Origination Form

Specifications

Name:	Ronald Meyer	**Specification Number:**	996-1.3, 996-2.2, 996-2.3, 996-3.2.1, 996-3.2.2, 996-3.2.5, 996-3.2.8, 993-3.3.1, 996-3.3.2, 996-3.3.5, 996-3.4.1, 996-3.4.2, 996-3.5, 996-3.6.2, 996-3.7, 996-4.2.6, 996-6.3.2, 996-7.2.1, 996-7.2.7, 996-7.3.5,
Email:	ronald.meyer@dot.state.fl.us	**Associated Specs:**	684
Date:	2024-06-30T14:00:57Z	**Verified:**	VERIFIED

Summary:

The following changes are proposed: 1. Remove obsolete reference to Electronic Industries Alliance (EIA). 2. Remove material requirements for obsolete analog cameras. 3. Consolidate requirements for PTZ cameras. 4. Update material requirements for Video Display Control Systems. 5. Introduce material requirements for Wireless Communication Systems and cellular modems. 6. Remove material requirements for obsolete standalone encoders and decoders. 7. Update NEMA references for consistency with other sections.

Justification:

The language must be changed to remove obsolete content and reflect currently used devices and technologies.

Do the changes affect other types of specifications?

Neither

List Specifications Affected:

Other Affected Documents/Offices	Contacted	Yes/No
Other Standard Plans		No
Florida Design Manual		No
Structures Manual		No
Basis of Estimates Manual	Ryan Gray	Yes
Approved Product List	Melissa Hollis	Yes
Construction Office		No

Maintenance Office		No
Materials Manual		No
Traffic Engineering Manual		No

Are changes in line with promoting and making progress on improving safety, enhancing mobility, inspiring innovation, and fostering talent; explain how?

Yes. Changes reflect stakeholder needs and improve consistency of specification content.

What financial impact does the change have; project costs, pay item structure, or consultant fees?

No expected financial impact. Only minor changes to pay item structures.

What impact does the change have on production or construction schedules?

No expected impacts to production or construction schedules.

How does this change improve efficiency or quality?

Changes improve efficiency and quality by updating content to reflect currently used devices and technology, reducing need for project-specific MSPs and TSPs, via consistency with similar requirements, and adherence to standardized formatting styles.

Which FDOT offices does the change impact?

Traffic Engineering and Operations

What is the impact to districts with this change?

Need for TSPs and MSPs on District projects for Wireless Communication Systems and cellular modems should be reduced.

Does the change shift risk and to who?

No expected shift in risk.

Provide summary and resolution of any outstanding comments from the districts or industry.

Comments and Responses are available on the Track the Status of Revisions hyperlink located on the Specifications landing page: https://www.fdot.gov/programmanagement/Specs.shtm

What is the communication plan?

Through the established specification revision process (e.g., Internal and Industry Review)

What is the schedule for implementation?

The Standard Specifications eBook and Workbook are effective July 1st every year.

INTELLIGENT TRANSPORTATION SYSTEM DEVICE MATERIALS
(REV 6-30-2024)

SUBARTICLE 996-1.3 is deleted and the following substituted:

996-1.3 Abbreviations: The following abbreviations are used in this Section:

Alternating Current (AC)
Closed Circuit Television (CCTV)
Direct Current (DC)
~~Electronic Industries Alliance (EIA)~~
Hypertext Transfer Protocol (HTTP)
Internet Protocol (IP)
Local Area Network (LAN)
Network Time Protocol (NTP)
Pan, Tilt, Zoom (PTZ)
Telecommunications Industry Association (TIA)
Uniform Resource Locator (URL)
Ultraviolet (UV)

ARTICLE 996-2 is deleted and the following substituted:

996-2 Video Equipment.

996-2.1 General: All CCTV camera equipment shall be listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6. All parts shall be constructed of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. All fasteners exposed to the elements shall be Type 304 or 316 passivated stainless steel.

996-2.2 CCTV Camera:

996-2.2.1 Camera: CCTV cameras shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216. ~~CCTV c~~Cameras shall be compatible with the current version of the Department's SunGuide® software system. Camera types include ~~dome~~ pan-tilt-zoom (PTZ)~~, external positioner PTZ,~~ and fixed. ~~Video types include analog and internet protocol (IP). Analog camera shall produce a National Television System Committee (NTSC) composite video output of 1V peak-to-peak (Vp-p) at 75 ohms with a minimum resolution of 470 horizontal and 350 vertical TV lines~~.

~~Analog and IP cameras shall~~Cameras shall be IP cameras that shall provide the following features and capabilities:

1. Day (color)/night (monochrome) switchover.
2. Manual and automatic focus.
3. Automatic iris.
4. Ability to produce clear, detailed, and usable video images of the areas, objects, and other subjects visible from a roadside ~~CCTV~~ field site. Video produced by the camera is true, accurate, distortion free, and free from transfer smear, oversaturation, and any

other image defect that negatively impacts image quality under all lighting and weather conditions in both color and monochrome modes.

5. ~~User-selectable a~~Automatic gain control (AGC) ~~that is peak-average adjustable to 28 dB~~.

6. A minimum signal-to-noise ratio of 50 dB.

7. Automatic color balance that references the white areas of the scene through the lens.

8. An automatic electronic shutter that is user selectable from 1/60 to 1/10,000 of a second.

9. PTZ cameras shall include a minimum 10x digital zoom.

10. PTZ cameras shall include programmable azimuth and compass display with ability to display pan and tilt position with a 1 degree resolution.

~~CCTV c~~Cameras shall provide titling and masking features including, but not limited to, programmable camera title, programmable preset titles for each preset position, and programmable privacy zones. Programmable titles shall allow a minimum of 18 characters per line.

996-2.2.2 Lens: ~~Standard definition PTZ cameras shall include a minimum 22x motorized optical zoom lens with automatic iris. High definition~~ PTZ cameras shall include a minimum 18x motorized optical zoom lens with automatic iris. Fixed cameras shall have a 3-9 mm varifocal lens with automatic iris unless otherwise shown in the Plans. The lens shall have a maximum aperture of at least f/1.6 and the depth of field shall provide a clear image of roadside areas under all lighting conditions.

