GBIC, Type F (SFP ZX): (SMFO at 1550nm) optical link budget: 20.0dB, typical
 - GBIC, Type G (SFP SX): (MMFO at 850nm) optical link budget: 7.0dB, typical
- d. Allow for hot swapping failed components.
- e. Operate as its own switched port.
- f. Support detecting and shutting down one-way link failures, using auto-negotiation.
- g. 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.
- h. GBICs, all types, furnished with field switches shall meet the same environmental operating requirements as the field switch.

939.2.08 Field Switch

All Field Switches shall meet the following requirements:

a. General Characteristics and Capabilities:

- 1) Meet the IEEE 802.3 (10Mbps Ethernet) standard.
- 2) Meet the IEEE 802.3u (Fast Ethernet 100 Mbps) standard
- 3) Provide Gigabit-Ethernet SFP GBIC sockets as specified in Field Switch Types subsection.
- 4) Provide a minimum of six (6) 10/100 Base-T/TX ports unless otherwise specified in the Field Switch Types subsection. Each 10/100Base-T/TX port shall connect via RJ45 connector. The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over 100m segment lengths and provide auto-negotiation.
- 5) 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.
- 6) Operate non-blocking, at full wire speed
- 7) Support remote reset and remote management
- 8) Minimum MTBF of 100,000 hrs using Bellcore TS-332 standard.

b. Network Capabilities and Features:

The Field Switch shall support/comply with the following minimum requirements:

- 1) Provide full implementation of IGMPv2 and IGMP snooping
- 2) Meet the IEEE 802.3x (Full Duplex with Flow Control) standard.
- 3) Meet the IEEE 802.1p (Priority Queuing) standard.
- 4) Meet the IEEE 802.1Q (VLAN) standard per port for up to four VLAN's.
- 5) The switch shall meet the IEEE 802.1D (Spanning Tree Protocol) and IEEE 802.1w (Rapid Spanning Tree) standards.
- 6) Meet the IEEE 802.3ad (Link Aggregation) standard for a minimum of two groups of four ports.
- 7) Full implementation of GVRP (Generic VLAN Registration Protocol).

c. Port Security:

The Field Switch shall support/comply with the following (remotely) minimum requirements:

- 1) Ability to configure static MAC addresses access
- 2) Ability to disable automatic address learning per ports; know hereafter as Secure port. Secure Ports only forward statically configured Mac addresses.
- 3) Trap and alarm upon any unauthorized MAC address and shutdown. Port shutdown requires administrator to manually reset the port before communications are allowed.

d. Network Management Functions:

The Field Switch shall support/comply with the following minimum requirements:

- 1) Password manageable
- 2) Full implementation of SNMPv1 and SNMPv2c.
- 3) Full implementation of RMON I statistics, history, alarms, and events objects.
- 4) Capable of mirroring any port to any other port within the switch.

e. Remote Management and Configuration:

The Field Switch shall support/comply with the following minimum requirements:

- 1) SNMP
- 2) Telnet/CLI
- 3) HTTP (Embedded Web Server) with Secure Sockets Layer (SSL).
- 4) Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.

f. Mounting:

The Field Switch shall be rack mountable as shown on the Detail Drawings in this section. 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.)

g. Environmental:

The Field Switch shall support/comply with the following minimum requirements:

- 1) Operate between -34 to +74 degree Celsius. (-29°F to +165°F). No fans are permitted.
- 2) Operate from 10% to 90% humidity
- 3) Maximum size of 1 rack unit high by 12.5 in (320 mm) deep

h. 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) The Field Switch shall be provided with all power conversion which is temperature hardened from -34 to +70 degrees Celsius (-29°F to +165°F) and all regulation necessary to support electronics operation. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under voltage condition.
- 3) All power transformers provided shall be “fastening mechanism” type. No plug-in types will be provided. All corded transformers shall be mountable with the ability to neatly secure power cords.
- 4) Include UL approval
- 5) Provide rubber dust caps/covers with insertion/removal handles that completely seal the port opening for all unused copper and optical ports.

i. Status Indicators:

The Field Switch shall support/comply with the following minimum requirements:

- 1) Power: On, Off
- 2) Network Status per port: Transmit, Receive, Link, Speed
- 3) Status indicators shall be LED.

j. Field Switch Types:

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

- Field Switch, Type A – provide a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets, populated with three (3) GBIC, Type D (SFP LX)
- Field Switch, Type B – provide a minimum of three (3) Gigabit-Ethernet SFP GBIC sockets, populated with one (1) GBIC, Type D (SFP LX) and two (2) GBIC, Type E (SFP XD)

- Field Switch, Type C – provide a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets, populated with two (2) GBIC, Type D (SFP LX)
- Field Switch, Type D – provide a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets, populated with one (1) GBIC, Type D (SFP LX) and one (1) GBIC, Type E (SFP XD)
- Field Switch, Type E – provide a minimum of two (2) Gigabit-Ethernet SFP GBIC sockets, populated with two (2) GBIC, Type E (SFP XD)
- Field Switch, Type F – provide a minimum of eight (8) Gigabit-Ethernet SFP GBIC sockets, populated with four (4) GBIC, Type D (SFP LX). One 10/100 Base-TX port is required unless otherwise specified.
- Field Switch, Type G – provide a minimum of (3) Gigabit-Ethernet SFP GBIC sockets, populated with two (2) GBIC, Type D (SFP LX) and one (1) GBIC, Type E (SFP XD)

939.2.09 Video Encoder (All Types)

Provide a Video Encoder in accordance with the minimum requirements below for the encoding of analog video inputs and transmission as digital streams over a network.

A. Video Encoder, Type B

Video Encoder, Type B is a standalone, environmentally hardened encoder for a single video signal, suitable for field cabinet use.

1. General

a. Chassis

- 1) Furnish rack-mountable or shelf-mountable units.
- 2) Rack-mountable units shall include integrated brackets for mounting in standard EIA 19-inch rack rack-mountings, and shall be no more than one (1) rack unit (1.75 inches (45 mm)) high and 13 in. (330 mm) deep.
- 3) Shelf-mountable units shall be no more than 3.5 in. (89 mm) (H) x 9 in. (229 mm) (W) x 11 in. (280 mm) (D), and shall include a perforated ventilated shelf for mounting in a standard EIA 19-inch rack, no more than 13 inches (330 mm) deep with mounting flanges of two (2) rack units (3.5 in. (89 mm)) and a minimum 20 lb (9 kg) load rating.

b. Labeling and Identification

- 1) Provide external silk-screened markings for all connectors, indicators, switches, and replaceable components.
- 2) Provide external labeling on the front or rear enclosure face for the manufacturer's name, product, model and part numbers, revision numbers, serial number, and MAC address.

c. Environmental

- 1) Operating temperature of -30 degrees F (-34 C) to 165 degrees F (74 C) with relative humidity between 10% to 90% non-condensing.
- 2) Ventilation fans are not permitted.

d. Power

- 1) Nominal power input voltage of 120 VAC.
- 2) Maximum power consumption of 20 watts.
- 3) If external power supplies are used, they shall fit into the allotted space for the encoder, and shall meet the same operating temperature and relative humidity requirements.

e. Connectors

- 1) Video Input: BNC connector with gold-plated center socket.
- 2) Network: RJ-45 jack

