Florida Department of Transportation

CHARLIE CRIST
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

STEPHANIE KOPELOUSOS
SECRETARY

January 22, 2010

Monica Gourdine
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 784
Proposed Specification: **7840104 ITS – Network Devices.**

Dear Ms. Gourdine:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

These changes were proposed by Trey Tillander of the State Traffic Engineering and Operations Office to define minimum requirements for video encoders that include support of the H.264 compression standard, to clarify requirements for serial port attributes, and to delete duplicate language requiring Design Approval Lists.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to ST986RP or rudy.powell@dot.state.fl.us.

If you have any questions relating to this specification change, please call Rudy Powell, State Specifications Engineer at 414-4280.

Sincerely,

Signature on File

Rudy Powell, Jr., P.E.
State Specifications Engineer

RP/ft
Attachment
cc: Gregory Jones, Chief Civil Litigation
Florida Transportation Builders' Assoc.
State Construction Engineer

INTELLIGENT TRANSPORTATION SYSTEMS–NETWORK DEVICES.
(REV ~~1-22-*11-09*-09~~*1-20-10*~~) (FA 2-4-09) (7-09)~~

SUBARTICLE 784-1.4 (of the Supplemental Specifications) is deleted and the following substituted:

784-1.4 Testing:

784-1.4.1 General: Subject the MFES to ~~design approval tests (DATs) and~~ field acceptance tests (FATs). Develop and submit a test plan for ~~DATs and~~ FATs to the Engineer for consideration and approval.

~~The Engineer may accept certification by an independent testing laboratory in lieu of the DATs to satisfy the requirement that certain features and functions have been witnessed and documented as performing satisfactorily. The Contractor shall arrange for and conduct the tests and is responsible for satisfying all inspection requirements prior to submission for the Engineer's inspection and acceptance.~~

The Engineer reserves the right to witness all ~~DATs and~~ FATs. Complete the tests within five calendar days.

~~**784-1.4.2 Transient, Temperature, Voltage, and Humidity Testing:**~~
~~The selected manufacturer will provide two MFES units for testing and evaluation purposes at no cost to the Department. The units shall be tested and evaluated as indicated below.~~

~~The Department's Traffic Engineering Research Laboratory (TERL), or another independent testing facility of the Engineer's choice, shall test the units. The TERL shall perform the test procedures as noted within Section 2.2.7 of the NEMA TS 2-1998 standard and shall include the following tests:~~

~~1. Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.~~

~~2. Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).~~

~~3. Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.~~

~~4. Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.~~

~~5. Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.~~

~~6. Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.~~

~~7. Test G: Test Termination (All Tests).~~

~~8. Test H: Appraisal of Equipment under Test.~~

784-1.4.*2*~~3~~ Field Testing: Once the MFES has been installed, conduct local FATs at the MFES field site according to the submitted test plan. Perform the following:

1. Verify that physical construction has been completed as detailed in the plans.

2. Inspect the quality and tightness of ground and surge protector connections.

3. Verify proper voltages for all power supplies and related power circuits.

4. Connect devices to the power sources.

5. Verify all connections, including correct installation of communication and power cables.

6. Verify configuration of the MFES Internet Protocol (IP) addresses and subnetwork mask.

7. Verify the network connection to the MFES through ping and telnet sessions from a remote personal computer (PC).

8. Perform testing on multicast routing functionality.

SUBARTICLE 784-2.2.2 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.2.2 Serial Interface: Ensure that the device server provides a minimum of one serial data interface and connector as specified in the plans that conforms to EIA-232/422/485 standards. Ensure that the device server supports 2-wire and 4-wire EIA-485 connections. Ensure that the device server serial port(s) support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, *and* odd~~, mark, and space~~); and stop bits (1 or 2).

Ensure that the device server provides flow control (request to send [RTS]/clear to send [CTS] and transmit on/transmit off [XON/XOFF]), as well as allow control of the data terminal ready (DTR), data carrier detect (DCD), data set ready (DSR), CTS, and RTS signals. Ensure that the device server supports RTS toggle for half-duplex emulation.

