Office of Traffic Operations

Intelligent Transportation System / Traffic Signal Section

Handbook

Version 7.4
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MATERIALS

THE CONTRACTOR SHALL SUPPLY EQUIPMENT LISTED ON THE MOST CURRENT REVISION OF THE ODOT TRAFFIC AUTHORIZED PRODUCT (TAP) LIST AT THE TIME OF BID. THE TAP LISTED PRODUCTS ARE BASED ON THE SPECIFICATIONS WITHIN THIS HANDBOOK.

THE SPECIFICATIONS CONTAINED HEREIN, ALONG WITH THE PRODUCTS LISTED ON THE TRAFFIC AUTHORIZED PRODUCT (TAP) LIST ARE APPROVED BY ODOT TO FIT INTO EXISTING ODOT ITS SYSTEMS AND FUNCTIONS CONTAINED WITHIN THE STATEWIDE ITS ARCHITECTURE.

SUCH SPECIFICATIONS ARE NOT REQUIRED OF LOCAL AGENCIES IF THEY DO NOT FIT INTO THEIR EXISTING SYSTEMS AND/OR REGIONAL ITS ARCHITECTURE. LOCALS MAY CREATE THEIR OWN SPECIFICATIONS AND REQUIREMENTS FOR ITS PROJECTS TO MEET THEIR NEEDS. IF THE PROJECT IS NOT USING FEDERAL FUNDS, NO FEDERAL CFR 940 JUSTIFICATION IS REQUIRED. IF A PROJECT IS USING FEDERAL FUNDS, LOCALS SHALL REFER TO FEDERAL REGULATION 23 CFR 940, AS A SYSTEM ENGINEERING ANALYSIS (SEA) OR SYSTEMS ENGINEERING REVIEW FORM (SERF) WILL BE REQUIRED. FOR MORE INFORMATION, REFER TO SECTION 1301 OF THE TRAFFIC ENGINEERING MANUAL (TEM).

Traffic Authorized Product List
http://www.dot.state.oh.us/Divisions/Operations/Traffic/Pages/tap.aspx
SECTION 1300 - Closed Circuit TV (CCTV) CAMERAS
1300 Closed Circuit Television (CCTV) Cameras - Standard

ITEM 809E60000: CCTV IP-CAMERA SYSTEM, DOME -TYPE

1300.1 GENERAL DESCRIPTION

Closed Circuit Television (CCTV) Pole Camera Assembly – The CCTV Pole Camera Assembly shall include the IP camera with unpressurized dome or other type housing and PTZ unit all necessary connectors/cables of appropriate length, and all materials, labor, workmanship, equipment, testing, documentation, and incidental items required to deliver a fully operational CCTV Pole Camera Assembly in accordance with this specification and the Plans.

The CCTV IP-camera system will be placed at roadside locations and will meet NEMA Type 4X and IP66 environmental standards and will be suitable for outdoor installation atop poles up to 100 feet.

The Ohio Department of Transportation will be responsible for all communications with the TMC; all contrary requirements in this provision will be excluded.

The IP-camera assembly will be capable of individual, or local, camera site control by way of a laptop computer. Communications to the IP-camera will be Ethernet I/O protocol.

The use of a separate control box for testing, video processing and camera control will not be required or accepted by ODOT. All cables (Ethernet, or any other proposed conductive cable) shall be equipped with surge suppression capable of withstanding a minimum 1 kA surge current. The cost of this surge suppression shall be incidental to the bid price of the camera.

All camera control, video compression, and related CCTV functionality shall be contained in the IP CCTV housing unit. No separate unit will be required or accepted by ODOT in the ITS cabinet.

The CCTV IP-camera system will be capable of user selectable video compression rates of H.265, H.264, MPEG-4 or MJPEG. At a minimum, the system shall support simultaneous streaming of H.265 and MJPEG.

The CONTRACTOR shall submit a demo camera and driver for materials acceptance testing prior to ODOT providing authorization to the CONTRACTOR to move forward with camera purchasing for the entire project.

The IP-camera assembly shall be capable of transmitting simultaneous video via the IP encoder located in the camera housing with multiple IP streams. The camera may optionally/additionally transmit video via a coaxial cable connected to the camera and run into the ITS cabinet. If supported, this coaxial cable shall be fitted with compression BNC-type connectors but shall not be used for the sole test of the camera. The sole purpose of this coaxial connection shall be for verifying camera power/video for maintenance operations. All main testing of the camera operation shall be performed through communications with the camera IP encoder.

1300.2 FUNCTIONAL PROVISIONS

The CCTV assembly components will be compatible with each other. All CCTV assembly components will be provided and warranted by a single vendor, to provide an end-to-end manufacturer responsibility.

A minimum of sixty-four presets will be provided on both the zoom lens and the pan/tilt mechanism to allow setting the lens and the pan/tilt to predefined locations in accordance with the project requirements. The pan, tilt, zoom, preset selection, power on/off and other functions of each CCTV field
IP-camera will be controlled from the central site, by using a HTTP browser-based application with a graphical user interface.

The CCTV shall be capable of displaying custom and built-in text overlays. Normal font formats shall be available for use. The text overlays shall be capable of being positioned in one corner of the video feed or custom moved to the desired location. Text overlays shall be used to display, but not limited to, the current date/time, describe the location of the camera, and display the compass heading as described above. The date/time shall be capable of being set by a user-defined NTP (Network Time Protocol) server. The date/time shall be capable of updating for daylight savings time automatically.

The CCTV shall be capable of displaying the compass heading of the camera direction (i.e.; N, S, E, W, NE, SW, etc.) permanently over the video feed, without timing out. The camera shall have functionality to set the north position by an operator panning to the correct position and setting north or zero degrees pan. The compass heading shall be capable of being positioned in one corner of the video feed or custom moved to the desired location. The compass heading shall be capable of being displayed standalone without any other text for pan/tilt positioning.

The CCTV shall be capable of displaying custom image overlays. Custom image overlays shall be uploaded to the camera in a standard image format (jpeg or bitmap). The image overlay shall be capable of being positioned in any corner of the video feed or custom moved to the desired location (top right corner is generally used for ODOT logo).

All text or image overlays shall be capable of scaling appropriately for different resolutions. All of the above requirements for text/image overlays shall be capable of being displayed on different streaming protocols for compression, simultaneously running at the same time (i.e. H.265 and MJPEG streams running simultaneously shall be capable of the same text/image overlays). ODOT typically uses H.265 or H.264 compression for video management software and MJPEG for pulling snapshot images from the camera every 5 seconds to be displayed on the public website.