- 3) Serial Data: 9-pin D-subminiature (DE-9), keyed pluggable locking terminal block, or keyed locking connector jack. If DE-9 connector is used, comply with TIA-574. If keyed locking connector jack is used, furnish an adapter cable (no greater than 1m in length) with the required DE-9F/TIA-574 connector and labeled "DATA".
 - 4) Console: Female 9-pin D-subminiature (DE-9F) connector for RS-232 DCE (data circuit equipment) console interface compliant with TIA-574. If encoder housing has a connector interface other than DE-9F, furnish an adapter cable (no greater than 1m in length) with the required DE-9F connector for each encoder and labeled "CONSOLE".
 - 5) Power: NEMA 5-15 plug
2. Interfaces
 - a. Video Input: Color NTSC signal, 1 volt peak-to-peak.
 - b. Serial Data
 - 1) RS-232 operation, bidirectional with minimum data receive, data transmit, and ground signal connections.
 - 2) Baud-rate selectable between 1200 and 38400 bits per second.
 - 3) Line parameters of 1 start bit, 8 data bits, no parity, and no flow control.
 - c. Console: RS-232 operation for PC communications.
 - d. Ethernet
 - 1) IEEE 802.3/802.3u 10/100Mbps Ethernet.
 - 2) Auto-negotiation of speed/duplex operation according to IEEE 802.3ab.
 3. Network Communication
 - a. Provide a fully functional IP stack and interface that is both standards compliant and consistent with established practices. IP stack must include TCP (per RFC 793), UDP (per RFC 768), IGMPv2 (per RFC 2236), ARP (per RFC 826), ICMP (per RFC 792), SNMP (per RFC 1157), and unicast/broadcast/multicast support.
 - b. Provide statically configurable IP address, subnet netmask, and default gateway.
 - c. Provide support for managing the following network communication parameters via the Local Management functionality required herein.
 - IP Address
 - Subnet Mask
 - Default Gateway
 4. Video Encoding and Streaming
 - a. Encode video input using ISO/IEC 14496-2:2004/Amd.2:2005 MPEG-4 Part 2 Simple Profile Level 5 or ISO/IEC 14496-2:2004 MPEG-4 Part 2 Advanced Simple Profile Level 5.
 - b. Support streaming via RTP (per RFC 3550) to configurable unicast or multicast address and port.
 - c. Support configurable multicast time-to-live (TTL) parameter.
 - d. Maintain 4:3 frame aspect ratio.
 - e. Support the following simultaneous settings:
 - Minimum encoded image resolution of 704x480
 - 30 frames-per-second frame rate
 - I-to-P (group of pictures) ratio of 1:30
 - 4Mbps encoding bit rate
 - Constant bit rate encoding or constrained variable bit rate encoding

- f. Support access to SDP file (per RFC 4566) matching current stream configuration via HTTP (per RFC2616), RTSP (per RFC 2336), or SAP (per RFC 2974).
 - g. Upon loss of sync on the video input, continue streaming with a solid black image or some indication of “video loss” other than interrupting the stream.
 - h. Any on-screen text or title overlay features shall be configurable to be fully disabled.
 - i. Provide maximum encoding and transmission latency of 300 milliseconds with minimal transmission jitter and no video image degradation or transmission interruptions.
 - j. RTP packet stream’s timestamp is derived from the encoder’s 90KHz clock reference. Reference clock must be synchronized with the actual wall-clock time and the MPEG4 stream, with no noticeable clock drift, for an interval of at least one (1) hour.
 - k. Provide support for managing the following video streaming parameters via the Remote Management functionality required herein.
 - Target address and port
 - TTL parameter
 - Resolution
 - Frame rate
 - I/P ratio
 - Encoding bit rate
 - On-screen text or title overlay features
5. Serial Data Communication
- a. Support network/serial data pass-through operation via UDP or TCP.
 - b. Pass traffic between the UDP/TCP port and the serial data port without modifying the payload, defined as raw pass-through with no TELNET or other character escaping.
 - c. Support configurable TCP or UDP listener port number.
 - d. UDP network/serial data pass-through implementation shall not require pre-configuration of the IP address for return traffic from an attached serial device. Forwarding incoming serial data to the originating source address and port of the most recently received UDP pass-through traffic is an acceptable implementation.
 - e. TCP network/serial data pass-through implementation shall include a method of automatic network fault recovery initiated by the encoder in 60 seconds or less. TCP keepalives with configurable parameters for inactivity period, number of probes to send, and probe timeout interval is an acceptable implementation.
 - f. Provide support for managing the following serial data parameters via the Remote Management functionality required herein:
 - Serial data line parameters including baud rate, parity, data and stop bits, and flow control.
 - Network protocol (TCP or UDP) and port number
6. Management
- a. Local Management
 - 1) Provide a command-line interface on the console port.
 - 2) Support configuration via the local management interface of the parameter groups detailed in the following sections:
 - Network Communication
 - Administrative Security
 - b. Remote Management
 - 1) Configuration

- a) Support remote configuration using either the SNMP Agent required herein or a documented and programmatically parsible file accessible for upload and download via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - b) No manufacturer-sourced configuration utilities, applications, or drivers shall be required to configure the encoder.
 - c) Support interactive remote management interface using one or more of the following:
 - Command-line interface via TELNET and/or SSH
 - Embedded HTTP server
 - d) Support configuration of all settings in the following parameter groups via the remote management interface(s).
 - Video Encoding and Streaming
 - Serial Data
 - SNMP Agent
 - SNMP Traps
- 2) SNMP Agent
- a) Provide an SNMPv1 agent accessible on UDP port 161 over the network interface per RFC 1157.
 - b) Support separate configurable read-only and read-write community strings.
 - c) Provide the standard MIB-II objects per RFC 1213.
 - d) Provide the following data in MIB-II object “sysDescr”:
 - Manufacturer name
 - Manufacturer model number
 - Manufacturer part number
 - Version identifiers for hardware and firmware components
 - e) Provide the following information via SNMP; using vendor-specific MIB object(s) when necessary:
 - Video Status – whether sync is detected in the video input or not
 - f) Furnish list of all industry standard MIBs that are supported.
 - g) Furnish properly formatted MIB files detailing all vendor-specific objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
 - h) Provide support for managing the following SNMP Agent parameters via both the Local and Remote Management interfaces required herein.
 - Read-only and read-write community strings
- 3) SNMP Traps
- a) Provide support for transmitting SNMPv1 traps over the network interface to UDP port 162 on configured receivers per RFC 1157 and RFC 1215.
 - b) Support a minimum of four (4) configurable trap receivers with corresponding IP addresses and community strings.
 - c) Provide traps reporting changes in the state of the video input sync (i.e. video input sync lost, video input sync restored).
 - d) Furnish list of all industry standard traps that are supported.
 - e) Furnish properly formatted MIB files detailing all vendor-specific trap objects supported. All MIB files should conform to RFC 1155 and RFC 1212.

- f) Provide support for managing the following SNMP Trap parameters via both the Local Management and Remote Management interfaces required herein.
 - Trap receiver IP addresses and corresponding community strings.
- c. Firmware Updates
 - 1) Provide firmware update mechanism via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
No manufacturer-sourced firmware update utilities, applications, or drivers shall be required to perform firmware updates.
 - 2) Provide password protection for firmware update mechanism or support for enabling and disabling the mechanism if the protocol doesn't support authentication (i.e. embedded TFTP server).
 - 3) Provide support for managing the following firmware update parameters via both the Local Management and Remote Management interfaces required herein.
 - Enable/disable insecure firmware update mechanism
- d. Administrative Security
 - 1) Provide administrative access control via a configurable password.
 - 2) Provide support for managing the following administrative security parameters via both the Local Management and Remote Management interfaces required herein.
 - Administrative password
- e. Factory Reset
 - 1) Provide mechanism of resetting the device to a known and documented factory default configuration.
 - 2) Prior knowledge of the current administrative password or current network configuration shall not be necessary to reset the unit to the factory default configuration.
 - 3) Opening the encoder case or enclosure shall not be necessary to reset the unit to the factory default configuration.
- f. LED Indicators

Provide separate LED indicators on the exterior of the unit indicating:

 - Power
 - Video input status (video input sync detected or not detected)
 - Network link status and activity

B. Video Encoder, Type C

Video Encoder, Type C is a high density encoder unit for multiple video signals, with one encoder per video signal, suitable for control center use.

1. General

a. Chassis

- 1) Furnish rack-mountable units.
- 2) Rack-mountable units shall include integrated brackets for mounting in standard EIA 19-inch rack rack-mountings, and shall be no more than one (1) rack unit (1.75 inches (45 mm)) high and 13 in. (330 mm) deep.
- 3) High density rack-mountable units are either self-contained, or a card/module-based chassis cage with individual encoders.
- 4) Furnish a high-density modular chassis cage when card/module-based encoders units are used.
- 5) High density rack-mountable units shall hold a minimum of eight (8) individual encoders.