SUBARTICLE 784-24 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.4 ~~Device and Subsystem~~ Testing:

784-2.4.1 ~~Contractor Test Results~~*General*: *Subject the Device Server to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.*~~Supply documentation of all test results to the Engineer prior to approval of the system.~~

~~In lieu of or in addition to the above, the Engineer may consider outside contractor and third party test results.~~

~~**784-2.4.2 Environmental Testing:** Provide two device servers for testing and evaluation purposes at no cost to the Department. The servers shall be tested and evaluated as specified in this section.~~

~~**784-2.4.2.1 Transient, Temperature, Voltage, and Humidity Test Specifications:** The Department's Traffic Engineering Research Laboratory (TERL), or an independent testing facility of the Engineer's choice, shall test the device servers. The testing shall be performed according to the procedures in Section 8.7 of the NEMA TS 2 standard and shall include:~~

~~1. Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.~~

~~2. Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).~~

~~3. Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.~~

~~4. Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.~~

~~5. Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.~~

~~6. Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.~~

~~7. Test G: Test Termination (All Tests).~~

~~8. Test H: Appraisal of Equipment under Test.~~

784-2.4.2.~~2~~ Field Test*ing*~~ Requirements~~: Perform local field operational tests at device server field sites according to the test procedures stated herein.

1. Verify that physical construction has been completed as specified in the plans.
2. Verify the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify the network connection to the device server through ping and telnet session from a remote personal computer (PC).
7. Verify serial data transmission through the device server.

SUBARTICLE 784-3.2 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2 Materials:

784-3.2.1 General: Use DVEs and DVDs that are specialized network-based hardware devices and software which allow video and data signals to be encapsulated and transmitted across IP networks. Ensure that the video and data packets produced by the DVE and placed onto the network allow reconstruction of digital video signals by hardware-based and software-based DVDs that are also attached to the network.

Ensure that the complete video and data transmission system, defined as the combination of DVE and DVD hardware together with the existing or planned network infrastructure, simultaneously transports video and data from multiple remote field locations to multiple monitoring locations for roadway surveillance and traffic management. Ensure that end-to-end transmission of 30 frames-per-second (fps)

D1 resolution video and data signals from DVE inputs to DVD outputs occurs within 250 milliseconds.

784-3.2.2 Software: Provide a software decoding and control package that allows the viewing of any video source connected to the network through a DVE, and which allows the pan-tilt-zoom (PTZ) control of any PTZ camera on the network, the discovery of DVE and DVD devices on the network, and the control and adjustment of programmable parameters in the DVE and DVD equipment, including the network addresses of these devices, at no additional cost.

Provide all setup, control programs, and diagnostic software related to the DVE or DVD. Provide all equipment licenses, where required for any software or hardware in the system. Ensure that the DVE and DVD are compatible with the Department's SunGuide®~~SM~~ Software System.

784-3.2.3 ***MPEG-2*** **Format:** Furnish DVE and DVD components that utilize the Moving Picture Experts Group's MPEG-2 video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 13818 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Differentiated Services/Quality of Service (DiffServ/QoS) software components. Ensure that the DVE provides 99.999% error-free operation. *Ensure MPEG-2 DVE and DVD equipment supports programmable bit rates from 1Mbps to 8 Mbps. Ensure that MPEG-2 equipment supports fixed bit rate mode.*

~~The Department shall consider the introduction, and possible use, of maturing MPEG-4 and H.264 video compression technologies as an alternate to MPEG-2 if the proposed device meets all requirements herein, excluding MPEG-2 specifics, and provided that the device is interoperable with the Department's SunGuide℠ software. The Department may require certification of compliance with these specifications by an independent technical laboratory. The cost of this certification shall be the responsibility of the Contractor.~~