The CCTV shall have a web-based application platform to control/configure the IP camera through a web browser using HTTP. The web-based platform shall give an administrator the ability to change network settings and configure most or all camera settings. The web-based platform shall have a specific URL for displaying the current live video snapshot at any time (ex. http://<IP_Address>/snapshot.jpg). This URL shall be accessible anonymously without any user login required even when administrator level credentials have been configured.

The CCTV assembly will additionally include, but not be limited to, the following components and features:

- Password Protection: Programmable settings with optional password protection
- Open API for software integration
- A CCTV IP camera with auto focus zoom lens in an outdoor dome or other type housing attached to the IP-camera-lowering device.
- A domed or other type housing, watertight, environmental housing with an integrated positioner for pan and tilt unit
- All camera circuitry shall be located within the dome or other type housing
- Domed or other type mounting hardware to connect to 1.5-inch NPT used on standard lowering units and camera mounts.
- Junction boxes as needed
- IP-Camera control electronics and equipment (i.e., hardware and software)
- Compass heading and azimuth positioning capabilities
- Exterior Ethernet STP Cat-6 or equal composite cabling with power and data/video cables for power supply, images, and camera controls;
- Transient voltage suppression and protection;
1300.3 IP-CAMERA ASSEMBLY ELECTRICAL PROVISIONS

The IP-camera assembly will be furnished with any and all equipment required for a fully functional system, including all appropriate power and communication cables as defined by the manufacturer. The power cables will be sized to meet the applicable National Electrical Code (NEC) requirements. The communication cables from the IP-camera assembly to the network communication devices will be appropriate for the technology employed (e.g., fiber optic, twisted pair,) and will meet the minimum size and/or bandwidth requirements defined by the manufacturer. The Exterior camera CAT-6 STP or equal composite cable will be outdoor NEC rated.

The IP-Camera assembly and all components shall be powered by either 24 Volts AC (VAC) and/or Power over Ethernet (POE). Any other devices supplied as system components will accept, as a primary power source, 120 volts alternating current (VAC)/60 Hertz (Hz) input, excluding cameras.

The length of the cables will be based upon the CCTV pole length (70 and 80 Feet) and necessary cable to be routed into the ITS cabinet.

1300.4 NETWORK COMMUNICATION PROVISIONS

ODOT will furnish the network switches, install, configure and test the video and network equipment.

1300.5 PROTOCOL

The CCTV shall also be capable of configuring advanced network settings. At a minimum, the following supported Protocols will be provided for the IP-Camera:

- IP, HTTP, HTTPS, UPnP, SNMP, System logging, telnet, SSH,
- RTSP, RTP, TCP, UDP, ICMP, IGMP, DHC, H.265, MJPEG

1300.6 IP-CAMERA ASSEMBLY PERFORMANCE PROVISIONS

1300.6.1 IP-CAMERA IMAGE SENSOR PROVISIONS

The CCTV IP-camera image sensor will be a day/night camera that provides color images during daytime and black and white (monochrome) images during nighttime both with manual or automatic control capabilities. The IP-camera video output will be compliant with ITU-T Video Coding Experts Group (VCEG) and ISO/IEC Moving Picture Experts Group (MPEG) standards. The IP-camera sensor will be a Charge-Coupled Device (CCD) with 1/4-inch Progressive Scan.

The minimum resolution supported will be NTSC: 1920 x 1080. The CCTV assembly shall be capable of adjusting the resolution stream settings lower to 1280 x 720 and 720 x 480 or lower equivalent. The CCTV assembly will provide video images with minimal quality/bandwidth degradation in various environmental conditions. The CCTV assembly will provide low light-level sensitivity to achieve desired levels of operation at night.

The IP-Cameras will include frame integration to enhance night viewing. Minimum illumination at (COLOR) 0.5 lux at 30 IRE and (B/W) .008 lux at 30 IRE. Make a videotape that verifies the CCTV IP-camera performance during night conditions at five CCTV IP-camera locations. The selected five locations will be approved by the Department before making the videotape. This field demonstration test will be performed, and the results approved by the Department before the IP-camera selection is finalized.

The IP-camera will support the following image settings:
- Wide Dynamic Range (WDR),
- Electronic Image Stabilization (EIS),
- Manual shutter time color, brightness, contrast, sharpness
- Text and image overlay and privacy mask

The IP-camera will support automatic shutter time/speed that is selectable allow setting to yield optimal results under low lighting conditions without blooming or smearing.

The IP-camera sensor will support automatic and manual iris adjustment. The IP-camera will support Automatic Gain Control (AGC). The IP-camera assembly will be capable of generating and overlaying lines of English language text on the video image. A minimum of twenty alphanumeric characters per line will be supported. Control (enable, disable, and edit) of this feature will be available remotely and at the site using a laptop computer. The text messages will be stored in non-volatile memory. The IP-Camera ID text will consist of one line of text. Sector text will consist of text messages that change based on the position of the IP-camera within a sector. A minimum of eight uniform sectors will be provided.

The IP-camera will include privacy zones so that the operator cannot view scenes at preprogrammed camera positions. This prevents viewing the windows of private homes, hotels, or other buildings in the vicinity of the camera. The privacy zones will be user definable. There will be a minimum of eight privacy zones. Provide an IP-camera interface compatible with the communication equipment.

1300.6.2 IP-CAMERA LENS PROVISIONS

The IP-camera lens will be motorized and be mechanically or electrically protected from overrunning in extreme positions. Integrated camera/lens combination may be substituted.

Optical zoom range will be a minimum of 20X. Digital zoom range will be 1X through 12X with a smooth transition from optical to digital zoom.

The lens will have an automatic iris capability with manual override.

The zoom lens will be selected automatically or manually to provide a minimum focal length of 0.14 to 3.2 inches (3.5 to 81 mm) that provides the full coverage of the corridor mainlines and shoulders. The minimum focusing distance will be a distance of 4 feet (1.2 m). The lens will also have a minimum aperture of f/1.2 and a 1/4 inch [0.6 cm] with 10 preset position points. The iris, zoom, and focus will be controlled from the central location via HTTP protocol. The motors controlling the iris, zoom and focus will not be damaged due to overload at travel limits. The IP-camera lens will support optical zooming ranging from 25° telephoto (max) to 25° wide angle (min). The IP-camera will support automatic focus adjustments, with manual override. Vibration or ambient temperature changes will not affect the automatic iris function, focus mechanism, and zoom mechanism.