996-2.2.3 Pan/Tilt Mechanism for ~~Dome Type~~ Cameras: ~~Dome~~ PTZ cameras shall meet the following requirements:

1. Have an integrated pan/tilt mechanism that provides 360 degree continuous pan with a minimum 90 degree tilt range (i.e., 0 degrees to minus 90 degrees);

2. Provide for variable speed control;

3. Have a preset position return accuracy of plus or minus 0.36 degree, or less than 0.10% or better;

4. Support a minimum of ~~64~~ 32 presets; support a minimum of one tour with a minimum of 32 presets; and support a minimum of eight programmable blackout zones.

~~The positioner within the dome-type CCTV camera shall have a minimum automatic pan speed of 240 degrees per second to a preset camera position, a maximum manual pan speed of 80 degrees per second minimum and a maximum manual tilt speed of 40 degrees per second minimum.~~

~~**996-2.2.4 Pan/Tilt Mechanism for External Positioner-Type Cameras:** External positioner-type CCTV cameras shall include a pan/tilt mechanism that provides 360 degree continuous pan with a minimum 115 degree tilt range (i.e., minus 90 to plus 25 degrees), provide for variable speed control, have a preset position return accuracy of plus or minus 0.36 degree or less than 0.10% or better, and support a minimum of 32 presets.~~

996-2.2.5~~4~~ Communication: ~~Analog CCTV cameras shall support the National Transportation Communications for ITS Protocol (NTCIP) 1205 v1.08. The camera shall communicate with other devices using Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA) 232 or TIA-422 at a rate of 9600 bps, transmission control~~

protocol (TCP)/IP, or user datagram protocol (UDP)/IP. All CCTV eCameras shall provide for remote firmware upgrades via the communication interface.

IP eCameras shall support either National Transportation Communications for ITS Protocol (NTCIP) 1205v01.08 or the Open Network Video Interface Forum (ONVIF) Core, Streaming, and Media Service specifications.

The eCameras shall implement all objects, operations, and commands required by SR-682-1.2.1-01, Supplemental CCTV Camera NTCIP and ONVIF Requirements, as published on the Department's State Traffic Engineering and Operations Office website at the following URL: https://www.fdot.gov/traffic/Traf_Sys/Product-Specifications.shtm.

996-2.2.4.1 Network Interface: The camera's Local Area Network (LAN) connection shall support the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet connections. The camera shall have a minimum of one 10/100 Base-TX connection Ethernet port.

Unshielded twisted pair/shielded twisted pair network cables shall be compliant with the TIA-568-B Standard. The network communication shall conform to TCP, UDP, IPv4, RTSP, and Internet Group Multicast Protocol Version 2 (IGMPv2), at a minimum. If the camera supports NTCIP, then the camera shall be able to be controlled via TCP/IP or UDP/IP.

996-2.2.4.2 Video Encoding: The camera shall utilize the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the ISO and IEC requirements detailed in the ISO/IEC 14496-10:2009 Standard.

Cameras shall establish unicast and multicast sessions using the Real-Time Streaming Protocol (RTSP). The encoded video shall transmit using programmable bit rates and the camera supports, at a minimum, a fixed bit rate mode. Cameras must be able to provide 2 simultaneous multicast streams using different configurations (e.g., multicast address, resolution, frame rate, bitrate, etc.).

The camera's encoded video shall support resolutions that include; but are not limited to, those defined in Table 996-1. The camera shall deliver color and monochrome video at 30 frames per second (fps), regardless of resolution.

Table 996-1
Minimum Resolution Requirements

Format	Vertical Resolutions
H.264	240, 480, 1080
Note: The resolutions attained depend on the data transmission rate.	

996-2.2.9.4.3 Configuration and Management: The camera shall support local and remote configuration and management via serial login, telnet login, or a web-based interface. Configuration and management functions shall include access to all user-programmable features including, but not limited to, network configuration, video settings, device monitoring, and security functions.

996-2.2.65 Electrical Requirements: Cameras shall operate on a nominal voltage of 120 V_{AC}. Provide an appropriate voltage converter for devices that require operating voltages of less than 120 V_{AC}.

996-2.2.76 Mechanical Requirements: Camera housings shall include a sunshield to reduce the solar heating of the camera. The total weight of dome-type PTZ CCTV cameras (including the housing, sunshield, and all internal components) shall be less than

~~17.0~~35 lbs. ~~The lower dome of the camera housing~~If the camera includes an acrylic lower dome, it shall be constructed of distortion free clear plastic.

Pressurized cameras~~dome-type housings~~ shall include a housing~~be~~ capable of pressurization at 5 psi using dry nitrogen, have a low-pressure alarm feature, and a NEMA 4X/IP-67 rating.

~~If a n~~Non-pressurized ~~dome-type housing enclosure is used, the unit shall be vented with a thermostat-controlled heater and blower. The non-pressurized enclosure~~cameras shall have a NEMA 4/IP-66 rating.

~~The total weight of external positioner-type CCTV cameras (including housing, sunshield, all internal components, and external pan and tilt mechanism) shall be less than 35 lb.~~

996-2.2.8~~7~~ Environmental Requirements: CCTV cameras shall perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

All CCTV cameras, mounting hardware, and any other camera-related material that is exposed to the environment shall be designed for 150 mph wind speeds and meet the requirements of the Department's Structures Manual.