784-3.2.4 H.264 Format: *Furnish DVE and DVD components that utilize video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, Real Time Streaming Protocol (RTSP), and Differentiated Services/Quality of Service (DiffServ/QoS) software components. Ensure that the DVE provides 99.999% error-free operation. Ensure H.264 DVE and DVD equipment supports programmable bit rates from 64kbps to 8 Mbps. Ensure that H.264 equipment supports fixed bit rate mode.*

784-3.2.4*5* **Digital Video Encoder:** Provide a DVE that is a hardware-based network device able to accept a minimum of one analog National Television System Committee (NTSC) video input and digitize it for transport across IP networks. Use a DVE that provides a minimum of *one*~~two~~ serial data interfaces~~s~~ for transmission of command and control data to other devices (typically camera PTZ commands), as well as

console and configuration functions. Provide compatible decoder software along with the DVE at no additional cost, as shown in the plans, or as directed by the Engineer.

784-3.2.5~~5~~*6* Digital Video Decoder: Provide a DVD that is either a hardware-based network device or a software application that resides on a workstation personal computer (PC).

784-3.2.5~~5~~*6*.1 Hardware-based Decoder: Provide a hardware-based decoder that has a minimum of one analog NTSC video output and decodes digital video and data streams present on an IP network into analog formats for interconnection with other devices. Use a DVD that has a minimum of *one*~~two~~ serial data interface~~s~~ for transmission of command and control data to other devices, as well as console and configuration functions. Use a DVD that includes an Ethernet interface for connection to IP networks.

784-3.2.5~~5~~*6*.2 Software-based Decoder: Provide a software-based DVD that is compatible with the Department's SunGuide®~~SM~~ software. Ensure that any software-based decoder applications do not interfere with SunGuide®~~SM~~ software operating when installed and used together on a shared hardware platform. Ensure that the software application provides PC desktop display of IP network video streams and control of any PTZ camera connected to the network. The decoder and PTZ functions may be achieved through the use of discrete software applications. Ensure that the software-based decoder offers an open *Application Programming Interface (*API*)* and software development kit available to the Department at no cost for integration with third party software and systems.

784-3.2.6*7* Interoperability: Provide DVE and DVD devices and software that are interoperable and interchangeable with DVE and DVD devices and software from other manufacturers. Ensure that the DVE is compatible and fully interoperable with software and hardware DVDs from the DVE manufacturer, as well as a minimum of two software and hardware DVDs from other manufacturers. Ensure that the DVD is compatible and fully interoperable with DVEs from the DVD manufacturer, as well as a minimum of two other DVEs from other manufacturers.

784-3.2.7~~7~~*8* Video Specifications: Ensure that any video input utilizes a BNC connector and delivers 1 volt peak-to-peak (Vp-p) NTSC composite video signals for encoding. Ensure that the DVE and DVD operate with both color and monochrome video, and that they allow the user to select and adjust video resolution. Ensure that the DVE and DVD support resolutions that include, but are not limited to, those defined in Table 3.1. Ensure that the DVE and DVD are capable of delivering color and monochrome video at 30 fps regardless of resolution~~, and that they can do so using, programmable bit rates from 128 Kbps to 8 Mbps. Ensure that the DVE provides fixed and variable bit rate modes.~~

Table 3.1 – Resolution ~~Specifications~~*Requirements*	
~~Resolution~~*Format*	~~NTSC Requirements~~*Resolutions*
MPEG-2	*352 x 240, 352 x 480, 720 x 480*
H.264	*176 x 120, 352 x 240, 720 x 480*
~~D1~~	~~720 horizontal x 480 vertical~~

~~1/2 D1~~	~~352 horizontal x 480 vertical~~
~~SIF~~	~~352 horizontal x 240 vertical~~
Note: The resolutions attained depend on the data transmission rate.	