The IP-camera/lens combination will support automatic recovery from over and under voltage conditions, when power is returned to normal values. The lens will return to the last position prior to the over/under voltage condition.

If the camera has a dome lens or globe/bubble of any kind, it shall be optically clear, impact resistant and acrylic. The acrylic dome lens will not yellow, introduce appreciable light loss, or distort over a 10-year service life when exposed to anti-icing chemicals. Certification of meeting this requirement will be required. The dome/globe/bubble will be of anti-fog design with nominal light loss of no greater than 5 percent and geometric distortion of no more than 1 percent.

1300.6.3 IP-CAMERA PAN/TILT UNIT (PTU)/POSITIONER PROVISIONS

The PTU will be a doom integrated motorized, remotely controlled device that allows the operator to point the IP-camera into a pan (horizontal vectoring) range with the following requirements:
• 360° Continuous rotation capability in either direction. Software limits provided for pan mode.
• 95° of tilt movement, video rotation at 90° down with auto-flip, and 5° up without obstructions.
• Pan Speed (Operator Control): Variable from 0.1°/s to 80 °/s
• Pan Speed (Preset Control): minimum 120°/s
• Tilt Speed (Operator Control): Variable from 0.1°/s to 40 °/s
• Tilt Speed (Preset Control): 60°/s
• Minimum sixty-four preset positions with repeatability within ± 0.1°

1300.6.4 IP-CAMERA CONTROLLER

The IP-camera controller will provide a single point interface for control and video communications. It will also provide a single point interface for prime power that provides power protection, conversion, and distribution to the IP-camera assembly. The IP-camera controller will have 10/100 Base-T RJ-45 Ethernet output for local video monitoring and communications to a laptop.

The IP-camera controller will receive process and control camera, zoom lens, and PTU central commands. These commands will be processed and distributed to the appropriate devices. The camera controller will use non-volatile memory to store the required information for presets, camera ID, and sector text. A minimum of sixty-four presets will be supported. Each preset will consist of pan, tilt, zoom, and focus positions.

The use of a separate control box for power surges, testing, video processing and camera control will not be required or accepted by ODOT.

1300.7 IP-CAMERA ENVIRONMENTAL ENCLOSURE PROVISIONS

The CCTV IP-camera assembly will meet NEMA Type 4X and IP66 environmental standards and include an unpressurized housing enclosure with a minimum ambient operating temperature of -40 to 140 °F (-40 to 60 °C) with 100 percent relative humidity that provides complete protection for the camera and zoom lens assembly from moisture and airborne contaminants. The enclosure will protect the camera electronics and zoom lenses from blowing rain at storm rates, blowing sand, blowing dust, temperature, and solar loading, with an internal heater and blower. The enclosure will be corrosion resistant, and mountable in a manner, which leaves no exposed cabling.

1300.8 IP-CAMERA CABLES

Furnish all cables needed for the IP-camera to be a complete and functional unit. The mounting height will be 100 feet maximum. The cable should be composite single jacket and fully compatible with the camera lowering unit.

1300.9 IP-CAMERA CONSTRUCTION PROVISIONS

Furnish all tools, equipment, materials, supplies, and manufactured articles, and perform all operations and equipment integration necessary to provide a complete, fully operational IP-camera site as depicted herein, within the plan set, and/or in the Contract.

Provide the Department with a written inventory by location including serial numbers of items received and the condition in which they were received. Once received, the equipment becomes the Contractor's responsibility. Provide all labor and equipment necessary to move inventory out of the designated storage facility and to transport it to the installation location. All items will be installed in accordance with the manufacturer's instructions or as directed by the Department.

Messenger wire (if required) will be used for all overhead wiring of IP-camera cable. Cables will be attached to messenger wire as per plan sheet TC-24.81.
If it is determined that radio frequency interference (RFI) is inducing noise and degrading the quality of the video images being transmitted by the IP-camera assembly or its components, if required by the Department, furnish and install ferrite coils or other radio frequency (RF) suppression devices for RFI dampening. This installation and the placement of these RF suppression devices will be as recommended by the manufacturer. The furnishing and installation of these devices will be an ancillary cost to the IP-camera assembly pay item.

**1300.10 IP-CAMERA TESTING PROVISIONS**

The contractor will provide one (1) complete IP-CCTV unit including software to ODOT for testing in advance of installation. The contractor will not order additional IP-camera units until ODOT has tested the first unit and determined it acceptability. If approved, this unit shall become the property of ODOT and shall not be included in the quantity for the total number of cameras to be provided on the project.

Testing process will include IP-camera cable testing and IP-camera local control testing via a laptop.

The Department will be notified at least fourteen working days prior to installation of the IP-camera assembly so that the Department, or his representative(s), can be present to establish the appropriate settings for the pan-and-tilt stops.

The Department will be notified at least five working days in advance of the proposed date for the IP-camera cable test and the local field operational test. The Department has the right to witness such tests or to designate a representative or entity to witness such tests on the ODOT’s behalf.

**1300.10.1 IP-CAMERA CABLE TESTING PROVISIONS**

Furnish all equipment, appliances, and labor necessary to test the installed IP-camera cable between the IP-camera assembly and the network communication device. Before any connections are made.

- Verify exterior IP-camera CAT-6 STP cable is outdoor NEC rated and is compliant to Telecommunications Industry Association (TIA). International Organization for Standards (ISO/IEC) creates and maintains standards for telecommunication cabling.
- Perform a cable analysis to ANSI/TIA-568-C.2 standards of category 6 cabling and continuity test on the IP-camera cable, which must not exhibit any discontinuities, such as openings, shorts, crimps, or defects;
- Replace any cable that fails to meet these parameters, or if any testing reveals defects in the cable, and retest new cable as specified above; and
- Furnish all test equipment.