~~**996-2.2.9 Additional Requirements for IP Cameras:**~~

~~**996-2.2.9.1 Video Encoding:** The camera shall utilize the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the ISO and IEC requirements detailed in the ISO/IEC 14496-10:2009 Standard.~~

~~Cameras shall establish unicast and multicast sessions using the Real-Time Streaming Protocol (RTSP). The encoded video shall transmit using programmable bit rates and the camera supports, at a minimum, a fixed bit rate mode.~~

~~**996-2.2.9.2 Encoded Video Requirements:** The camera's encoded video shall support resolutions that include; but are not limited to, those defined in Table 996-1. The camera shall deliver color and monochrome video at 30 frames per second (fps), regardless of resolution.~~

~~Table 996-1~~
~~Minimum Resolution Requirements~~

~~Format~~	~~Vertical Resolutions~~
~~H.264~~	~~240, 480~~

~~Note: The resolutions attained depend on the data transmission rate.~~

~~**996-2.2.9.3 Network Interface:** The camera's Local Area Network (LAN) connection shall support the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet connections. The camera shall have a minimum of one 10/100 Base-TX connection Ethernet port.~~

~~Unshielded twisted pair/shielded twisted pair network cables shall be compliant with the EIA/TIA-568-B Standard. The network communication shall conform to TCP, UDP, Version 4 of the IP, RTSP, and Version 2 of the Internet Group Multicast Protocol (IGMP), at a minimum. If the camera supports NTCIP, then the camera shall be able to be controlled via TCP/IP or UDP/IP.~~

~~**996-2.2.9.4 Configuration Management:** The camera shall support local and remote configuration and management via serial login, telnet login, or a web-based interface.~~

~~Configuration and management functions shall include access to all user-programmable features including, but not limited to, network configuration, video settings, device monitoring, and security functions.~~

996-2.3 Video Display Control System:

996-2.3.1 Display Control System: The video display control system shall allow ~~the operator~~multiple authorized users to control and manage the display of video and computer-generated graphics on the display equipment connected to the system as well as provide selection and switching of multiple sources for display, including video streams available on the Traffic Management Center (TMC) Ethernet network. The display control system shall also allow ~~for operator~~authorized users to control ~~of~~ all displays from the same workstation that is used for the SunGuide® operator interface. ~~The video display control system shall decode and display all video streams produced by encoders listed on the APL.~~

The video display control system shall be able to simultaneously display~~s~~ a minimum of 32 video streams on various display layouts.~~windows, each containing streaming video at a minimum resolution of 720 pixels by 480 pixels and frame rate of 30 fps.~~ The system shall allow display of multiple video windows containing streaming video from different sources using various common codecs (e.g., H.264, MPEG-2) at various resolutions and bitrates. Common resolution, frame rate, and bitrate for streaming sources includes 1920x1080, 30FPS, 3Mb/s video streams~~any display window to be sized from 1/32 of the total display area up to the total display area, and any size in between~~.

The video display control system hardware shall be a specialized computing platform for video wall control and management that is designed to be rack mounted and secured in an ~~EIA~~ TIA 19 inch equipment rack and operated on an enterprise Ethernet network domain. Any ~~system incorporating~~ Personal Computer (PC) hardware incorporated within the system shall use current microprocessor technology and commercial, off-the-shelf components, including RAM, hard disk drives, ~~and~~ network interface cards, operating system, and applications ~~sufficient to provide the functional requirements of the system~~.

The video display control system shall be expandable and scalable to support any combination of inputs and outputs.

The video display control system shall have a minimum configuration of ~~4 composite video inputs, 4 component (red, green, and blue (RGB) video inputs, and~~ 4 High-Definition Multimedia Interface (HDMI) inputs and 12 HDMI outputs~~as well as network connections, decoders, and associated hardware and software required to display 32 inputs simultaneously at a minimum resolution of 720 pixels by 480 pixels and a frame rate of 30 fps.~~

~~The video display control system shall have a minimum configuration of 4 composite video outputs, 2 component (RGB video outputs), and 4 HDMI outputs~~.

996-2.3.2 Display Control Software: The display control software shall provide centralized system management functions and allow multiple ~~operators~~ authorized users to control all features and functions of the video display control system. These features and functions shall include~~, but are not limited to,~~ creation of display layouts (i.e., customizable window arrangements that include multiple sources displayed at various sizes); selection of video sources for display, including switching layouts; adjusting the size, location, and layout of video and other graphic information the system displays; and system configuration and setup. The control software shall be able to operate ~~a video~~display walls composed of multiple display components as though ~~it were~~they are a single, high-resolution displays.

The system shall provide a user interface that allows users to create, edit, store, and recall content arrangement on multiple displays (i.e., primary and secondary display walls as well as freestanding displays) and allow any display window to be sized from 1/32 of the total display area up to the total display area, and any size in between by dragging, dropping, moving, layering, and resizing content boundaries.

The display control software shall include a ~~non-proprietary Software Development Kit (SDK) including, but not limited to, an~~documented Application Programming Interface (API) that describes interfaces and protocols which can be used to integrate system features and functions with third-party applications. The display control software shall accept external alarm triggers to automatically switch layouts.

996-2.3.3 ~~Controller~~ Inputs and Outputs: The video display control system shall support and display a variety of video and data inputs simultaneously, including ~~composite and component NTSC video,~~ HDMI~~, Digital Visual Interface (DVI),~~ and network computer desktop graphics such as Video Graphics Array (VGA), Super Video Graphics Array (SVGA), and Super Extended Graphics Array (SXGA) computer graphics via remote desktop connections. All inputs and outputs shall allow ~~for operator control in order~~ authorized users to display any or all ~~of~~ this information on any number of display devices within the system. All inputs ~~and~~, outputs, and display windows shall be able to be sized and resized with and without constrained proportions across multiple screens and moved at will around any display area and combination of displays.