784-3.2.8~~9~~ Serial Interface: *Ensure that hardware-based DVEs and DVDs provide a minimum of one serial data interface and connector that conforms to EIA-232/422/485 standards. Ensure that the device server supports 2-wire and 4-wire EIA-485 connections. Ensure that the device server serial port(s) support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).*

Ensure that the serial interface provides flow control (request to send [RTS]/clear to send [CTS] and transmit on/transmit off [XON/XOFF]), as well as allow control of the data terminal ready (DTR), data carrier detect (DCD), data set ready (DSR), CTS, and RTS signals. Ensure that the serial interface supports RTS toggle for half-duplex emulation. Ensure that hardware-based DVEs and DVDs provide a TCP/IP interface to their serial port using a network socket connection with configurable IP address and port number.

~~Use hardware-based DVEs and DVDs having a minimum of two serial data interfaces and connectors that conform to EIA-232/422/485 standards. Ensure that the serial interfaces support EIA-232 as well as 2-wire and 4-wire EIA-422/485 connections. Ensure that the serial port(s) support data rates up to 115.2 Kbps. Serial interface parameters, such as data format, number of bits, handshaking, and parity, shall be software programmable through local connection to the DVE and DVD and through connections over the network.~~ Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

784-3.2.9~~10~~ Network Interface: Ensure that the DVE/DVD local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. Provide a DVE having a minimum of one Ethernet port, which shall be a 10/100 Base-TX connection or a 100 Base-FX ST, SC, LC or FC interface capable of multi-hop configuration using two sets of optical ports (e.g., Tx^1, Rx^1, Tx^2, Rx^2). Ensure that the connector complies with applicable EIA and TIA requirements. Provide copper-based network interface ports that utilize RJ-45 connectors. Ensure that all fiber-based ports are single mode and provide a link budget of 30 dB or greater.

Ensure that all Category 5E, unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-A standard. Ensure that the network communication conforms to User Datagram Protocol (UDP), Version 4 of the Internet Protocol (IP) and Version 2 of the Internet Group Multicast Protocol (IGMP).

784-3.2.10~~1~~ Front Panel Status Indicators: Provide DVEs and DVDs that have light-emitting diode (LED) displays, liquid crystal displays (LCDs), or similar illuminated displays to indicate status for power, data activity, link status, and video transmission.

784-3.2.11~~2~~ Configuration and Management: Provide DVEs and DVDs that support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including

but not limited to addressing, serial port configuration, video settings, device monitoring, ~~diagnostic utilities,~~ and security functions. Ensure that the DVE and DVD support configuration and management via serial login, telnet login, and Simple Network Management Protocol (SNMP).

784-3.2.12~~2~~*3* Electrical Specifications: Ensure that all wiring meets NEC requirements and standards. Provide equipment that operates on a nominal voltage of 120 volts alternating current (V_{AC}). The equipment shall operate within a voltage range of 89 V_{AC} to 135 V_{AC}. The operating frequency range for power shall be 60 hertz ±3 Hz. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter.

784-3.2.13~~4~~*4* Environmental Specifications: Except as may be stated otherwise in the plans, provide DVEs and *hardware* DVDs that meet all specifications during and after being subjected to an ambient operating temperature range of -30 degrees (°) to 165° Fahrenheit (F) as defined in the environmental requirements section of the NEMA TS 2 standard, with a maximum non-condensing relative humidity of 95%.

Ensure that cabinets housing system components comply with the environmental requirements detailed in the NEMA TS 2 standard. House the DVE in a field cabinet with protection from moisture and airborne contaminants, blowing rain, wind, blowing sand, blowing dust, humidity, roadside pollutants, vandalism, and theft. Ensure that the DVE is resistant to vibration and shock, and conforms to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

Ensure that a *hardware* DVD installed in a climate-controlled environment, such as a TMC computer room, meets all specifications during and after being subjected to an ambient operating temperature range of 32 degrees (°) to 113° Fahrenheit (F).