- b. Labeling and Identification
 - 1) Provide external silk-screened markings for all connectors, indicators, switches, and replaceable components.
 - 2) Provide external labeling on the front or rear enclosure face for the manufacturer's name, product, model and part numbers, revision numbers, serial number, and MAC address(es).
- c. Environmental
 - 1) Operating temperature of 32 degrees F (0 C) to 113 degrees F (45 C) with relative humidity between 20% to 80% non-condensing.
- d. Power
 - 1) Nominal power input voltage of 120 VAC.
 - 2) If external power supplies are used, they shall fit into the allotted space for the high density unit, and shall meet the same operating temperature and relative humidity requirements.
 - 3) High density unit shall be powered from a single power connection.
- e. Connectors
 - 1) Video Inputs: Multiple BNC connectors with gold-plated center sockets.
 - 2) Network: Single network connection, RJ-45 jack
 - 3) Power: Single power connection, NEMA 5-15 plug
- 2. Interfaces
 - a. Video Inputs: 1 input for each video signal, color NTSC signal, 1 volt peak-to-peak.
 - b. Ethernet
 - 1) IEEE 802.3/802.3u 10/100Mbps Ethernet.
 - 2) Auto-negotiation of speed/duplex operation according to IEEE 802.3ab.
 - 3) High density unit shall be connected with a single network cable connection.
- 3. Network Communication
 - a. Provide a fully functional IP stack and interface, on a per encoder unit or per high density unit basis, that is both standards compliant and consistent with established practices. IP stack must include TCP (per RFC 793), UDP (per RFC 768), IGMPv2 (per RFC 2236), ARP (per RFC 826), ICMP (per RFC 792), SNMP (per RFC 1157), and unicast/broadcast/multicast support.
 - b. Provide statically configurable IP address, subnet netmask, and default gateway.
 - c. Provide support for managing the following network communication parameters via the Local Management functionality required herein.
 - IP Address
 - Subnet Mask
 - Default Gateway
- 4. Video Encoding and Streaming
 - a. For each video input, encode video input using ISO/IEC 14496-2:2004/Amd.2:2005 MPEG-4 Part 2 Simple Profile Level 5 or ISO/IEC 14496-2:2004 MPEG-4 Part 2 Advanced Simple Profile Level 5.
 - b. Support streaming via RTP (per RFC 3550) to configurable unicast or multicast address and port.
 - c. Support configurable multicast time-to-live (TTL) parameter.
 - d. Maintain 4:3 frame aspect ratio.
 - e. Support the following simultaneous settings on all encoder inputs:

- Minimum encoded image resolution of 704x480
 - 30 frames-per-second frame rate
 - I-to-P (group of pictures) ratio of 1:30
 - 4Mbps encoding bit rate
 - Constant bit rate encoding or constrained variable bit rate encoding
- f. Support access to SDP file (per RFC 4566) matching current stream configuration via HTTP (per RFC2616), RTSP (per RFC 2336), or SAP (per RFC 2974).
 - g. Upon loss of sync on a video input, continue streaming with a solid black image or some indication of “video loss” other than interrupting the stream.
 - h. Any on-screen text or title overlay features shall be configurable to be fully disabled.
 - i. Provide maximum encoding and transmission latency of 300 milliseconds with minimal transmission jitter and no video image degradation or transmission interruptions.
 - j. RTP packet stream’s timestamp is derived from the encoder’s 90KHz clock reference. Reference clock must be synchronized with the actual wall-clock time and the MPEG4 stream, with no noticeable clock drift, for an interval of at least one (1) hour.
 - k. Provide support for managing the following video streaming parameters via the Remote Management functionality required herein.
 - Target address and port
 - TTL parameter
 - Resolution
 - Frame rate
 - I/P ratio
 - Encoding bit rate
 - On-screen text or title overlay features
 - l. Video parameters for each encoder input shall be individually configurable.
 - m. Encoders shall provide a method of reporting video input sync status via an SNMP Agent or HTTP server.
5. Management
- a. Local Management

Provide a command-line or HTTP server interface for configuring the parameter groups detailed in the following sections:

 - Network Communication
 - Administrative Security
 - b. Remote Management
 - 1) Configuration
 - a) Support remote configuration using either the SNMP Agent required herein or a documented and programmatically parsible file accessible for upload and download via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - b) No manufacturer-sourced configuration utilities, applications, or drivers shall be required to configure the encoders.
 - c) Support interactive remote management interface using one or more of the following:
 - Command-line interface via TELNET and/or SSH
 - Embedded HTTP server

- d) Support configuration of all settings in the following parameter groups via the remote management interface(s).
 - Video Encoding and Streaming
 - SNMP Agent
- 2) SNMP Agent
 - a) Provide an SNMPv1 agent accessible on UDP port 161 over the network interface per RFC 1157.
 - b) Support separate configurable read-only and read-write community strings.
 - c) Provide the standard MIB-II objects per RFC 1213.
 - d) Provide the following data in MIB-II object “sysDescr”:
 - Manufacturer name
 - Manufacturer model number
 - Manufacturer part number
 - Version identifiers for hardware and firmware components
 - e) Furnish list of all industry standard MIBs that are supported.
 - f) Furnish properly formatted MIB files detailing all vendor-specific objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
 - g) Provide support for managing the following SNMP Agent parameters via both the Local and Remote Management interfaces required herein.
 - Read-only and read-write community strings
- c. Firmware Updates
 - 1) Provide firmware update mechanism via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - 2) No manufacturer-sourced firmware update utilities, applications, or drivers shall be required to perform firmware updates.
 - 3) Provide password protection for firmware update mechanism or support for enabling and disabling the mechanism if the protocol doesn't support authentication (i.e. embedded TFTP server).
 - 4) Provide support for managing the following firmware update parameters via both the Local Management and Remote Management interfaces required herein.
 - Enable/disable insecure firmware update mechanism
- d. Administrative Security
 - 1) Provide administrative access control via a configurable password.
 - 2) Provide support for managing the following administrative security parameters via both the Local Management and Remote Management interfaces required herein.
 - Administrative password
- e. Factory Reset
 - 1) Provide mechanism of resetting the device to a known and documented factory default configuration.
 - 2) Prior knowledge of the current administrative password or current network configuration shall not be necessary to reset the unit to the factory default configuration.
 - 3) Opening the encoder case or enclosure shall not be necessary to reset the unit to the factory default configuration.
- f. LED Indicators

Provide separate LED indicators on the exterior of the unit indicating:

- Power
- Network link status and activity

939.2.10 Video Decoder (All Types)

A. Video Decoder, Type B

Video Decoder , Type B is a standalone decoder for a single RTP video stream, suitable for dedicated point-to-point analog video transport links, or viewing encoded video on a single monitor.

1. General

a. Chassis

- 1) Furnish rack-mountable or shelf-mountable units.
- 2) Rack-mountable units shall include integrated brackets for mounting in standard EIA 19-inch rack rack-mountings, and shall be no more than one (1) rack unit (1.75 inches (45 mm)) high and 13 in. (330 mm) deep.
- 3) Shelf-mountable units shall be no more than 3.5 in. (89 mm) (H) x 9 in. (229 mm) (W) x 11 in. (280 mm) (D), and shall include a perforated ventilated shelf for mounting in a standard EIA 19-inch rack, no more than 13 inches (330 mm) deep with mounting flanges of two (2) rack units (3.5 in. (89 mm)) and a minimum 20 lb (9 kg) load rating.

b. Labeling and Identification

- 1) Provide external silk-screened markings for all connectors, indicators, switches, and replaceable components.
- 2) Provide external labeling on the front or rear enclosure face for the manufacturer's name, product, model and part numbers, revision numbers, serial number, and MAC address.

c. Environmental

- 1) Operating temperature of -30 degrees F (-34 C) to 165 degrees F (74 C) with relative humidity between 10% to 90% non-condensing.
- 2) Ventilation fans are not permitted.

d. Power

- 1) Nominal power input voltage of 120 VAC.
- 2) Maximum power consumption of 20 watts.
- 3) If external power supplies are used, they shall fit into the allotted space for the decoder, and shall meet the same operating temperature and relative humidity requirements.

e. Connectors

- 1) Video Output: BNC connector with gold-plated center socket.
- 2) Network: RJ-45 jack
- 3) Console: Female 9-pin D-subminiature (DE-9F) connector for RS-232 DCE (data circuit equipment) console interface compliant with TIA-574. If decoder housing has a connector interface other than DE-9F, furnish an adapter cable (no greater than 1m in length) with the required DE-9F connector for each decoder and labeled "CONSOLE".
- 4) Power: NEMA 5-15 plug

2. Interfaces

- a. Video Output: Color NTSC signal, 1 volt peak-to-peak.
- b. Console: RS-232 operation for PC communications.