**1300.10.2 IP-CAMERA LOCAL CONTROL TESTING**

The following local field operational tests will be performed at the IP-camera assembly field site in accordance with the test plans. A PDA or a laptop computer will provide IP-camera control and positioning. After the IP-camera assembly, including the camera hardware, power supply, and connecting cables, has been installed:

- Verify that physical construction has been completed as detailed herein, within the plan set, and/or in the Contract;
- Inspect the quality and tightness of ground and surge protector connections;
- Check the power supply voltages and output;
- Connect devices to the power source;
- Verify installation of specified cables and connections with the IP-camera
- Connect to IP-camera through a laptop Ethernet connection and establish communication with IP-camera via TCP/IP-HTTP protocols.
• Set the IP-camera address;
• Verify the presence of industry compliant video image i.e. H.265 with local or remote laptop/computer. Exercise the pan, tilt, zoom, focus, iris opening, and manual iris control selection, and the operation, low pressure alarm (if present), preset positioning, and power on/off functions;
• Observe the video picture on a laptop/computer, demonstrate IP-camera sensitivity at low light levels to meet the provisions;
• Demonstrate the pan/tilt speed and extent of movement to meet the provisions;

1300.11 VENDOR AND MANUAL PROVISIONS

Provide a training and maintenance manual for the IP-camera assembly and the CCTV networks, including detailed provisions and information regarding the following CCTV system components.

Weight and dimensions;
Resolution;
Sensitivity;
Power consumption;
Optical zoom range;
Digital zoom range;
Zoom and focus presets;
Pan/tilt presets;
Ethernet connection;
Security;
Supported network protocols;
Video Compression;
Frame Rate;
Number of video streams and stream outputs;
IP-Camera control interface as required by recommended Standard 10/100 Base-T RJ-45 Ethernet, etc.;
Operating temperature and relative humidity; and General maintenance procedures

Provide documentation detailing the technical and operational aspects of the completed system. This will include device manuals, system diagrams, cabling diagrams, any and all field engineering notes specific to each installed IP-camera assembly, and any other documentation as required by the Department.

Supply a minimum of one day of training for operations and maintenance personnel regarding all functional, operational, and mechanical aspects of the IP-camera assembly and the supporting network communication devices.

The vendor shall supply ODOT with any computer software needed for setup, testing, and control of the CCTV locally.

1300.12 METHOD OF MEASUREMENT

Measurement will be made as an IP-camera site and as follows:

ITEM 809E60000.: CCTV IP-CAMERA SYSTEM, DOME-TYPE furnished and installed in place, complete and accepted by the ENGINEER.

1300.13 BASIS OF PAYMENT

The payment for this item will be made for the accepted number of quantities at the contract unit price.
1300.14 UNIT OF PAYMENT

Each
1301 Closed Circuit Television (CCTV) Cameras – Tunnel / Wall

ITEM 809E60010: CCTV IP-CAMERA SYSTEM, TYPE HD, WALL/TUNNEL

1301.1 GENERAL DESCRIPTION

Closed Circuit Television (CCTV) Structure Mounted Camera Assembly, hereafter referred to as CCTV ASSEMBLY, TYPE HD (WALL MOUNT / TUNNEL APPLICATION), shall include all specification requirements from Section 1300 for ITEM 809E60000 CCTV IP-CAMERA SYSTEM, DOME-TYPE, except for the following differences as defined below.

The camera shall not be required to be of dome-type housing but shall be capable of being mounted in a vertical (upright or upside down from a lowering unit), or adapted wall mounting type.

Functional Provisions

The CCTV ASSEMBLY, TYPE HD (WALL MOUNT / TUNNEL APPLICATION) will include, but not limited to, the following additional components and features:

- Mounting hardware of the vertical (upright or upside down from a lowering unit), or adapted wall mounting type with no exposed camera control wiring (any gasketed opening of the mounting hardware shall occur on the bottom-side of the camera/mount to avoid entry of water due to damaged gaskets)
- Housing Faceplate Wiper to clear dirt/debris over the camera lens and/or Hydrophilic “self-cleaning” glass window

The IP-camera will support the following image settings:

- Wide Dynamic Range (WDR),
- Electronic Image Stabilization (EIS),
- Manual shutter time, color, brightness, contrast, sharpness
- Text and image overlay and privacy mask
- Image Defogging Capability

IP-CAMERA LENS PROVISIONS

The CCTV ASSEMBLY, TYPE HD (WALL MOUNT / TUNNEL APPLICATION) camera lens will be motorized and be mechanically or electrically protected from overrunning in extreme positions. Integrated camera/lens combination may be substituted.

Optical zoom range of x20 and digital zoom range of x2 shall be supported by camera.

The lens will have an automatic iris capability with manual override.

The zoom lens will be selected automatically or manually to provide a minimum focal length of 4.3 to 129 mm that provides the full coverage of the corridor mainlines and shoulders. The minimum focusing distance will be a distance of 4 feet (1.2 m). The lens will also have a minimum aperture of f/1.2 and a 1/4 inch [0.6 cm] with 10 preset position points. The iris, zoom, and focus will be controlled from the central location via HTTP protocol. The motors controlling the iris, zoom and focus will not be damaged due to overload at travel limits. The IP-camera lens will support FOV optical zooming ranging from 3.5° telephoto (max) to 55.4° wide angle (min). The camera will support automatic focus adjustments, with manual override. Vibration or ambient temperature changes will not affect the automatic iris function, focus mechanism, and zoom mechanism.

The IP-camera/lens combination will support automatic recovery from over and under voltage conditions, when power is returned to normal values. The lens will return to the last position prior to the over/under voltage condition.
The lens will be optically clear, impact resistant and acrylic. The acrylic lens will not yellow, introduce appreciable light loss, or distort over a 10-year service life when exposed to anti-icing chemicals. Certification of meeting this requirement will be required. The lens will be of anti-fog design with nominal light loss of no greater than 5 percent and geometric distortion of no more than 1 percent.

**CCTV ASSEMBLY, TYPE HD (WALL MOUNT / TUNNEL APPLICATION) PAN/TILT UNIT (PTU)/POSITIONER PROVISIONS**

The PTU will be an integrated motorized, remotely controlled device that allows the operator to point the camera into a pan (horizontal vectoring) range with the following requirements:

- X, Y axis positioner
- 360° Continuous rotation capability in either direction. Software limits provided for pan mode.
- +90° to -90° of tilt movement
- Minimum sixty-four preset positions with repeatability within ± 0.1°
- High speed pan/tilt drive capable positioning speeds of 80°/30° per second respectively.

**METHOD OF MEASUREMENT**

Measurement of ITEM 809E60010: CCTV IP-CAMERA SYSTEM, TYPE HD, WALL/TUNNEL includes all materials and work as described within this section that leads to a complete installation accepted by the ENGINEER.