The video display control system shall be expandable and scalable to support ~~any combination of~~additional inputs and outputs. The video display control system shall be provided with a minimum configuration of ~~4 composite video inputs, 4 component (RGB video inputs), and~~ 4 HDMI inputs and 12 HDMI outputs. All HDMI interfaces must be HDMI 2.0 and capable of 4K resolution at 60 frames per second. The video display control system shall include all~~as well as~~ network connections, decoders, and associated hardware and software required to simultaneously display ~~32 inputs simultaneously at a minimum resolution of 720 pixels by 480 pixels and a frame rate of 30 fps, or as shown in the Plans~~32 video streams from different sources. ~~Provide the video display control system with a minimum configuration of 4 composite video outputs, 2 component (RGB video outputs), and 4 HDMI outputs. The video display control system can be expanded to accommodate at least 128 discreet inputs and outputs.~~

~~A single input shall be able to be routed to~~ The video display control system must be able to simultaneously display a single input source on multiple displays ~~simultaneously~~ and multiple input~~s~~ sources on ~~can be routed to~~ a single display ~~simultaneously for viewing in separate windows~~. ~~All inputs and outputs shall be synchronized by the video display control system and s~~Switching between inputs or outputs ~~does~~ shall not cause displayed images to unlock, roll, or otherwise exhibit visible distortion.

996-2.3.3.1 ~~Analog Video:~~ ~~The video display control system shall be able to accept S-video, composite, and component video sources, and can digitize these signals for manipulation and display on any display device attached to the system. All analog video inputs shall use BNC connectors.~~**Network Connections:** The video display control system shall use a single 10/100/1000 RJ45 Ethernet port for network connection. If the video display control system requires multiple Ethernet ports to provide required functionality (e.g., additional ports for decoder card connections), the system must be supplied with a managed Ethernet switch that provides ports for additional connections.

Analog video sources shall display within their own windows and can be resized up to or beyond their native resolution to conform to the wall display size.

996-2.3.3.2 Digital Video: The video display control system shall be able to accept digital video sources ~~and can~~as well as manipulate and display these signals on any display attached to the system. All digital video inputs and outputs shall use HDMI connectors ~~unless otherwise directed~~. All HDMI interfaces shall be HDMI 2.0 and capable of 4K resolution at 60 frames per second.

~~Each MPEG video stream shall display within its own window and be freely movable and sizable up to or beyond its native resolution to conform to the wall display size.~~

~~**996-2.3.3.3 RGB Video:** Include an analog input that enables the TMC operator to project an exact copy of his or her workstation desktop display on the video wall display. Analog RGB inputs shall allow native images up to 1,280 pixels by 1,024 pixels at 60 Hz to be displayed on the video wall.~~

~~RGB inputs shall be sizable up to or beyond their native resolution to conform to the wall display size.~~

996-2.3.3.43 Streaming Media: The video display control system shall be able to display a minimum of 32 compressed video streams simultaneously ~~in MPEG-2 over TCP/UDP/RTP over IP and supports multicasting as defined in Version 2 of the IGMP~~. The video display control system ~~can~~ shall display MPEG-42 and H.264 streams. ~~The MPEG video input interface is, at minimum, a 10/100 megabit per second network port per every 15 streams.~~ Each video stream shall display within its own window and be freely movable and sizable up to or beyond its native resolution to conform to the wall display size.

996-2.3.3.54 ~~Primary~~ Display Outputs: The ~~V~~video display control system ~~can~~ must be able to process ~~the~~ various signal input types to be output and viewed on display walls and freestanding display monitors, such as ~~the RGB feeds from monitor outputs and~~multi-window layouts of streaming video feeds and desktop computer graphics (e.g., applications on network computers via remote desktop display windows). ~~The unit shall provide direct digital streaming video through cable feeds using a digital video decoder. The video display control system shall provide the layout definitions for each signal to be displayed and save the predefined layouts and shall also permit switching of the predefined layouts and accept external alarm triggers to change the layouts.~~

The output capacity shall have sufficient memory and processing speed to provide fast rendering of video and image displays simultaneously on a minimum of 12 HDMI displays. ~~The output has, at a minimum, a dual HDMI connector that supports 1,280 horizontal pixels by 1,024 vertical pixels or greater resolution. The color depth is a minimum of 24 bits per pixel~~.

996-2.3.4 Electrical Requirements: Provide equipment that operates on 120 V_{AC} at a frequency of 60 Hz. Furnish a transformer or other necessary means of power conversion for any device that requires another voltage or frequency.

ARTICLE 996-3 is deleted and the following substituted:

996-3 Network Devices.

996-3.1 General: Network devices shall be listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

996-3.2 Managed Field Ethernet Switch:

996-3.2.1 Description: The Managed Field Ethernet Switch (MFES) shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

The MFES provides wire-speed fast Ethernet connectivity at transmission rates of 100 megabits per second.

Each MFES shall be managed individually and as a group for switch configuration, performance monitoring, and troubleshooting. The MFES shall include Layer 2+ capabilities, including, Quality of Service (QoS), IGMP v2, rate limiting, security filtering, and general management.

The MFES shall support half and full duplex Ethernet communications.

The MFES shall provide 99.999% error-free operation. The MFES shall comply with ~~the EIA~~ Ethernet data communication requirements using single-mode fiber optic transmission medium and Category 5E copper transmission medium.

The MFES shall have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

996-3.2.2 Networking Standards: The MFES shall comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

1. IEEE 802.1Q standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks used with port-based Virtual Local Area Networks (VLANs) and Rapid Spanning Tree Protocol (RSTP).

2. IEEE 802.1 ~~P~~p ~~standard~~ for QoS.

3. IEEE 802.3 standard for LAN and Metropolitan Area Network (MAN) access and physical layer specifications.

4. IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX.

5. IEEE 802.3x standard regarding flow control with full duplex operation.

996-3.2.3 Optical Ports: All fiber optic link ports operate at 1,310 or 1,550 nanometers in single mode. All optical ports are Type ST, SC, LC, or FC only. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

MFES shall provide a minimum of two optical 100 Base FX ports capable of transmitting data at 100 megabits per second. MFES shall provide optical ports designed for use with a pair of fibers; one fiber will transmit (TX) data and one fiber will receive (RX) data. The optical ports shall have an optical power budget of at least 15 dB.

996-3.2.4 Copper Ports: MFES shall include a minimum of four copper ports. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half). All 10/100 Base TX ports shall meet the specifications detailed in this section and shall be compliant with the IEEE 802.3 standard pinouts.