- c. Ethernet
 - 1) IEEE 802.3/802.3u 10/100Mbps Ethernet.
 - 2) Auto-negotiation of speed/duplex operation according to IEEE 802.3ab.
- 3. Network Communication
 - a. Provide a fully functional IP stack and interface that is both standards compliant and consistent with established practices. IP stack must include TCP (per RFC 793), UDP (per RFC 768), IGMPv2 (per RFC 2236), ARP (per RFC 826), ICMP (per RFC 792), SNMP (per RFC 1157), and unicast/broadcast/multicast support.
 - b. Provide statically configurable IP address, subnet netmask, and default gateway.
 - c. Provide support for managing the following network communication parameters via the Local Management functionality required herein.
 - IP Address
 - Subnet Mask
 - Default Gateway
- 4. Video Decoding and Streaming
 - a. For each video output, decode video streams that are compliant to all of the following ISO/IEC 14496-2:2004/Amd.2:2005 MPEG-4 Part 2 profiles:
 - Simple Profile Level 0 (QCIF)
 - Simple Profile Level 1 (QCIF)
 - Simple Profile Level 2 (CIF)
 - Simple Profile Level 3 (CIF)
 - Simple Profile Level 5 (D1)
 - Advanced Simple Profile Level 0 (QCIF)
 - Advanced Simple Profile Level 1 (QCIF)
 - Advanced Simple Profile Level 2 (CIF)
 - Advanced Simple Profile Level 3 (CIF)
 - Advanced Simple Profile Level 4 (CIF)
 - Advanced Simple Profile Level 5 (D1)
 - b. Support streaming via RTP (per RFC 3550) to configurable unicast or multicast address and port.
 - c. Maintain 4:3 frame aspect ratio.
 - d. Support for the following resolutions, scaled to the proper aspect ratio:
 - D1 (720x480)
 - 4CIF (704x480)
 - CIF (352x240)
 - QCIF (176x120, 176x112, 160x120, 160x112)
 - e. Support the following simultaneous capabilities on the decoder output:
 - 30 frames-per-second frame rate
 - I-to-P (group of pictures) ratio from 1:1 to 1:30
 - Up to 4Mbps encoding bit rate
 - Automatic adjustment to stream format changes

- Switch between RTP streams on different addresses and port numbers and resynchronize with the new stream within 3 I-frames.
- f. Upon loss of video stream, output an indication in the video image that the video stream was lost.
 - g. Any on-screen text or title overlay features shall be configurable to be fully disabled.
 - h. Provide maximum decoding latency of 300 milliseconds with minimal transmission jitter and no video image degradation or transmission interruptions.
 - i. Decoded video must remain synchronized with the RTP packet stream with no noticeable drift for an interval of at least one (1) hour. RTP packet stream is derived from a 90 KHz clock reference.
 - j. Provide support for managing the following video streaming parameters via the Remote Management functionality required herein.
 - Unicast or multicast stream selection
 - Target address (for multicast sources)
 - Target port
5. Management
- a. Local Management
 - 1) Provide a command-line interface on the console port.
 - 2) Support configuration via the local management interface of the parameter groups detailed in the following sections:
 - Network Communication
 - Administrative Security
 - b. Remote Management
 - 1) Configuration
 - a) Support remote configuration using either the SNMP Agent required herein or a documented and programmatically parsible file accessible for upload and download via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - b) No manufacturer-sourced configuration utilities, applications, or drivers shall be required to configure the decoder.
 - c) Support interactive remote management interface using one or more of the following:
 - Command-line interface via TELNET and/or SSH
 - Embedded HTTP server
 - d) Support configuration of all settings in the following parameter groups via the remote management interface(s).
 - Video Decoding and Streaming
 - SNMP Agent
 - SNMP Traps
 - 2) SNMP Agent
 - a) Provide an SNMPv1 agent accessible on UDP port 161 over the network interface per RFC 1157.
 - b) Support separate configurable read-only and read-write community strings.
 - c) Provide the standard MIB-II objects per RFC 1213.
 - d) Provide the following data in MIB-II object "sysDescr":
 - Manufacturer name

- Manufacturer model number
 - Manufacturer part number
 - Version identifiers for hardware and firmware components
- e) Furnish list of all industry standard MIBs that are supported.
- f) Furnish properly formatted MIB files detailing all vendor-specific objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
- g) Provide support for managing the following SNMP Agent parameters via both the Local and Remote Management interfaces required herein.
- Read-only and read-write community strings
- 3) SNMP Traps
- a) Provide support for transmitting SNMPv1 traps over the network interface to UDP port 162 on configured receivers per RFC 1157 and RFC 1215.
- b) Support a minimum of four (4) configurable trap receivers with corresponding IP addresses and community strings.
- c) Provide traps reporting changes in the state of the video input sync (i.e. video input sync lost, video input sync restored).
- d) Furnish list of all industry standard traps that are supported.
- e) Furnish properly formatted MIB files detailing all vendor-specific trap objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
- f) Provide support for managing the following SNMP Trap parameters via both the Local Management and Remote Management interfaces required herein.
- Trap receiver IP addresses and corresponding community strings.
- c. Firmware Updates
- 1) Provide firmware update mechanism via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
- 2) No manufacturer-sourced firmware update utilities, applications, or drivers shall be required to perform firmware updates.
- 3) Provide password protection for firmware update mechanism or support for enabling and disabling the mechanism if the protocol doesn't support authentication (i.e. embedded TFTP server).
- 4) Provide support for managing the following firmware update parameters via both the Local Management and Remote Management interfaces required herein.
- Enable/disable insecure firmware update mechanism
- d. Administrative Security
- 1) Provide administrative access control via a configurable password.
- 2) Provide support for managing the following administrative security parameters via both the Local Management and Remote Management interfaces required herein.
- Administrative password
- e. Factory Reset
- 1) Provide mechanism of resetting the device to a known and documented factory default configuration.
- 2) Prior knowledge of the current administrative password or current network configuration shall not be necessary to reset the unit to the factory default configuration.

- 3) Opening the decoder case or enclosure shall not be necessary to reset the unit to the factory default configuration.

f. LED Indicators

Provide separate LED indicators on the exterior of the unit indicating:

- Power
- Video stream status (video stream detected or not detected)
- Network link status and activity

B. Video Decoder, Type C

Video Decoder, Type C is a high density decoder unit to decode multiple RTP video streams and display them on analog video outputs, with one output per video stream, suitable for control center use.

1. General

a. Chassis

- 1) Furnish rack-mountable units.
- 2) Rack-mountable units shall include integrated brackets for mounting in standard EIA 19-inch rack rack-mountings, and shall be no more than five (5) rack units (8.75 inches (223 mm)) high and 13 in. (330 mm) deep.
- 3) High density rack-mountable units are either self-contained, or a card/module-based chassis cage with individual decoders.
- 4) Furnish a high-density modular chassis cage when card/module-based decoder units are used.
- 5) High density rack-mountable units shall hold a minimum of twelve (12) individual decoders.

b. Labeling and Identification

- 1) Provide external silk-screened markings for all connectors, indicators, switches, and replaceable components.
- 2) Provide external labeling on the front or rear enclosure face for the manufacturer's name, product, model and part numbers, revision numbers, serial number, and MAC address(es).

c. Environmental

- 1) Operating temperature of 32 degrees F (0 C) to 113 degrees F (45 C) with relative humidity between 20% to 80% non-condensing.

d. Power

- 1) Nominal power input voltage of 120 VAC.
- 2) If external power supplies are used, they shall fit into the allotted space for the high density unit, and shall meet the same operating temperature and relative humidity requirements.
- 3) High density unit shall be powered from a single power connection.