**BASIS OF PAYMENT**

Communication must be completed and accepted prior to final payment of this item. CCTV Assembly, Type HD (Wall Mount / Tunnel Application) will be paid for at the contract unit price for:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>809</td>
<td>Each</td>
<td>CCTV IP-CAMERA SYSTEM, TYPE HD, WALL/TUNNEL</td>
</tr>
</tbody>
</table>
1304 Closed Circuit Television (CCTV) Cameras – ENHANCED

ITEM 809E60030: CCTV IP-CAMERA SYSTEM, ENHANCED

1304.1 GENERAL DESCRIPTION

An Enhanced Closed-Circuit Television (CCTV) Camera Assembly, hereafter referred to as CCTV ASSEMBLY, ENHANCED, shall include all specification requirements from Section 1300 for ITEM 809E60000 CCTV IP-CAMERA SYSTEM, DOME-TYPE, except for the following differences as defined below.

The camera assembly shall be capable of performing enhanced features for analytics processing, reporting, and alerting. The minimum enhanced features which the camera shall be capable of are defined below:

- Rules based alerting/notification: The camera shall be capable of sending alarms or notifications based on events that occur from other features.
- Object tracking
- Detection zones when objects enter
- Detection lines when objects cross
- Wrong Way detection

The enhanced features shall be easily configurable within the camera web browser GUI.

METHOD OF MEASUREMENT

Measurement of ITEM 809E60030: CCTV IP-CAMERA SYSTEM, ENHANCED includes all materials and work as described within this section that leads to a complete installation accepted by the ENGINEER.

BASIS OF PAYMENT

Communication must be completed and accepted prior to final payment of this item. CCTV Assembly, Type HD (Wall Mount / Tunnel Application) will be paid for at the contract unit price for:

<table>
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<tr>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td>809</td>
<td>Each</td>
<td>809E60030: CCTV IP-CAMERA SYSTEM, ENHANCED</td>
</tr>
</tbody>
</table>
1305 Closed Circuit Television (CCTV) Cameras – QUAD MULTI-VIEW FIXED WITH PTZ

ITEM 809E60040: CCTV IP-CAMERA SYSTEM, QUAD MULTI-VIEW FIXED WITH PTZ

1305.1 GENERAL DESCRIPTION

A Closed-Circuit Television (CCTV) all-in-one assembly with Four (4) Fixed Cameras as well as One (1) Pan-Tilt-Zoom (PTZ) Camera, hereafter referred to as CCTV ASSEMBLY, QUAD MULTI-VIEW FIXED WITH PTZ, shall include all specification requirements from Section 1300 for ITEM 809E60000 CCTV IP-CAMERA SYSTEM, DOME-TYPE, except for the following differences as defined below.

The camera all-in-one assembly shall consist of an enclosed ring of four fixed-view cameras, each with a minimum 90 degree field of view horizontally, to provide a 360 degree panoramic field of view over large areas, and a PTZ camera for detailed viewing, located within the all-in-one assembly. This shall be considered the standard all-in-one assembly for this item CCTV ASSEMBLY, QUAD MULTI-VIEW FIXED WITH PTZ. The minimum resolution supported will be 1920 x 1080 for the PTZ camera and 1280 x 720 for each of the fixed view cameras. Each camera shall be capable of adjusting the resolution stream settings lower to 1280 x 720 and 720 x 480 or lower equivalent. Each camera in the all-in-one assembly shall have multiple, individually configurable streams. Each camera stream shall be capable of H.264 and MJPEG at a minimum.

The four fixed cameras/lenses shall offer flexible positioning anywhere within the 360 degree ring and each lens shall have individual tilt functionally in order to establish desired views and then physically lock them into place so they shall not move after installation due to vibration or weather events. The individual lenses shall be easily removed/replaced and may be interchangeable with lenses with different fields of view to focus better on particular areas if desired. Lenses with a field of view less than 90 degrees horizontally may be used to accomplish this if the other lenses within the all-in-one assembly have a greater horizontal field of view in order to accomplish 360 degree viewing of all roadway approaches. For various options/combinations of camera lenses included for the four fixed cameras within the all-in-one enclosure, separate submittals may be submitted. If projects desire a specific combination of lenses which are different from the standard all-in-one assembly, the project will specify the field of view desired.

The camera shall be capable of being powered by Power over Ethernet (PoE) and shall be supplied with a PoE injector capable of running all camera system functions. The camera shall also be supplied with any weatherproofing pigtails or connectors needed to connect directly to outdoor CAT5E cabling supplying PoE to the camera.

The camera shall be supplied with and be capable of being mounted with a 1.5” NPT Pipe Mount adapter, for connecting to standard camera lowering unit systems.

Each camera shall be capable of overlaying text and custom images consistent with ODOT standards and have the ability to pull snapshot jpeg images so they can be pulled/posted on ODOT websites.

The camera assembly shall be capable of performing enhanced features for analytics processing, reporting, and alerting. For instance, each fixed camera shall be able to detect an event which can be configured to send a command to the PTZ camera to move to that location. The camera may be able to detect other events and configure actionable responses/notifications. The camera shall be supplied with built-in analytics functionality available and any licensing needed to activate it.
METHOD OF MEASUREMENT

Measurement of ITEM 809E60040: CCTV IP-CAMERA SYSTEM, QUAD MULTI-VIEW FIXED WITH PTZ includes all materials and work as described within this section that leads to a complete installation accepted by the ENGINEER.

BASIS OF PAYMENT

Communication must be completed and accepted prior to final payment of this item. CCTV Assembly, Quad Multi-View Fixed with PTZ will be paid for at the contract unit price for:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>809</td>
<td>Each</td>
<td>CCTV IP-CAMERA SYSTEM, QUAD MULTI-VIEW FIXED WITH PTZ</td>
</tr>
</tbody>
</table>
1390 Closed Circuit Television (CCTV) Cameras – Portable

ITEM 809E60020: CCTV IP-CAMERA SYSTEM, PORTABLE

1390.1 GENERAL DESCRIPTION

The CONTRACTOR shall provide a portable camera unit to the project and shall be responsible for the proper operation of the unit for the duration of the construction period. All units shall be in working condition and shall be streaming video over a CONTRACTOR provided IP cellular connection so that ODOT specified areas of the project can be monitored by the ODOT project engineer. The ODOT project engineer shall be the sole determining party for the placement of these cameras and may request the contractor to change camera locations as needed depending on the phasing of the project. The portable camera units shall be operated and maintained by the CONTRACTOR for the duration of the project. The portable camera units shall be one of the following types and shall meet the following specifications:

1390.2 Minimum Requirements

A. Winch-operated mast with a minimum mast height: 27 ft.
B. Electrical Charging System including all of the following:
   a. Solar Panels with user selectable output
      i. Solar Charge Controller shall have Digital Display to monitor solar output to batteries
   b. AGM Batteries rated for use of the entire electronic system simultaneously for 30 days
   c. Ultra-Quiet Generator with Auto-Start to charge batteries when needed.
C. Remote Monitoring with email alerts based on user defined thresholds
   a. Generator Fuel Level
   b. Battery Level
D. GPS Monitoring
E. Spare Tire
F. Removable Tow Hitch following Ohio DOT Trailer Lighting & Wiring Standard and Specifications per Office of Equipment Management
   a. ODOT will only purchase trailers that meet the following lighting and wiring specifications (Reference Drawing):
   b. Trailer shall meet or exceed all current Federal Motor Carrier Safety Regulations 393.9 thru 393.33.
   c. Trailer cord plug shall meet SAE spec. J560 and be wired directly to trailer cord with no adaptors.
   d. Plug to be wired as follows (no other plug wiring will be accepted):
      i. White – Ground return to towing vehicle
      ii. Black – Electric break controller – or not utilized if trailer has air, hydraulic or no brakes
      iii. Yellow – Left turn signal and on some light duty tow vehicles, stop/hazard lamps
      iv. Red – Stop lamps and antilock device
      v. Green – Right turn signal and on some light duty tow vehicles, stop/hazard lamps
      vi. Brown – Clearance, marker, license plate and tail lights
      vii. Blue – If air Brake – Continuous ABS power – If electric Brake – Ing. Controlled B+ for break-away battery charge maintenance circuit
   e. No adapters will be accepted.
f. Trailer cord to be wired to a weatherproof, 7-terminal junction block (Waytek part #47290 or approved equal).

g. All trailer light wiring (including ground wiring) must be routed to junction block.

h. Wire splices will be done with heat shrink butt connectors or soldered with heat-shrink.

i. No wire nuts, closed end connectors or self-stripping displacement connectors (i.e. Scotch Loks).

j. All lights to be LED. There shall be individual brake (2 ea.) and turn signal lights (2 ea.) for a total of 4 lights. These lights shall be 4” Round lights in rubber grommets or 3”x7” oval lights in rubber grommets. Clearance and Marker lights shall be 2” round lights in rubber grommets or ODOT approved equal.

G. Configurable SNMP and Email/SMS Alarms
   a. GPS Location with Geo-fencing
   b. Compartment Access Intrusion alarms

H. Interior Compartments
   a. Lockable
   b. Easy access and replacement of any interior part/component of the system within 10 minutes
   c. Extra storage for misc. items; such as removable tow hitch and necessary tools
   d. Tool kit including any specialty tools needed for maintenance.
   e. Easy visual inspection of all batteries without the use of tools

I. Minimum 30 days of operation between power-related site visits

J. Shall be configured with cameras listed in 809.05.A or 809.05.B or POE versions of those listed.

K. Communications via CONTRACTOR provided Sierra Wireless MP70 cellular modem with external mounted antenna with compatible connections for (Cellular, Cellular/Diversity, and GPS). Contact ODOT for activation of modem and provide modem model, serial number, and IMEI number.
M. Camera communications shall be configured by ODOT for integration of CONTRACTOR provided portable camera units to view all cameras simultaneously and provide PTZ control of selected camera through the use of ODOT ITS Camera Management Software. (A test camera shall be required to ensure functionality with ODOT ITS installation.)

N. Camera frame rate: the minimum acceptable frame rate of the video that is transmitted over the network is 15 frames/second. The video shall be free from packet loss and shall produce a clear and smooth image.
SECTION 1400 - POLES AND STRUCTURES
1400 Concrete Closed Circuit Television (CCTV) Pole

ITEM 809E61002: CCTV CONCRETE POLE, 70 FEET
ITEM 809E61012: CCTV CONCRETE POLE, 50 FEET

1400.1 Description
This work consists of furnishing concrete closed-circuit television poles only, of specified height above ground, and installing in conjunction with a camera and/or mount and/or lowering system (separate items) to be complete and ready for service.

1400.2 Materials
Furnish materials and equipment that are new, top quality, of current design, and free from defects.

1400.3 Design Requirements
The CCTV pole will be designed in accordance with the latest AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals.” Minimum loading requirements will be based on an isotach wind velocity of 100 MPH (145 km/hr.) including a 3 second gust. Calculations and detailed drawings will be submitted to the Engineer demonstrating compliance with the AASHTO specification. Crushed aggregate of any sort will not be acceptable for backfill around the pole. Use natural soil as defined in 203.02 only.

The concrete pole will be designed to support an ITS Cabinet located 30 inches above final grade. Embedment Depth shall be determined during the design of the project unless otherwise specified in the project plan set. If these items have not been provided during the design process, the contractor/manufacturer shall be responsible to submit procedures and calculations for embedment depth and backfill material to the ODOT Project Engineer and Geotech Engineer. A minimum of 12 feet shall be used in regards to imbeddment depth. Please note that crushed aggregate shall not be accepted for use in any way for the backfill. If there is not adequate existing soils data available, the contractor/manufacturer shall have a consultant pre-qualified in Geotechnical Testing, Field Exploration, and Drilling, as outlined in the ODOT Consultant Prequalification Requirements and Procedures, perform a geotechnical exploration (excluding design) in accordance with the ODOT Specifications for Geotechnical Explorations (SGE) at each site. The borings shall be drilled in accordance with SGE 303.7.5. The exploration reports shall be sent to the ODOT Project Engineer, so they can be sent to the ODOT Office of Traffic Operations and ODOT Office of Geotechnical Engineering for review and potential design assistance of the embedment depth required for each concrete pole. The contractor shall not order poles until the embedment depth has been determined and the drawing submittals are accepted/approved by ODOT.