SUBARTICLE 784-3.4 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.4 ~~Device and Subsystem~~ Testing:

~~Supply documentation of all test results to the Engineer prior to approval of the system. In lieu of or in addition to this requirement, the Engineer may consider outside contractor and third party test results.~~

784-3.4.1 ~~Environmental Testing~~*General*: *Subject the DVEs and DVDs to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval.*~~Provide two units for environmental testing and evaluation purposes at no cost to the Department. The units shall be tested and evaluated as specified in this section. The FDOT Traffic Engineering Research Laboratory (TERL), or another independent testing facility of the Engineer's choice, shall test the DVE and hardened DVD with respect to environmental requirements. The TERL shall perform the test procedures noted in Section 8.7 of the NEMA TS 2 standard, and shall include the following tests:~~

~~1 .Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.~~

~~2. Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).~~

~~3. Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.~~

~~4. Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.~~

~~5. Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.~~

~~6. Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.~~

~~7. Test G: Test Termination (All Tests).~~

~~8. Test H: Appraisal of Equipment under Test.~~ *The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.*

784-3.4.2 Field Test*ing*~~ Requirements~~: Perform local field operational tests at the device field site and end-to-end video streaming tests as required by the Engineer in order to demonstrate compliance with Department specifications. Testing will include, but not be limited to, the following:

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify video image is present and free from oversaturation and any other image defect in both color and monochrome mode.
7. Verify network connection to the DVE and DVD through ping and telnet session from a remote PC.
8. Verify serial data transmission through the DVE and DVD serial ports.
9. Verify support of unicast, multicast, SAP, and QoS.

INTELLIGENT TRANSPORTATION SYSTEMS–NETWORK DEVICES.
(REV 1-20-10

SUBARTICLE 784-1.4 (of the Supplemental Specifications) is deleted and the following substituted:

784-1.4 Testing:

784-1.4.1 General: Subject the MFES to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.

784-1.4.2 Field Testing: Once the MFES has been installed, conduct local FATs at the MFES field site according to the submitted test plan. Perform the following:

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify configuration of the MFES Internet Protocol (IP) addresses and subnetwork mask.
7. Verify the network connection to the MFES through ping and telnet sessions from a remote personal computer (PC).
8. Perform testing on multicast routing functionality.

SUBARTICLE 784-2.2.2 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.2.2 Serial Interface: Ensure that the device server provides a minimum of one serial data interface and connector as specified in the plans that conforms to EIA-232/422/485 standards. Ensure that the device server supports 2-wire and 4-wire EIA-485 connections. Ensure that the device server serial port(s) support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that the device server provides flow control (request to send [RTS]/clear to send [CTS] and transmit on/transmit off [XON/XOFF]), as well as allow control of the data terminal ready (DTR), data carrier detect (DCD), data set ready (DSR), CTS, and RTS signals. Ensure that the device server supports RTS toggle for half-duplex emulation.

SUBARTICLE 784-24 (of the Supplemental Specifications) is deleted and the following substituted:

784-2.4 Testing:

784-2.4.1 General: Subject the Device Server to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days. **784-2.4.2 Field Testing:** Perform local field operational tests at device server field sites according to the test procedures stated herein.

1. Verify that physical construction has been completed as specified in the plans.
2. Verify the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify the network connection to the device server through ping and telnet session from a remote personal computer (PC).
7. Verify serial data transmission through the device server.

SUBARTICLE 784-3.2 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.2 Materials:

784-3.2.1 General: Use DVEs and DVDs that are specialized network-based hardware devices and software which allow video and data signals to be encapsulated and transmitted across IP networks. Ensure that the video and data packets produced by the DVE and placed onto the network allow reconstruction of digital video signals by hardware-based and software-based DVDs that are also attached to the network.

Ensure that the complete video and data transmission system, defined as the combination of DVE and DVD hardware together with the existing or planned network infrastructure, simultaneously transports video and data from multiple remote field locations to multiple monitoring locations for roadway surveillance and traffic management. Ensure that end-to-end transmission of 30 frames-per-second (fps) D1 resolution video and data signals from DVE inputs to DVD outputs occurs within 250 milliseconds.

784-3.2.2 Software: Provide a software decoding and control package that allows the viewing of any video source connected to the network through a DVE, and which allows the pan-tilt-zoom (PTZ) control of any PTZ camera on the network, the discovery of DVE and DVD devices on the network, and the control and adjustment of programmable parameters in the DVE and DVD equipment, including the network addresses of these devices, at no additional cost.