Ethernet over very high speed digital subscriber line (EoVDSL) ports shall support standard telephone-grade twisted copper pair and automatically negotiate the fastest data rate possible depending on cable length and quality.

996-3.2.5 Management Capability: The MFES shall support all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

1. An MFES that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard and has a minimum 4-kilobit VLAN address table.
2. A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.
3. A minimum 4 kilobit MAC address table.
4. Support of, at a minimum, IGMP ~~Version~~ v2.
5. Support of remote and local setup and management via ~~s~~Secure ~~s~~Shell Version 2 (SSHv2 ~~Version2~~) and secure Web-based GUI.
6. Support of the Simple Network Management Protocol (SNMP) version 1/2/3. Verify that the MFES can be accessed using the resident ~~EIA~~TIA -232 management port or a telecommunication network.
7. Support of Remote Authentication Dial-In User Service (RADIUS) or Terminal Access Controller Access-Control System Plus (TACACS+)
8. Support of remote monitoring (RMON) of the Ethernet agent and the ability to be upgraded to switch monitoring (SMON), if necessary.
9. Support of Secure Copy (SCP) or Secure File Transfer Protocol (SFTP) and either Network Time Protocol (NTP) or the Simple Network Time Protocol (SNTP). Ensure that the MFES supports port mirroring for troubleshooting purposes when combined with a network analyzer.

996-3.2.6 Mechanical Requirements: Every conductive contact surface or pin shall be gold-plated or made of a noncorrosive, nonrusting, conductive metal. Do not use self-tapping screws on the exterior of the assembly. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.2.7 Electrical Requirements: The MFES shall operate on a nominal Voltage of 120 V_{AC}. Supply an appropriate voltage converter for devices that require operating voltages of less than 120 V_{AC}. The MFES shall have diagnostic Light Emitting Diodes (LEDs), including link, TX, RX, and power LEDs.

996-3.2.8 Environmental Requirements: MFES shall operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2 ~~2021~~, Sections 2.2.7, 2.2.8., and 2.2.9.

996-3.3 Managed Hub Ethernet Switch:

996-3.3.1 Description: The Managed Hub Ethernet Switch (MHES) shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

The MHES shall provide Ethernet connectivity at transmission rates of 10/100/1000/10000 megabits per second. The MHES shall support half and full duplex Ethernet communications. The MHES must support 12000 IPv4 routes and 2000 IPv6 routes and all routing protocols shall be in performed hardware to ensure maximum speed.

The MHES shall support management individually and as a group for switch configuration, performance monitoring, and troubleshooting. The MHES shall include Layer 2 capabilities, including, QoS, IGMP v2, rate limiting, security filtering, and general management.

The MHES shall include full Layer 3 capabilities, including Open Shortest Path First (OSPF) routing protocol, Routing Information Protocol (RIP), and Protocol Independent Multicasting (PIM). The MHES includes all license(s) required to utilize all Layer 3 features.

996-3.3.2 Networking Standards: The MHES shall comply with all applicable IEEE networking standards for Ethernet communications, including:

1. IEEE 802.1Q Standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks used with port-based Virtual Local Area Networks (VLANs) and Rapid Spanning Tree Protocol (RSTP).

2. IEEE 802. 1Pp ~~standard~~ for QoS.

3. IEEE 802.3 standard for Local Area Network (LAN) and metropolitan area network (MAN) access and physical layer specifications.

4. IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX.

5. IEEE 802.3x standard regarding flow control with full duplex operation.

6. IEEE 802.3z supplement standard regarding 1000 Base X.

996-3.3.3 Optical Ports: All fiber optic link ports operate at 1,310 or 1,550 nanometers in single mode. Provide Type LC connectors unless otherwise directed. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

MHES shall provide a minimum of 6 optical ports capable of transmitting data at 10/100/1000/10000 megabits per second. MHES shall provide optical ports designed for use with a pair of fibers; one fiber will transmit (TX) data and one fiber will receive (RX) data. The optical ports shall have an optical power budget of at least 15 dB.

996-3.3.4 Copper Ports: MHES shall include a minimum of 12 10/100/1000 Base TX copper ports. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). All 10/100/1000 Base TX ports shall meet the specifications detailed in this section and shall be compliant with the IEEE 802.3 standard pinouts.

996-3.3.5 Management Capability: MHES shall support all Layer 2 management features and all Layer 3 features as defined by this Section. Layer 2 and Layer 3 features must include:

1. Port-based VLAN and VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard and has a minimum 4-kilobit VLAN address table.

2. A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second, 148,800 packets per second for 100 megabits per second, and 1,488,000 packets per second for 1000 megabits per second.

3. A minimum 4 kilobit MAC address table.

4. Support of IGMP ~~Version~~ v2.

5. Support of remote and local setup and management via ~~secure shell~~SSHv2 and secure Web-based GUI.

6. Support of the Simple Network Management Protocol (SNMP) version 2 and version 3.

7. Support of Remote Authentication Dial-In User Service (RADIUS) or Terminal Access Controller Access-Control System Plus (TACACS+).

8. Support of remote monitoring (RMON) of the Ethernet agent and the ability to be upgraded to switch monitoring (SMON), if necessary.

9. Support of SCP or SFTP and either Network Time Protocol (NTP) or the Simple Network Time Protocol (SNTP). Ensure that the MHES supports port mirroring for troubleshooting purposes when combined with a network analyzer.

10. Sampled Flow Network Monitoring export protocol capable of being turned on or off on individual Ethernet ports without affecting traffic.

1~~2~~1. OSPF routing protocol. 12000 IPv4 routes and 2000 IPv6 routes.

12. RIP.

13. Virtual Router Redundancy Protocol (VRRP).

996-3.3.6 Mechanical Specifications. Ensure the MHES is no greater than 1-Rack Unit tall.