e. Connectors

- 1) Video Outputs: Multiple BNC connectors with gold-plated center sockets.
- 2) Network: Single or multiple network connection(s), RJ-45 jack(s)
- 3) Console: Single or multiple console ports using female 9-pin D-subminiature (DE-9F) connector for RS-232 DCE (data circuit equipment) console interface compliant with TIA-574. If encoder housing has a connector interface other than DE-9F, furnish an adapter cable (no greater than 1m in length) with the required DE-9F connector for each encoder and labeled "CONSOLE".
- 4) Power: Single power connection, NEMA 5-15 plug

2. Interfaces

- a. Video Outputs: 1 output for each video signal, color NTSC signal, 1 volt peak-to-peak.
 - b. Console: RS-232 operation for PC communications.
 - c. Ethernet
 - 1) IEEE 802.3/802.3u 10/100Mbps Ethernet.
 - 2) Auto-negotiation of speed/duplex operation according to IEEE 802.3ab.
3. Network Communication
- a. Provide a fully functional IP stack and interface, on a per decoder unit or per high density unit basis, that is both standards compliant and consistent with established practices. IP stack must include TCP (per RFC 793), UDP (per RFC 768), IGMPv2 (per RFC 2236), ARP (per RFC 826), ICMP (per RFC 792), SNMP (per RFC 1157), and unicast/broadcast/multicast support.
 - b. Provide statically configurable IP address, subnet netmask, and default gateway.
 - c. Provide support for managing the following network communication parameters via the Local Management functionality required herein.
 - IP Address
 - Subnet Mask
 - Default Gateway
4. Video Decoding and Streaming
- a. For each video output, decode video streams that are compliant to all of the following ISO/IEC 14496-2:2004/Amd.2:2005 MPEG-4 Part 2 profiles:
 - Simple Profile Level 0 (QCIF)
 - Simple Profile Level 1 (QCIF)
 - Simple Profile Level 2 (CIF)
 - Simple Profile Level 3 (CIF)
 - Simple Profile Level 5 (D1)
 - Advanced Simple Profile Level 0 (QCIF)
 - Advanced Simple Profile Level 1 (QCIF)
 - Advanced Simple Profile Level 2 (CIF)
 - Advanced Simple Profile Level 3 (CIF)
 - Advanced Simple Profile Level 4 (CIF)
 - Advanced Simple Profile Level 5 (D1)
 - b. Support RTP (per RFC 3550) stream decoding from configurable unicast port, or multicast address and port.
 - c. Maintain 4:3 frame aspect ratio.
 - d. Support for the following resolutions, scaled to the proper aspect ratio:
 - D1 (720x480)
 - 4CIF (704x480)
 - CIF (352x240)
 - QCIF (176x120, 176x112, 160x120, 160x112)
 - e. Support the following simultaneous capabilities on all decoder outputs:
 - Up to 30 frames-per-second frame rate
 - I-to-P (group of pictures) ratio from 1:1 to 1:30

- Up to 4Mbps encoding bit rate
 - Automatic adjustment to stream format changes
 - Switch between RTP streams on different addresses and port numbers and resynchronize with the new stream within 3 I-frames.
- f. Upon loss of video stream, output an indication in the video image that the video stream was lost.
- g. Any on-screen text or title overlay features shall be configurable to be fully disabled.
- h. Provide maximum decoding latency of 300 milliseconds with minimal transmission jitter and no video image degradation or transmission interruptions.
- i. Decoded video must remain synchronized with the RTP packet stream with no noticeable drift for an interval of at least one (1) hour. RTP packet stream is derived from a 90KHz clock reference.
- j. Provide support for managing the following video streaming parameters via the Remote Management functionality required herein.
- Unicast or multicast stream selection
 - Target address (for multicast sources)
 - Target port
- k. Video parameters for each decoder shall be individually configurable.
5. Management
- a. Local Management
- 1) Provide a command-line interface on the console port.
 - 2) Support configuration via the local management interface of the parameter groups detailed in the following sections:
 - Network Communication
 - Administrative Security
- b. Remote Management
- 1) Configuration
 - a) Support remote configuration using either the SNMP Agent required herein or a documented and programmatically parsible file accessible for upload and download via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - b) No manufacturer-sourced configuration utilities, applications, or drivers shall be required to configure the decoders.
 - c) Support interactive remote management interface using one or more of the following:
 - Command-line interface via TELNET and/or SSH
 - Embedded HTTP server
 - d) Support configuration of all settings in the following parameter groups via the remote management interface(s).
 - Video Decoding and Streaming
 - SNMP Agent
 - SNMP Traps
 - 2) SNMP Agent
 - a) Provide an SNMPv1 agent accessible on UDP port 161 over the network interface per RFC 1157.
 - b) Support separate configurable read-only and read-write community strings.

- c) Provide the standard MIB-II objects per RFC 1213.
 - d) Provide the following data in MIB-II object "sysDescr":
 - Manufacturer name
 - Manufacturer model number
 - Manufacturer part number
 - Version identifiers for hardware and firmware components
 - e) Furnish list of all industry standard MIBs that are supported.
 - f) Furnish properly formatted MIB files detailing all vendor-specific objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
 - g) Provide support for managing the following SNMP Agent parameters via both the Local and Remote Management interfaces required herein.
 - Read-only and read-write community strings
- 3) SNMP Traps
- a) Provide support for transmitting SNMPv1 traps over the network interface to UDP port 162 on configured receivers per RFC 1157 and RFC 1215.
 - b) Support a minimum of four (4) configurable trap receivers with corresponding IP addresses and community strings.
 - c) Provide traps reporting changes in the state of the video input sync (i.e. video input sync lost, video input sync restored).
 - d) Furnish list of all industry standard traps that are supported.
 - e) Furnish properly formatted MIB files detailing all vendor-specific trap objects supported. All MIB files should conform to RFC 1155 and RFC 1212.
 - f) Provide support for managing the following SNMP Trap parameters via both the Local Management and Remote Management interfaces required herein.
 - Trap receiver IP addresses and corresponding community strings.
- c. Firmware Updates
- 1) Provide firmware update mechanism via embedded FTP or TFTP client, TFTP server, SSH/SCP server, or HTTP server.
 - 2) No manufacturer-sourced firmware update utilities, applications, or drivers shall be required to perform firmware updates.
 - 3) Provide password protection for firmware update mechanism or support for enabling and disabling the mechanism if the protocol doesn't support authentication (i.e. embedded TFTP server).
 - 4) Provide support for managing the following firmware update parameters via both the Local Management and Remote Management interfaces required herein.
 - Enable/disable insecure firmware update mechanism
- d. Administrative Security
- 1) Provide administrative access control via a configurable password.
 - 2) Provide support for managing the following administrative security parameters via both the Local Management and Remote Management interfaces required herein.
 - Administrative password
- e. Factory Reset
- 1) Provide mechanism of resetting the device to a known and documented factory default configuration.

- 2) Prior knowledge of the current administrative password or current network configuration shall not be necessary to reset the unit to the factory default configuration.
 - 3) Opening the encoder case or enclosure shall not be necessary to reset the unit to the factory default configuration.
- f. LED Indicators

Provide separate LED indicators on the exterior of the unit indicating:

- Power
- Video stream status (video stream detected or not detected)
- Network link status and activity

939.2.11 Equipment Rack

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

939.2.12 Equipment Frame

Provide equipment frames meeting the following requirements:

- Overall dimensions of approximately 84" (210 mm) high by 20.25" (514.4 mm) wide and meeting EIA standards for mounting 19" (480 mm) equipment.
- Equipment frame upright channels fabricated from 6061-T6 aluminum extrusions with minimum depth of 5.75" (146 mm), flange thickness of 0.19" (4.8 mm) and web thickness of 0.16" (4.1 mm).
- Fully assembled frames, with all mounting and accessories as required herein, that comply with Telcordia GR-63-CORE Network Equipment Building System Seismic Zone Rating 4..
- Equipment frame upright channels manufactured with threaded #12-24 mounting holes of entire channel length front and rear with standard EIA spacing. Do not use non-threaded clearance holes with separate "clip nuts".
- Provide front and rear mounting base angles fabricated from 6061-T6 aluminum extrusions with minimum 6" (150 mm) footing extension. Secure base angles to floor with a minimum of four 0.625 threaded expansion anchor bolts with steel or brass expansion sleeves. Do not use any other type of anchor.
- Provide front and rear top angles fabricated from 6061-T6 aluminum extrusions with minimum 1.5" (38 mm) by 2.0" (51 mm) web.
- Provide a front-mounted lower guard-rail fabricated from minimum 0.25" (6.4 mm) by 2.0" (51 mm) bar stock with 6.0" (150 mm) to 7.0" (180 mm) standoff from the upright channel.