1400.4 Concrete CCTV Pole
Poles will be prestressed, and the concrete placed by the centrifugal spinning process. The centrifugal spinning is to insure both a minimum 28-day compressive strength of 8,000 psi and a minimum of ¾ inch (19 mm) cover over the prestressing strand. Poles will have a smooth natural form finish, soft gray in color. Poles will be designed and constructed so that all wiring and grounding facilities are concealed within the pole. All handholes, couplings, thru-bolt holes and ground wire will be cast into the pole during the manufacturing process. Please note that all unused couplings shall have PVC coupling caps. Rubber caps shall be unacceptable. Poles will be round in cross section and provide a continuous taper of 0.18 inches per foot of length and provide a minimum ¾ inches (19 mm) of concrete coverage over the prestressing strands. All cable entry holes, and sizes required will be in accordance with the location on submittal drawings. The cable entry holes will also be free from sharp edges for passages of electrical wiring. Other general concrete pole specifications include:

1. Two 4 inches x 12 inches (75 x 300 mm) conduit entrance openings centered 20 inches (450 mm) below grade. The installation of two 3-inch conduits from the “TRAFFIC” pull box to the inside of the concrete pole shall be incidental to the CCTV pole. These conduits shall be fitted with 90-degree elbows
so as to direct any fish tapes upward when pushed through the conduit from pull box, or as directed by the engineer.

2. One 4.5 inches x 30 inches (114.3 x 762 mm) steel galvanized or cast aluminum reinforced handhole frame with flush cover and 9/16-inch hex screws. The bottom shall be located approximately 38 inches above grade.

3. The pole shall be capable of mounting a camera lowering device which must mount to a specially designed tenon bolted to the top of pole and shall be within a range of 60 to 300 degrees from the handhole, so the camera won’t be lowered over the technician operator. The orientation shall be installed to see all roadway directions, as per plan, or as directed by the Project Engineer. The contractor/manufacturers shall coordinate to make sure the pole tenon and camera lowering system are compatible.

4. All poles will be provided with a fish wire to facilitate cable installation.

5. All poles must have a minimum inside raceway dimension of 5 inches (125 m) at tip of pole.

6. All poles up to 75 feet (22.9 m) long above ground will be designed to have a minimal deflection not greater than 1.00 inches (25 mm). All poles over 75 feet (22.9 m) long above ground will be designed to have a minimal deflection less than 1.62” (40 mm) at 30 MPH (50 km/hr.) non-gust wind speed.

7. All manufacturing tolerances, details of reinforcement, and finishes will be in accordance with the Guide Specification for Prestressed Concrete Poles as published in the May-June 1982 issue of the Journal of the Prestressed Concrete Institute.

8. Prestressed concrete poles will be lifted and supported during manufacturing, stockpiling, transporting and erection operations only at the points shown on the shop drawings.

9. Transportation, site handling, and erection will be performed with acceptable equipment and methods by qualified personnel.

10. Poles shall be capable of housing a minimum 1 ¼ inch PVC conduit installed inside of the pole from the top of the pole to the top of the handhole. The purpose of this conduit is to house the lowering cable so that it is separate from the communication cable(s).

11. Poles shall be coated in a weatherproof Silane treatment for the bottom 30-foot (9.144 m) section of the concrete pole and in accordance with the product specifications.

A. Concrete
   The pole will achieve a minimum 28-day compressive strength of 8,000 psi. Cement will conform to the latest requirements of Type I Portland Cement in accordance with ASTM-C150. Maximum size aggregate must be either ¾ inch (19mm) or ¾ of the clear spacing between reinforcing steel and surface of pole. Any water reducers, retarders, or accelerating admixtures will conform to ASTM-C494. Water will be free from foreign materials in amounts harmful to concrete and embedded steel.

B. Reinforcing Steel
   Deformed steel reinforcement will conform to requirements of ASTM-A615 for Grade 60 Rebar.

C. Prestressing Steel
   Prestressing steel reinforcement will conform to uncoated 7-wire, stress relieved strand; ASTM-A416.

D. Spiral Reinforcement
   Steel spiral reinforcement will conform to the requirements of ASTM-A82 and will not be less than .150-inch (3.75 mm) diameter.

E. Hardware
All structural steel will conform to ASTM-A36 and zinc alloy AC41A will conform to ASTM-B240. The finish will be hot dipped galvanized in accordance with ASTM-A153.

**F. Electrical Ground**

All poles will be supplied with a number 6 stranded copper ground wire cast into the wall of the pole at the handhole box location. This ground lug shall not interfere with the mounting of a lowering device.

**1400.5 Camera Lowering Device**

The pole shall be capable of mounting a camera lowering device which must mount to a special designed tenon bolted to the top of pole and shall be within a range of 60 to 300 degrees from the handhole, so the camera won’t be lowered over the technician operator. The orientation shall be installed to see all roadway directions, as per plan, or as directed by the Project Engineer. The contractor/manufacturers shall coordinate to make sure the pole tenon and camera lowering system are compatible.

The camera lowering system shall be per the requirements in Section 1401 for ITEM 809E61090: CCTV LOWERING UNIT.

**1400.6 Method of Measurement**

The Department will measure CCTV CONCRETE POLE by the number each, and will include anchor bolts, conduit ells furnished for the foundation, foundation, equipment, labor, and miscellaneous materials.

**1400.7 Basis of Payment**

The Department will pay for accepted quantities at the contract prices as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>809</td>
<td>Each</td>
<td>CCTV CONCRETE POLE, _____ Feet</td>
</tr>
</tbody>
</table>
1401 Closed Circuit Television (CCTV) Lowering Unit

ITEM 809E61090: CCTV LOWERING UNIT

1401.1 Description
This work consists of removal of an existing CCTV lowering unit (if one exists) and furnishing and installing a new closed-circuit television lowering unit system that meets the following specifications on top of an existing pole, up to 100 feet tall. Per project, one (1) wench will be provided per every 10 lowering units, rounded up. The Contractor shall be responsible for field verification of the existing pole top adapter to ensure that it is compatible with the new CCTV lowering unit. Any modifications or replacement pole top adapters shall be included in the bid price for the lowering unit replacement. Camera tenon arms shall be positioned as directed by the engineer.