Every conductive contact surface or pin shall be gold-plated or made of a noncorrosive, nonrusting, conductive metal. Do not use self-tapping screws on the exterior of the assembly. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.3.7 Electrical Specifications. MHES must shall operate on a nominal voltage of 120 V_{AC}. Supply an appropriate voltage converter for devices that require operating voltages of less than 120 V_{AC}. The MHES shall have diagnostic LEDs, including link, TX, RX, and power LEDs.

996-3.3.8 Environmental Specifications. Ensure that the MHES has an operating temperature range of -34° Celsius to 74° Celsius. Ensure that the MHES can withstand 90 percent non-condensing relative humidity at 40° Celsius.

996-3.4 Device Server:

996-3.4.1 Description: The device server allows the connection of serial devices with TIA~~EIA~~-232, ~~EIA~~TIA-422, and ~~EIA~~TIA-485 connections to an Ethernet network. The device server provides a TCP/IP interface to one or more field devices using ~~EIA~~TIA-232/422/485 standard connections. The device server supports TCP/IP, UDP/IP, Dynamic Host Configuration Protocol (DHCP), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), Simple Network Management Protocol (SNMP), Hypertext Transfer Protocol (HTTP), and telnet.

The device server shall provide 99.999% error-free operation and ~~EIA~~TIA-compatible Ethernet data communication by way of a Category 5E copper or fiber optic transmission medium.

The device server is resistant to all electromagnetic interference.

Data security shall comply with SSHv2 ~~Version 2 of the Secure Shell Protocol (SSHv2)~~, or the NIST requirements as defined in the Federal Information Processing Standard (FIPS) Publication (PUB)-197 for the Advanced Encryption Standard (AES).

The device server has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours.

996-3.4.2 Serial Interface: The device server provides a minimum of one serial data interface and connector that conforms to ~~EIA~~TIA-232/422/485 standards. The serial

interface supports 2-wire and 4-wire ~~EIA~~TIA-485 connections. The serial ports 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).

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. The device server supports RTS toggle for half-duplex emulation.

996-3.4.3 Network Interface: The device server includes a minimum of one Ethernet port, which shall provide a 10/100 Base TX or a 10/100 Base FX connection as specified in the Plans. All copper-based network interface ports utilize registered jack (RJ)-45 connectors. The optical ports are Type ST, SC, LC, or FC only. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

996-3.4.4 Configuration and Management: The device server shall support local and remote configuration and management, which shall include access to all user-programmable features, including but not limited to addressing, port configuration, device monitoring, diagnostic utilities, and security functions. The device server shall support configuration and management via SNMP, telnet login, and browser-based interface.

996-3.4.5 Mechanical Requirements: Do not use self-tapping screws on the exterior of the assembly. All parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.4.6 Electrical Requirements: The device server operates using a nominal input voltage of 120 V_{AC} If the device requires nominal input voltage of less than 120 V_{AC}, furnish the appropriate voltage converter. The maximum power consumption shall not exceed 12 watts. The device server has diagnostic LEDs, including link, TX, RX, and power LEDs.

996-3.4.7 Environmental Requirements: The device server performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

~~**996-3.5 Digital Video Encoder and Decoder:**~~

~~**996-3.5.1 Description:** The Digital Video Encoder (DVE) and Digital Video Decoder (DVD) are specialized network-based hardware devices and software which allow video and data signals to be transmitted across IP networks. 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.~~

~~**996-3.5.2 Software:** All setup, control programs, and diagnostic software related to the DVE or DVD shall be provided. All equipment licenses, where required for any software or hardware in the system, shall be provided.~~

~~**996-3.5.3 MPEG-2 Format:** DVE and DVD components 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. The DVE and DVD are capable of unicast and multicast operation. DVEs support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974. The DVE provides 99.999% error-free operation. The MPEG-2 DVE and DVD equipment support programmable bit rates. MPEG-2 equipment supports fixed bit rate mode.~~

~~**996-3.5.4 H.264 Format:** DVE and DVD components utilize the 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. The DVE and DVD are capable of unicast and multicast operation. DVEs shall support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Real Time Streaming Protocol (RTSP). The DVE provides 99.999% error-free operation. H.264 DVE and DVD equipment support programmable bit rates. H.264 equipment supports fixed bit rate mode.

996-3.5.5 Digital Video Encoder: The DVE is a hardware-based network device that is able to accept a minimum of one analog NTSC video input and digitize it for transport across IP networks. The DVE 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.

996-3.5.6 Hardware-based Decoder: The hardware-based DVD has a minimum of one video output. The DVD that has a minimum of one data interface for configuration functions. The DVD includes an Ethernet interface for connection to IP networks.

996-3.5.7 Interoperability: 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. 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. The DVE and DVD can be controlled using SunGuide® or support stream selection and switching using ONVIF commands.

996-3.5.8 Video Requirements: Composite video inputs and outputs utilize BNC connectors. Analog video inputs and outputs support 1 volt peak-to-peak (Vp-p) NTSC composite video. The DVE and DVD operate with both color and monochrome video, and DVEs allow the user to select and adjust video resolution. The DVE and DVD support resolutions that include, but are not limited to, those defined in Table 996-2. The DVE and DVD are capable of delivering color and monochrome video at 30 fps regardless of resolution.

Table 996-2
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.

996-3.5.9 Serial Interface: Hardware-based DVEs provide a minimum of one serial data interface that support EIA/TIA-232 and TIA-422. The serial ports support data rates up to 115 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Hardware-based DVEs 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.