Provide vertical cable management ducts in between all equipment frames and at each end of a row of equipment frames. Provide a vertical cable management duct on each side of a single equipment frame. Use vertical cable management ducts that reach from the bottom of the equipment frame fully to the top of the frame and that connect with the cable (fiber optic jumper) management ducts installed in the hub's cable runways. Use ducts that are double-sided, opening to the front and rear of the equipment frames, with each side having the minimum inside dimensions of 3.5" (89 mm) wide by 6.25" (159 mm) deep. Provide plastic or rubber grommeted openings, between the two sides of the duct, with a minimum opening of 2" (50 mm) and a maximum spacing of 12" (300 mm). On the front-opening of each side of the duct, provide positive cable restraint through opening latches or removable covers.

- For all assembly or fastening hardware use zinc-plated steel, nickel-plated brass, or stainless steel unless otherwise specified.
- Use a black color finish on upright channels, top and base angles, and lower guard rails.
- With each equipment frame provide a minimum of 50 #12-24 x 0.75" (19 mm) (minimum) cuphead phillips-slot mounting screws with pilot points and nylon washers. Use zinc-plated steel, nickel-plated brass, or stainless steel screws. Provide more screws if necessary to properly mount all equipment as shown in the Plans.

- Provide a rear-mounted, 20-amp, 10-receptacle power strip secured with a minimum of four rigid standoff brackets. Do not use threaded bolts or rods as standoff brackets.
- Provide a sliding drawer that is an aluminum storage compartment mounted in each frame 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 equipment frame upright channels. When extended, the storage compartment shall open to provide storage space for documentation and other miscellaneous items. The sliding drawer/storage compartment shall be 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.
- Perform all assembly and installation in accordance with the equipment frame manufacturer's recommendations.

939.2.13 Dial-up Modem

As required, furnish and ensure that the dial-up modems are stand-alone modems that support programmable communication rates of 0-56,000 bps and provide fully automatic communications rate selection. Provide modems meeting the following minimum specifications:

- Modulation: V.34, V.90, V.32
- Protocol: Asynchronous and synchronous supported
- Error control: V.42
- Hayes standard AT command set
- Automatic speed buffering
- Flow control
- (2) Modular RJ-11 telephone line connectors
- Modular DB-25 RS-232C serial interface connector
- LED indicators for TX, RX, RTS, DCD, PWR

A. Equipment Cabinet Assembly

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.

1. General

a. Standard Cabinet Housing

- 1) 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.
- 2) Unless otherwise specified in these Special Provisions 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.

- b. Type A Standard Cabinet Housing – Not Applicable
- c. Type B Standard Cabinet Housing – Not Applicable
- d. Type C Standard Cabinet Housing:
 - 1) The Type C cabinet housing (see Detail Drawings) 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).
 - 2) 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 as shown on the Detail Drawings in this section. Each side panel shall be fabricated from 5052 sheet aluminum alloy with a minimum thickness of 0.125 in (3.175 mm).
 - 3) Equip Type C cabinet housings with a cabinet sliding drawer. Follow the drawer specifications given in Subsection 939.2.B.5.
 - 4) 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 as shown in the Detail Drawings in this section.
- e. Type D Standard Cabinet Housing:
 - 1) 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).
 - 2) Equip all Type D cabinet housings with the standard EIA 19-inch rack cabinet cage as described in Section 3 of the Caltrans specifications and mounting panels as shown on the Detail Drawings in this section. The
 - 3) 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).
 - 4) Equip the Type D cabinet housing with a cabinet-sliding drawer. Follow the drawer specifications given in Subsection 939.2.B.5.
 - 5) 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 as shown in the Detail Drawings in this section. 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.
- f. Type F Standard Cabinet Housing:
 - 1) 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).
 - 2) 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).
 - 3) 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.

- 4) 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.
- 5) Equip the Type F cabinet housing with two cabinet-sliding drawers. Follow the drawer specifications given in Subsection 939.2.B.5.
- 6) 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 as shown in the Detail Drawings in this section. 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.

2. Internal Cabinet Assembly Components

- a. Unless otherwise specified in the Plans or approved by the Engineer, construct all cabinet assemblies in conformance with this Subsection 939.2.B including all Detail Drawings, 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.
- b. Provide a plastic documentation pouch to store the cabinet and equipment documentation. Use a pouch that is side-opening, resealable, 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 fabricated from galvanized passivated steel with prepunched 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 as show in the Details. 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 (see Detail Drawings).

- 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.
- Nominal operating Voltage 120 V
 - Max. Continuous Operating Voltage 150V
 - Max. Surge Current Rating 20 kA
 - Nominal Surge Current Rating for 8x20µs surge 20 kA
 - Internal Thermal Fuses
 - Failure/ replacement indication

- Operating Temperature: -40C to 80C
- 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.

4. 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.

939.2.02 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 the following GDOT Specifications and Special Provisions:

- Section 631—Changeable Message Signs
- Section 925—Traffic Signal Equipment
- Section 937—Video Detection System
- Section 938—Detection
- Section 939—Communications & Electronic Equipment

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

A. Cabinet Equipment and Components

Install in Types A, B, C, and D cabinet assembly one (1) fluorescent lighting fixture mounted inside the top front portion of the cabinet. Include with the fixture a cool white lamp, covered and operated by a normal power factor UL listed ballast. Install an RC network noise suppression filter in the light circuit. Install door actuated switches installed to turn on the cabinet light when either door is opened.

Install in Type F cabinet assembly four (4) fluorescent lighting fixtures mounted inside the top portions of the each cabinet side. Include with the fixture a cool white lamp, covered and operated by a normal power factor UL listed ballast. Install an RC network noise suppression filter in the light circuit. Install door actuated switches, front and rear of each door, installed to turn on all cabinet lights when any door is opened.

B. Cabinet Wiring, Conductors, and Terminal Blocks

Use two conductors per DIN terminal block (one conductor per terminal). Wire shall be stripped no longer than is necessary to provide a solid connection to the terminal block. No un-insulated wire shall be exposed at the terminal block. Number all terminal blocks, terminal strips, circuit breakers and have each item and each terminal position numbered and named according to function as shown in the “quoted labels” in the Detail Drawings. Label terminal blocks, terminal strips, and circuit breakers with silk-screened lettering on the mounting panel.

939.3.05 Construction

A. Equipment

1. Installation

- a. 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 Special Provisions, except when specifically identified as existing or as work to be performed by the Department.
- b. 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.
- c. 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.
- d. 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.
- e. For any equipment that is not rack mountable with “rack ears”, provide perforated shelves and secure all shelf-mounted equipment with rack mounting hardware.
- f. 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.
- g. 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:

- 1) Use patch cords only within control center buildings, communication Hubs, and equipment cabinets.
- 2) 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.

- 3) 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.
 - 1) 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-6 unshielded twisted pair (UTP)/shielded twisted pair (STP) patch cables that comply with EIA/TIA-568-A standards for all network to device interconnects (device to switch).
 - 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:
 - 1) For Traffic Signals, digital data communications between local controllers and system masters and to and from Hubs and control centers
 - 2) For Ramp Meters, digital data communications to and from equipment cabinets/Hubs/control centers
 - 3) Digital camera video and control data communications to and from equipment cabinets/Hubs/control centers
 - 4) Digital CMS control data communications to and from equipment cabinets/Hubs/control centers
 - 5) Digital detector data communications to and from equipment cabinets/Hubs/control centers

- 6) 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

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.

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.

- a. 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.
- b. 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. Radar Dial-up Modem

Furnish and install all cabling required to connect the radar dial-up modems to the telephone lines and the radar workstation.

4. CMS Dial-up Modem

Furnish and install all cabling required to connect the CMS dial-up modems to the telephone lines and the CMS workstation.

C. Equipment Cabinet Assembly

1. 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.B.

The equipment cabinet assembly, as described below, shall conform to all applicable sections of the Caltrans specifications and Georgia DOT Standard Specifications.