Provide all setup, control programs, and diagnostic software related to the DVE or DVD. Provide all equipment licenses, where required for any software or hardware in the system. Ensure that the DVE and DVD are compatible with the Department's SunGuide® Software System.

784-3.2.3 MPEG-2 Format: Furnish DVE and DVD components that utilize the Moving Picture Experts Group's MPEG-2 video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 13818 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Differentiated Services/Quality of Service (DiffServ/QoS) software components. Ensure that the DVE provides 99.999% error-free operation. Ensure MPEG-2 DVE and DVD equipment supports programmable bit rates from 1Mbps to 8 Mbps. Ensure that MPEG-2 equipment supports fixed bit rate mode.

784-3.2.4 H.264 Format: Furnish DVE and DVD components that utilize video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, Real Time Streaming Protocol (RTSP), and Differentiated Services/Quality of Service (DiffServ/QoS) software components. Ensure that the DVE provides 99.999% error-free operation. Ensure H.264 DVE and DVD equipment supports programmable bit rates from 64kbps to 8 Mbps. Ensure that H.264 equipment supports fixed bit rate mode.

784-3.2.5 Digital Video Encoder: Provide a DVE that is a hardware-based network device able to accept a minimum of one analog National Television System Committee (NTSC) video input and digitize it for transport across IP networks. Use a DVE that provides a minimum of one serial data interface for transmission of command and control data to other devices (typically camera PTZ commands), as well as console and configuration functions. Provide compatible decoder software along with the DVE at no additional cost, as shown in the plans, or as directed by the Engineer.

784-3.2.6 Digital Video Decoder: Provide a DVD that is either a hardware-based network device or a software application that resides on a workstation personal computer (PC).

784-3.2.6.1 Hardware-based Decoder: Provide a hardware-based decoder that has a minimum of one analog NTSC video output and decodes digital video and data streams present on an IP network into analog formats for interconnection with other devices. Use a DVD that has a minimum of one serial data interface for transmission of command and control data to other devices, as well as console and configuration functions. Use a DVD that includes an Ethernet interface for connection to IP networks.

784-3.2.6.2 Software-based Decoder: Provide a software-based DVD that is compatible with the Department's SunGuide® software. Ensure that any software-based decoder applications do not interfere with SunGuide® software operating

when installed and used together on a shared hardware platform. Ensure that the software application provides PC desktop display of IP network video streams and control of any PTZ camera connected to the network. The decoder and PTZ functions may be achieved through the use of discrete software applications. Ensure that the software-based decoder offers an open Application Programming Interface (API) and software development kit available to the Department at no cost for integration with third party software and systems.

784-3.2.7 Interoperability: Provide DVE and DVD devices and software that are interoperable and interchangeable with DVE and DVD devices and software from other manufacturers. Ensure that the DVE is compatible and fully interoperable with software and hardware DVDs from the DVE manufacturer, as well as a minimum of two software and hardware DVDs from other manufacturers. Ensure that the DVD is compatible and fully interoperable with DVEs from the DVD manufacturer, as well as a minimum of two other DVEs from other manufacturers.

784-3.2.8 Video Specifications: Ensure that any video input utilizes a BNC connector and delivers 1 volt peak-to-peak (Vp-p) NTSC composite video signals for encoding. Ensure that the DVE and DVD operate with both color and monochrome video, and that they allow the user to select and adjust video resolution. Ensure that the DVE and DVD support resolutions that include, but are not limited to, those defined in Table 3.1. Ensure that the DVE and DVD are capable of delivering color and monochrome video at 30 fps regardless of resolution.

Table 3.1 – Resolution Requirements

Format	Resolutions
MPEG-2	352 x 240, 352 x 480, 720 x 480
H.264	176 x 120, 352 x 240, 720 x 480
Note: The resolutions attained depend on the data transmission rate.	