996-3.5.10 Network Interface: The DVE/DVD LAN connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. The DVE/DVD has 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. The connector complies with applicable EIA and

~~TIA requirements. Copper-based network interface ports shall utilize RJ-45 connectors. Fiber ports are single mode with a minimum link budget of 30 dB.~~

~~The network communication conforms to UDP, Version 4 of the Internet Protocol (IP) and IGMP Version v2.~~

~~**996-3.5.11 Front Panel Status Indicators:** DVEs and DVDs have LED displays, Liquid Crystal Displays (LCDs), or similar illuminated displays to indicate status for power and data activity.~~

~~**996-3.5.12 Configuration and Management:** DVEs and DVDs shall 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. DVE and DVD support configuration and management via serial login, telnet login, web browser, or Simple Network Management Protocol (SNMP).~~

~~**996-3.5.13 Mechanical Requirements:** Do not use self-tapping screws on the exterior of the assembly. All equipment uses parts made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.~~

~~**996-3.5.14 Electrical Requirements:** All equipment operates on a nominal voltage of 120 V_{AC}. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter.~~

~~**996-3.5.15 Environmental Requirements:** DVEs and DVDs installed in roadside cabinets shall perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2-2021, Sections 2.2.7, 2.2.8, and 2.2.9. Hardware DVD installed in a climate-controlled environment, such as a TMC computer room, has an operating temperature range of 32 to 104°F.~~

996-3.5 Wireless Communication System

996-3.5.1 Description: The wireless communication system (WCS) shall be a wireless Ethernet device suitable for outdoor use and capable of transmitting TCP/IP data and multicast video streams. The WCS shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

WCS devices shall be compliant with FCC rules and operate within their authorized radio frequency range. Submit frequencies supported for approval. The WCS shall be clearly labelled with a Federal Communications Commission (FCC) identification number.

The WCS shall be compatible with the existing systems and management software maintained by the Department or provided with management software at no cost. WCS shall be able to provide point-to-point and point-to-multipoint wireless connections in outdoor environments.

WCS shall have and meet the following features and requirements:

1. Support data rates up to 450Mbps at minimum
2. Auto-sensing 10/100/1000Mbps Ethernet interface
3. Dynamic data rate selection
4. Transmit power control
5. Antenna alignment utility
6. QoS Support
7. Software integrity check

8. Dynamic frequency selection
9. Bridging and Routing modes
10. Protocol and address filtering
11. DHCP server function
12. VLAN support
13. Security Features
    a. RADIUS MAC authentication
    b. WEP/WPA/WPA2
14. Configuration and Management
    a. System configuration and user account management
    b. Ping watchdog
    c. SNMP
    d. HTTPS and SSHv2
    e. SCP and SFTP
    f. NTP

996-3.5.2 Networking Standards: The WCS shall be Wi-Fi certified and comply with IEEE 802.11 Wi-Fi standards.

996-3.5.3 Ports and Connectors: The WCS shall include all necessary ports and connectors for a complete weatherproof assembly. All ports shall be legibly and permanently marked designating their intended use. All copper ports shall be weatherproof Type RJ-45 and shall auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). All 10/100/1000 Base TX ports shall be compliant with the IEEE 802.3 standard.

996-3.5.4 Antennas: The WCS shall include all antennas necessary for a complete and functional system. The WCS shall include features or utilities to aid system setup and antenna alignment to provide minimum interference and maximum throughput for wireless links.

996-3.5.5 Configuration and Management: WCS devices shall be provided with all hardware, software, configuration tools and software licenses required for local and remote configuration, operation, and management including access to all user-programmable features as well as health and status monitoring, event logging, and diagnostic utilities. WCS devices shall support configuration and management via SNMP, telnet login, and browser-based interface. Configuration and management functions shall be password protected. The WCS shall provide the ability to:

1. Configure advanced security options like MAC address filtering and WPA3 features.
2. Configure Quality of Service (QoS) to prioritize bandwidth and optimize network performance for specific devices or applications.

996-3.5.6 Mechanical Requirements: All conductive surfaces and pins shall be either gold-plated or constructed from a corrosion and rust-resistant metal.

All parts and mounting hardware shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.5.7 Electrical Requirements: WCS devices shall be provided with a power over ethernet (PoE) injector. Powered ports on the PoE injector shall meet the requirements set forth in IEEE 802.3. The PoE injector shall operate using a nominal input voltage of 120VAC. If the PoE injector requires nominal input voltage other than 120VAC, furnish the appropriate voltage converter.

996-3.5.8 Environmental Requirements: The WCS shall have shall have an operating temperature range of -30° Celsius to 60° Celsius and withstand 95 percent non-condensing relative humidity.

996-3.6 Media Converter:

996-3.6.1 Description: The media converter connects different transmission media for the purposes of transmitting Ethernet data.

996-3.6.2 Network Interface: The media converter LAN connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. The media converter has a minimum of one Ethernet port, which shall be, at a minimum, a 10/100 Base TX connection or a 100 Base FX ST, SC, LC or FC interface. The connector complies with applicable ~~EIA and~~ TIA requirements. Copper-based network interface ports utilize RJ-45 connectors. Fiber ports are single mode with a minimum link budget of 30 dB.

996-3.6.3 Mechanical Requirements: Every conductive contact surface or pin shall be gold-plated or made of a noncorrosive, nonrusting, conductive metal. Do not use self-tapping screws on the exterior of the assembly. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.6.4 Electrical Requirements: Ethernet to coax media converters shall operate using Power Over Ethernet (POE). Media converters shall operate on a nominal voltage of 120 V_{AC} if POE is unavailable. Supply an appropriate voltage converter for devices that require operating voltages of less than 120 V_{AC}. Ensure that the media converter has diagnostic LEDs, including link, TX, RX, and power LEDs.

996-3.6.5 Environmental Requirements: Ensure media converters perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2 ~~2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

996-3.7 Cellular Modem:

996-3.7.1 Description: The cellular modem shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

The cellular modem shall be clearly labelled with a Federal Communications Commission (FCC) identification number.

The cellular modem shall be compatible with the existing systems and management software maintained by the Department or provided with management software at no cost. The cellular modem must support web-based user access through a Graphical User Interface (GUI) that provides secure access for device configuration, operation, and maintenance.

996-3.7.2 Network Interfaces: The cellular modem shall be configured to use a network service that is 4G LTE, at minimum. The modem shall support multiple cellular carrier services, including FirstNet. The modem shall comply with all applicable networking standards and protocols, including:

1. Network: TCP/IP, UDP/IP, Domain Name System (DNS).
2. Routing: Network Address Translation (NAT), Host Port Routing, DHCP, Point-to-Point Protocol over Ethernet (PPPoE), VLAN, Virtual Router Redundancy Protocol (VRRP), Reliable Static Route.
3. Application: Short Message Service (SMS), SSHv2, SCP, SFTP, Simple Mail Transfer Protocol (SMTP), SNMP, SNTP, HTTPS, Reliable Static Route.