2. Classification of Types

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.B using a Type C Standard Cabinet Housing (see Detail Drawing in this section).
- 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.B using a Type D Standard Cabinet Housing (see Detail Drawing in this section).
- 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.B using a Type F Standard Cabinet Housing (see Detail Drawing in this section).

3. Identification and Documentation

Include the manufacturer's name only on the inside of the front cabinet door along with the cabinet model number, serial number, schematic wiring diagram number, and month/year of manufacture. Provide this information on a waterproof, permanently affixed label.

Identify all components of the cabinet assembly, which are mounted on panels. Make identification on the panels with permanent silk-screen or other printed labels. These components include but are not limited to terminal blocks (with all positions numbered and labeled), panel and socket mounted surge suppressors, circuit breakers, accessory and equipment outlets, and communications transmitters/transceivers.

Provide complete documentation with each cabinet. Identify all cabinet documentation, including the maintenance logbook, by field site name and system ID. Make all cabinet documentation (except that documentation contained in the maintenance logbook below) on ledger size non-fading xerographic black-on-white 20# or greater bond paper. Supply four (4) sets of schematic wiring diagrams with complete parts lists with each cabinet. Draft the diagrams in neat, workmanlike manner. The diagrams shall be completely legible at the specified paper sizes and be non-proprietary. Identify in the diagrams all circuits in a manner as to be readily interpreted. Include in the diagrams a cabinet drawing showing the equipment layout in a front and rear elevation view and front views of each of the side panels. Label all equipment on the drawings with the same identifiers as labeled on the panels themselves. Identify all cabinet electrical components and equipment and the ventilation filter on parts lists on the wiring diagrams or in the maintenance logbook. The parts lists shall include manufacturer and complete model number. Store the diagrams in the documentation pouch on the door.

Include in the cabinet documentation an equipment list and maintenance logbook. This maintenance logbook shall contain a list of all major removable equipment items in the cabinet and all major items installed outside of the cabinet including but not limited to Field Switch, Video Encoders, VDS System Processors, Modems, CCR, camera, lens, housing, and pan/tilt unit, along with manufacturer name, model, and serial numbers. Include in the equipment list in the logbook spaces to enter the communications address, system identifier, and other site-specific configuration information. The maintenance logbook shall include a minimum of five (5) blank forms for documenting site visits, including the date, time, technician name, and work performed. The maintenance logbook pages shall be standard letter size 3-hole 20# or greater white paper bound in a plastic report cover.

4. Internal Cabinet Assembly Components and Wiring

a. Cabinet Assembly Installation

- 1) Install the cabinet assembly as shown in the Plans. Provide the cabinet assembly with a grounding system in accordance with the Department's Standard Specification for Traffic Signal Equipment grounding. Measure the resistance to ground in the presence of the Engineer. Resistance to the ground cannot exceed ten (10) ohms. Do not splice the ground conductor between the cabinet grounding terminal and the ground rod. Isolate and insulate the ground conductor from any utility grounding equipment. Completely isolate the cabinet assembly grounding system from any other grounding system, including the support pole grounding system, such that there is no electrical bond between any equipment (cabinet, conduit, camera support bracket, etc.) and any other grounding system. In the case of steel support poles, it is not necessary to insulate equipment strapped to the pole.
- 2) Mount all pole mounted cabinet assemblies to the support pole at a height of 4 ft +/- 3 in (1.2 m +/- 76 mm) from ground level to the centerline of the cabinet housing. Where the Plans show base-mounted cabinets, install the cabinets in accordance with the Department's Standard Specification for Traffic Signal Equipment installations.
- 3) Enclose all cabling and wiring entering the cabinet housing in conduit. Securely and neatly dress all cabling and wiring inside the cabinet, including field wiring. Provide sufficient slack (minimum 2 ft. (600 mm)) for cabinet equipment maintenance and re-termination of the field wiring. Route fiber drop cables into the cabinet to provide as much physical protection as possible. Secure the drop cables through the cabinet, and strain-relieve them within the fiber termination unit.

b. Wiring, Conductors and Terminal Blocks:

- 1) Use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners.
- 2) Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route camera control wiring, and 120VAC power wiring separately. Terminate all wiring on the DIN rail terminals. Use a minimum #12 AWG THHN-THWN for all conductors of 120VAC circuits. Install all wiring as shown in the Detail Drawings.

c. Surge Suppression:

- 1) Protect all copper wiring and cabling entering the cabinet housing, except for the earth ground conductor, by surge suppression devices as specified.
- 2) Terminate all power supply wiring between cabinet devices and the transient surge suppressors on DIN terminal block. Use a minimum #12 AWG grounding of each surge suppression device, or larger if recommended by the surge suppression device manufacturer. Use insulated green wire and connect the ground wire directly to the ground terminal block.
- 3) Do not “daisy chain” with the grounding wires of other devices including other surge suppressors. 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 terminal block. Label all surge suppressors with silk-screened lettering on the mounting panel.

d. Component Installation:

- 1) All components/devices of the cabinet assembly are to be rack mounted with Phillips-head machine screws. Install screws into tapped and threaded holes in the panels. These components/devices include but are not limited to DIN rails, terminal blocks, accessory and equipment outlets, DC power supply chassis, video encoders, video processors, and field switches.
- 2) Fasten all other cabinet components with hex-head or phillips-head machine screws installed with nuts (with locking washer or insert) or into tapped and threaded holes. These other components include but are not limited to door switches, fans, lights, thermostats, , and door lock mechanisms. Fasten stud-mounted components to a mounting bracket providing complete access to the studs and mounting nuts. All fastener heads and nuts (when used) shall be fully accessible with a complete cabinet assembly, and any component/device shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

5. Cables, Conduit and Power Service

Furnish and install electrical cables, conduit and power service necessary to make the system fully operational.

a. Electrical Cables:

- 1) Furnish and install electrical cables for providing electrical power service to the site and for providing telephone and/or /DSL service and/or cable service from the telephone company demarcation point to the equipment cabinet.
- 2) Furnish and install electrical cables used for power service, including grounding, in accordance with the Standard Specifications for electrical, lighting and traffic signal equipment.
- 3) Furnish and install electrical cables used for power supply as shown in the Detail Drawings. Do not splice any cable, shield or conductor used for power supply. Identify all conductors of all cables by color and number. Identify the conductor function in as-built documentation included in the cabinet documentation.
- 4) Electrical cables installed for telephone service from the telephone company demarcation point to the equipment cabinet shall be minimum #22 AWG twisted pair, UV-resistant shielded cable rated for wet/dry direct burial use. Install telephone service cable directly to or into the equipment cabinet in accordance with telephone company procedures. Install telephone service cable from the telephone company demarcation point to the equipment cabinet. Unless otherwise shown in the Plans or directed by the Engineer, install the telephone cable underground in conduit of minimum 1 in. (25 mm) diameter. Make all necessary connections at the telephone interface box and inside the equipment cabinet for proper operation of the video, control signaling and communications signaling. Neatly coil a minimum of 2 ft. (0.6 m) of telephone service cable in the bottom of the cabinet.

b. Electrical Conduit:

- 1) Install electrical conduit to provide enclosures for electrical cables at or terminating at the site. Furnish and install electrical conduit in accordance with the Standard Specifications for electrical, lighting and traffic signal equipment, and as required below.
- 2) Make all aboveground electrical conduit and conduit bodies rigid metal except as noted below. Terminate all aboveground conduit in either a weather head or in a cabinet. All conduits entering a pole-mounted equipment cabinet shall enter through the bottom with at least one conduit body with a sealable, removable cover for pulling access. All conduits entering in a base-mounted cabinet shall enter through the foundation and the base-mount adapter.