784-3.2.9 Serial Interface: Ensure that hardware-based DVEs and DVDs provide a minimum of one serial data interface and connector that conforms to EIA-232/422/485 standards. Ensure that the device server supports 2-wire and 4-wire EIA-485 connections. Ensure that the device server serial port(s) support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that the serial interface provides flow control (request to send [RTS]/clear to send [CTS] and transmit on/transmit off [XON/XOFF]), as well as allow control of the data terminal ready (DTR), data carrier detect (DCD), data set ready (DSR), CTS, and RTS signals. Ensure that the serial interface supports RTS toggle for half-duplex emulation. Ensure that hardware-based DVEs and DVDs provide a TCP/IP interface to their serial port using a network socket connection with configurable IP address and port number.

Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

784-3.2.10 Network Interface: Ensure that the DVE/DVD local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard

for 10/100 Ethernet connections. Provide a DVE having a minimum of one Ethernet port, which shall be a 10/100 Base-TX connection or a 100 Base-FX ST, SC, LC or FC interface capable of multi-hop configuration using two sets of optical ports (e.g., Tx^1, Rx^1, Tx^2, Rx^2). Ensure that the connector complies with applicable EIA and TIA requirements. Provide copper-based network interface ports that utilize RJ-45 connectors. Ensure that all fiber-based ports are single mode and provide a link budget of 30 dB or greater.

Ensure that all Category 5E, unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-A standard. Ensure that the network communication conforms to User Datagram Protocol (UDP), Version 4 of the Internet Protocol (IP) and Version 2 of the Internet Group Multicast Protocol (IGMP).

784-3.2.11 Front Panel Status Indicators: Provide DVEs and DVDs that have light-emitting diode (LED) displays, liquid crystal displays (LCDs), or similar illuminated displays to indicate status for power, data activity, link status, and video transmission.

784-3.2.12 Configuration and Management: Provide DVEs and DVDs that support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including but not limited to addressing, serial port configuration, video settings, device monitoring, and security functions. Ensure that the DVE and DVD support configuration and management via serial login, telnet login, and Simple Network Management Protocol (SNMP).

784-3.2.13 Electrical Specifications: Ensure that all wiring meets NEC requirements and standards. Provide equipment that operates on a nominal voltage of 120 volts alternating current (V_{AC}). The equipment shall operate within a voltage range of 89 V_{AC} to 135 V_{AC}. The operating frequency range for power shall be 60 hertz ±3 Hz. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter.

784-3.2.14 Environmental Specifications: Except as may be stated otherwise in the plans, provide DVEs and hardware DVDs that meet all specifications during and after being subjected to an ambient operating temperature range of -30 degrees (°) to 165° Fahrenheit (F) as defined in the environmental requirements section of the NEMA TS 2 standard, with a maximum non-condensing relative humidity of 95%.

Ensure that cabinets housing system components comply with the environmental requirements detailed in the NEMA TS 2 standard. House the DVE in a field cabinet with protection from moisture and airborne contaminants, blowing rain, wind, blowing sand, blowing dust, humidity, roadside pollutants, vandalism, and theft. Ensure that the DVE is resistant to vibration and shock, and conforms to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

Ensure that a hardware DVD installed in a climate-controlled environment, such as a TMC computer room, meets all specifications during and after being subjected to an ambient operating temperature range of 32 degrees (°) to 113° Fahrenheit (F).

SUBARTICLE 784-3.4 (of the Supplemental Specifications) is deleted and the following substituted:

784-3.4 Testing:

784-3.4.1 General: Subject the DVEs and DVDs to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.

784-3.4.2 Field Testing: Perform local field operational tests at the device field site and end-to-end video streaming tests as required by the Engineer in order to demonstrate compliance with Department specifications. Testing will include, but not be limited to, the following:

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify video image is present and free from oversaturation and any other image defect in both color and monochrome mode.
7. Verify network connection to the DVE and DVD through ping and telnet session from a remote PC.
8. Verify serial data transmission through the DVE and DVD serial ports.
9. Verify support of unicast, multicast, SAP, and QoS.