4. Serial: TCP/UDP Packet Assembly Disassembly (PAD) Mode, Modbus (ASCII, RTU, Variable), Point-to-Point Protocol (PPP).

The cellular modem LAN connections shall comply with the IEEE 802.3 standard for 10/100 Ethernet connections. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half).

996-3.7.3 Ports and Connectors: The cellular modem shall have following physical interfaces:

1. Two redundant SIM slots.
2. Three copper Type RJ-45 ports for 10/100 Ethernet connections.
3. Three SMA antenna connectors.
4. One RP-SMA Wi-Fi antenna connector.

996-3.7.4 Event Reporting: The cellular modem shall have the capability to report the following events in plain text:

1. Network parameters.
2. Data usage.
3. Power.
4. Device Temperature.
5. Digital input status.
6. Global Positioning.
7. System/Automatic.
8. Vehicle Locator (GPS/AVL).
9. Timer.

996-3.7.5 Security: The cellular modem shall have the following security provisions:

1. Ability to establish VPN tunnels.
2. IPsec, Secure Sockets Layer (SSL), and Generic Routing Encapsulation (GRE).
3. Port forwarding and Demilitarized Zone (DMZ).
4. Port Filtering.
5. Trusted IP.
6. MAC address filtering.

996-3.7.6 Antennas: Meet the following requirements:

1. Dual diversity.
2. NEMA 3 rating.
3. Frequencies: F1 = 824 to 896 MHz, F2 = 1850 to 1990 MHz, F3 = 1850 to 1955 MHz, F4 = 1710 to 1770 MHz, F5 = 2110 to 2170 MHz.
4. Voltage Standing Wave Ratio (VSWR) of 1.5:1 or less at resonant point.
5. 50 Ω nominal impedance.
6. Gain of 3.0 dB to 5.15 dB.
7. Omni-directional radiation pattern.
8. Vertical polarization.
9. Glass-filled polypropylene radome.
10. Adhesive mounting or Bolt mount
11. SMA male plug connectors 10 ft. (minimum) coaxial length.

996-3.7.7 Mechanical Requirements: Every conductive contact surface or pin shall be gold-plated or made of a noncorrosive, nonrusting, conductive metal. Do not use self-tapping screws on the exterior of the assembly. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

996-3.7.8 Electrical Requirements: The cellular modem shall operate on a nominal voltage of 12 V_{DC} and be provided with a power supply that also allows operation using 120 V_{AC}. The cellular modem shall have diagnostic LEDs including indications for power, link, TX, RX, and cellular communications connectivity.

996-3.7.9 Environmental Requirements The cellular modem shall have an operating temperature range of -30° Celsius to 70° Celsius and withstand 90 percent non-condensing relative humidity.

SUBARTICLE 996-4.2.6 is deleted and the following substituted:

996-4.2.6 Environmental Specifications: The SPDs shall operate properly during and after being subjected to the temperature and humidity test described in NEMA TS 2~~-2021~~, ~~Section 2.2.7, and the vibration and shock tests described in NEMA TS 2-2021,~~ Sections 2.2.7, 2.2.8, and 2.2.9.

SUBARTICLE 996-6.3.2 is deleted and the following substituted:

996-6.3.2 Connector Block: Modular, self-aligning and self-adjusting female and male socket contact halves in the connector block shall be provided. Equip the lowering device with enough contacts to permit operation of all required functions of the camera, up to a maximum of 20 contacts and include at least two spare contacts. Contact connections between the fixed and movable lowering device components that are capable of passing ~~EIA~~TIA -232, ~~EIA~~TIA -422, ~~EIA~~TIA -485, and Ethernet data signals and 1 volt peak to peak (Vp-p) video signals, as well as 120 V_{AC}, 9-24 V_{AC}, and 9-48 V_{DC} power shall be provided. The lowering device connections shall be capable of carrying the signals, voltages, and current required by the devices connected to them under full load conditions.

Only corrosion-resistant stainless steel hardware shall be used. male contacts used for grounding shall mate first and break last. All contacts and connectors shall be self-aligning and self-adjusting mechanical systems. A spring-assisted contact assembly to maintain constant pressure on the contacts when the device is in the latched position shall be provided.

Connector pins made of brass- or gold-plated nickel, or gold-plated copper shall be provided.

Current-carrying male and female contacts shall be a minimum of 0.09 inch in diameter and firmly affixed to the connector block. Ensure mated connectors do not allow water penetration.

SUBARTICLE 996-7.2.1 is deleted and the following substituted:

996-7.2.1 Configuration and Management: The UPS shall support local and remote configuration and management, including access to all user-programmable features as well as alarm monitoring, event logging, and diagnostic utilities. The UPS shall support SNMP, including configurable alarm and event trap notifications.

Configuration and management functions shall be password protected.

Alarm function monitoring shall include the following: loss of utility power, inverter failure, low battery, voltage, and temperature out of range. The UPS shall include an event log that indicates the date and time of the following events: AC high, AC low, AC frequency error, AC fail/blackout, and over temperature. The UPS event log shall be able to store a minimum of 60 events.

The UPS shall include a front panel display and controls that allows programming of configurable parameters, features, and functions without the need for another input device. The UPS shall have visual indications for Power-On, Mode of Operation (utility power or inverter), Battery Status, Alarm Status, Load Levels, and AC Output Voltage.

SUBARTICLE 996-7.2.7 is deleted and the following substituted:

996-7.2.7 Environmental: UPS assemblies, including batteries, shall provide continuous power with specified wattage and operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

SUBARTICLE 996-7.3.5 is deleted and the following substituted:

996-7.3.5 Environmental: The RPMU shall operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.