- 3) Install electrical conduits for electrical power service drops to the cabinet in the diameter indicated in the Plans. Conduits used as risers from a cabinet shall be minimum 2 in. (50 mm) diameter. Make nipples, welded collars, conduit bodies (e.g., LB condulets) and weather heads in hollow metal or concrete poles at the device mounting locations and at the cabinet mounting locations a minimum 2.5 in. (63 mm) diameter.
- c. Electrical Power Service:
- 1) Furnish and install materials and equipment to bring electrical power service to the cabinet from the source shown in the Plans. Furnish and install electrical power service in accordance with the Standard Specifications for electrical, lighting and traffic signal equipment, and as required below.
 - 2) Provide and terminate electrical power service equipment at the power service source as shown in the Plans. If the power service source is shown as a new power service drop, then furnish and install an electrical power service assembly at the new service drop location in accordance with the Standard Specifications. Include, as a minimum, with the electrical power service equipment at a new drop a service disconnect, surge arrestor, grounding electrode and conductor, and all necessary conduit, wiring and hardware. Provide a ground conductor, other than the electrical service conduit, between the electrical service disconnect ground buss and the equipment cabinet service entrance terminal block SE. Furnish and install a service metering base where required by the local utility or electrical codes or where shown in the Plans. Include a minimum 30 ampere circuit breaker with electrical service disconnects. Mount the electrical surge arrestor on the disconnect housing. The arrestor shall be rated for a maximum permissible line to ground voltage of 175RMS, and shall be in conformance with NEMA standards for surge arrestors. Electrical service conduit shall be minimum 2 in. (25 mm) diameter. Separate electrical service conduit from all other conduit. This conduit cannot contain any other wiring. Dedicate electrical service conduit from the electric utility drop point through the meter base and disconnect and to the cabinet, where the electrical service conduit shall enter the cabinet through the cabinet bottom.
 - 3) If the power service source is an existing service drop, then furnish and install the necessary materials and equipment to supply service to the cabinet from the existing service drop. Unless otherwise shown in the Plans, service the cabinet from a dedicated branch circuit with circuit breaker. Make all electrical service installation from the existing drop point as specified for new power service drops above.
 - 4) Furnish and install surge suppression at all electrical power service sources. Ground all electrical power service sources and bond the AC neutral and ground at the power service source only.
 - 5) The contractor will establish accounts with the appropriate utility provider. After all accounts are established, the contractor will submit the utility transfer form to the appropriate DOT Utility office through the Engineer for transfer. The Engineer will provide the utility transfer form to the contractor.

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 fourteen 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:

- Device or system power-on self test
- 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
- Test using the built-in manufacturer's product or system diagnostics to confirm proper performance
- Test all input and output ports
- Demonstrate that all functional features of the device or system are operational
- An operational test demonstrating equipment performs as intended and as prescribed by the manufacturer and meets the requirements of the Contract specifications.

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:

- Connect with serial cable to Serial Data Terminal Server with PC or laptop using HyperTerminal.
- Ensure that the Serial Data Terminal Server recognizes all ports and attached expansion modules.
- Input addressing for Serial Data Terminal Server and reset.
- Determine successful Ethernet connectivity (link light at Hub/switch).
- Successfully telnet from PC or laptop to Serial Data Terminal Server through Hub/switch.
- 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)

- 1) 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 tests for review and approval by the Department.
- 2) The Contractor shall provide all test equipment and software necessary to perform the tests.
- 3) The Department will perform the SAT in a test area provided by the Department. A Contractor representative shall be present during the SAT.
- 4) The Field Switch will be assembled and connected to power in a stand-alone configuration.
- 5) 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.
- 6) After the Field Switch has started and initialized, test procedures will be executed.

- 7) After the test procedures have been executed, the Field Switch will be allowed to run, uninterrupted, for a burn-in period of seventy-two (72) hours.
- 8) At the end of the burn-in period, the unit will be re-started and configuration verified.

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

- 1) 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.
- 2) The Contractor shall provide all test equipment and software necessary to perform the tests.
- 3) After successful completion of the SAT, the Department will configure and connect the Field Switch to the GDOT Network.
- 4) Verify communications and network control from the Field Switch to/from the Hub and TMC.
- 5) Verify system integrity through comprehensive diagnostics.
- 6) Verify 10/100Base-T/TX interfaces and operations.
- 7) Verify 1000Base-X interfaces and operations.

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. Video Encoders & Decoders (All Types)

Prior to acceptance of any Video Encoder and Decoder, (All types), the following shall be performed:

a. Stand-alone Acceptance Test (SAT)

- 1) 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 tests for review and approval by the Department.
- 2) The Contractor shall provide all test equipment and software necessary to perform the tests.
- 3) Using the Department approved Contractor-supplied test plan and procedures, the Department will perform SAT in a test area provided by the Department. A Contractor representative shall be present during the SAT.
- 4) The Video Encoder/Decoder will be assembled and connected to power in a stand-alone configuration.
- 5) The Video Encoder/Decoder will be powered up and allowed to initialize, boot and run self-diagnostic tests as defined in the Department-approved test procedures.
- 6) After the Video Encoder/Decoder has started and initialized, the test procedures will be executed.
- 7) After the test procedures have been executed, the Video Encoder/Decoder will be allowed to run, uninterrupted, for a burn-in period of seventy-two (72) hours.
- 8) At the end of the burn-in period, the unit will be restarted and configuration verified.

Upon completion of all test procedures, the Contractor will be notified of SAT acceptance or failure. If the unit fails the test, the Contractor shall replace the unit and/or update the firmware as required at no additional cost to the Department and the test procedure shall be restarted.

b. Operational Test

- 1) 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.
- 2) After successful completion of the SAT, the Contractor shall configure and connect the Video Encoder to the field switch and GDOT network.
- 3) Along with the Video Encoder, the Contractor shall provide a Video Decoder unit (as specified herein), a video monitor, a laptop, and camera control application provided by the Department. The Contractor shall be responsible to provide all test equipment and software necessary to perform the tests.
- 4) Verify MPEG video performance over the GDOT network.
- 5) Verify serial data channel performance using NaviGAtor PTZ control commands.
- 6) Verify and demonstrate user programmable parameters and functions.
- 7) Verify and demonstrate network management and remote configuration.

Upon completion of all the tests, the Contractor will be notified of Operational Test acceptance or failure. If the unit fails the test, the Contractor shall replace the unit and/or update the firmware as required at no additional cost to the Department and the test procedures shall be re-started.

6. 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 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. Include in the cost of training all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

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:

Field Switches

- Unit set-up and configuration
- Diagnostic and maintenance
- Performance tuning
- Hands-on use of Field Switches for each trainee

Video Encoders and Decoders

- Installation of all digital video compression system equipment
- Explanation of MPEG-4 digitized video
- Maintenance of all digital video encoder and decoder system components including software
- Measurement of digital video signals
- Hands-on use of digital video transport system equipment for each trainee

If CCTV training is also required in the project, digital video transport system training shall be provided in conjunction with the CCTV training specified herein. If so, the total of the CCTV and digital video transport system training shall consist of at least eight (8) clock hours of training for each participant. Meet all CCTV training requirements of Subsection 936.3.08.

939.4 Measurement

B. 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. Video Encoders, Type B:

Video Encoders, Type B, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

8. Video Encoders, Type C:

Video Encoders, Type C, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

9. Video Decoders, Type B:

Video Decoders, Type B, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

10. Video Decoders, Type C:

Video Decoders, Type C, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

11. Equipment Frame:

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

12. Dial-Up Modems:

As required, dial-up modems are measured for payment by the number actually installed, complete, functional and accepted. For each unit installed, furnish and install all mounting and interconnection materials, including but not limited to card cages, shelves, hardware, fiber, jumper cables, RS-232/422/485 converters and power supply cables at no separate cost to the Department.

C. 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.

D. Electrical Power Service Assembly

Electrical power service assemblies are measured for payment by the number actually installed, complete, functional, and accepted. For each assembly installed, furnish all required items, including but not limited to conduit; riser; wiring; hardware; disconnect; meter base; and Class 3, 30 ft. (9 m) timber pole at no separate cost to the Department. Exceptions to the previous sentence include horizontal conduit, wiring, Type 2 pull boxes, electrical junction boxes, and directional bores between the electrical service pole to the equipment cabinet requiring power service which will be measured for payment as conduit, nonmetal, type 2 – power service as per Section 682.

E. Testing

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

F. Training

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

939.4.02 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	Electrical Power Service Assembly (type)	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	Video Encoder, Type _	Per Each
Item No. 939	Video Decoder, Type _	Per Each
Item No. 939	Hub Uninterruptible Power Supply	Per Each
Item No. 939	Equipment Frame	Per Each
Item No. 939	Testing	Lump Sum
Item No. 939	Training	Lump Sum

939.5.01 Adjustments

Not applicable