1401.2 Materials
Furnish materials and equipment that are new, top quality, of current design, and free from defects.

1401.3 Camera Lowering Device
The camera lowering system shall be designed to support and lower a standard closed-circuit television camera, lens, housing, PTZ mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The camera lowering device and the pole are interdependent upon each other and thus, must be considered a single unit or system. The lowering system will consist of a pole, communications contact unit, self-aligning divided support arm, a pole adapter for attachment to a pole top tenon, and a camera junction box. The divided support arm and receiver brackets will be designed to self-align the contact unit with the pole center line during installation and insure the contact unit cannot twist under high wind conditions. Round support arms are not acceptable. The camera-lowering device will withstand wind forces of 100 MPH (160 km/hr.) with a 30 percent gust factor using a 1.65 safety factor. The lowering device manufacturer will furnish independent laboratory testing documents certifying adherence to the stated wind force criteria utilizing, as a minimum effective projected area, the actual EPA or an EPA greater than that of the camera system to be attached.

The lowering device manufacturer shall furnish a factory representative to assist the installation contractor with the assembly and testing of the first lowering systems onto the pole assemblies. The manufacturer will supply training for the contractor on the installation, operation, and safety of the poles and lowering devices. The manufacturer will furnish the Engineer documentation certifying that the specified electrical contractor personnel have been trained on the installation, operation, and safety features of the lowering device. These personnel shall be the only ones authorized by ODOT to work on the camera pole and lowering system for the duration of the project and any warranty period. Applicable maintenance personnel "on site" operational instructions must be provided. The Contractor/Manufacture shall also submit a wiring diagram to show details of all wires which go up the camera pole, through the lowering unit, and connect to the camera. The wiring diagram shall detail wire number/colors/size and exactly how they are mapped through the pole and lowering unit.

A. Suspension Contact Unit
The suspension contact unit will have a minimum load capacity of 600 lbs. with a 4 to 1 safety factor. There will be a locking mechanism between the fixed and moveable components of the lowering device. The movable assembly will have a minimum of 2 latches. This latching mechanism will securely hold the device and its mounted equipment. The latching mechanism will operate by alternately raising and lowering the assembly using the winch and lowering cable. When latched, all weight will be removed from the lowering cable. The fixed unit will have a heavy duty cast tracking guide and the means to allow latching in the same position each time. The contact unit housing will be weatherproof with a gasket provided to seal the interior from both dust and moisture.
The prefabricated components of the lift unit support system will be designed to preclude the lifting cable from contacting the power or video cabling. The contractor shall supply an internal pole conduit for the CCTV camera stainless steel lowering cable. The only cable permitted to move within the pole or lowering device during lowering or rising will be the stainless-steel lowering cable. All other cables must remain stable and secure during lowering and raising operations.

The connector block bodies shall hold the individual contacts together without separating or losing contact during normal operations. Guide pins and/or guide bushings will prevent misconnections and provide accurate mating without relying on the contact pins to provide alignment. There will be a minimum of 7 contacts, each having a minimum outer diameter of 1/16 inches, and 8 contacts, each having a minimum outer diameter of 1/16 inches, for Category 5 Ethernet connection. The maximum current rating for each pin will be at least 13 amps. The signal and power wires will be crimped with an industry standard 8-point crimp tool. The analog video signal shall be passed to the ITS cabinet utilizing two of the pins in the connector block not used for the Category 5 Ethernet connection. The camera cable will be assembled with the connector block in the factory and sealed with electrical insulating resin epoxy or other acceptable material of the same type. The entire connector block shall be sealed from external dust and external moisture when in the mated or un-mated condition.

B. Connectors
The connectors / connector blocks shall consist of outdoor-rated heavy duty material with male and female matched body parts that mate together to make an electrical connection between the composite cable and the camera housing when the camera is fully raised and locked. This connector shall be shielded environmentally as well as for IP communications. These connectors / contacts shall be successfully tested and certified for Category 5 100 base T specifications. All connectors shall be factory terminated onto the cable.

C. Contacts
The contacts shall supply metal, electrically conductive connections in the male and female connectors. Contacts shall be present for each function / communication method that the specified camera provides. These contacts shall be heavy duty, gold plated, copper material. Each male contact shall have a minimum outer diameter of 1/16 inches. The female sockets shall be sized accordingly to match the male contacts. The connector shall provide a rain and weather-tight seal when male and female components are fully connected.

D. Control Cable
This item shall include the replacement of up to 130 feet of CCTV Control Cable. The Control Cable shall be ran from the ITS Cabinet to the top of the CCTV pole. The control cable shall be easily replaceable without having to replace the lowering unit tenon arm. This shall be done by way of splicing the Ethernet cable (CAT5E or better) with Insulation Displacement Connectors at the top of the pole just inside the pole top adapter. The connectors shall be spliced in a manner to maintain the Ethernet cable’s functional properties and certification testing requirements. The splice connections shall be taped with electrical tape and installed with appropriate cable strain relief. The tenon arm shall also be capable of slight degrees of adjustment without completely removing the bolts securing the pole top adapter to the camera pole. The control cable shall be comprised of a composite cable that carries power (separate 24 VAC for heater and camera), serial data (RS-232, RS-422, or RS-485), analog video communications, and Ethernet communications (CAT 5 100 base T tested and certified). The control cable shall have all Ethernet and Coaxial connections pre-terminated at the factory. The cable shall be provided by the factory to the Contractor with testing certification showing that the connector passes specified tests.

E. Lowering Tool
The camera-lowering device will be operated by use of an externally-powered portable lowering tool. The tool will consist of a lightweight metal frame and winch assembly with
cable as described herein, two quick release cable connectors, an adjustable safety clutch and a variable speed industrial duty electric drill motor with a maximum of 550 rpm. This tool will be compatible with accessing the support cable through the hand hole of the pole. When attached to the hand hole by means of one single bolt and/or a speed adapter, the tool will support itself and the load assuring lowering operations and provide a means to prevent freewheeling when loaded. The lowering tool will be delivered to the Engineer upon project completion. The lowering tool will have a reduction gear to reduce the manual effort required to operate the lifting handle to raise and lower a capacity load. The lowering tool will be provided with an adapter for operating the lowering device by a portable drill using a clutch mechanism. The lowering tool will be equipped with a positive locking mechanism to secure the cable reel during raising and lowering operations. Manufacturer will provide a variable speed, heavy-duty reversible drill motor and a minimum of one lowering tool plus any additional tools required by plan notes. The lowering tool will be made of durable and corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment. Each lowering tool with associated drill shall be housed in a watertight case.

F. Lower Junction Box
The lower junction box shall consist of a heavy-duty clamshell box that is weather-sealed when closed, with the exception of a drain hole in the bottom. This box shall be closed by way of Stainless-Steel hex bolts or nuts. The hex bolts/nuts shall be secured in a way that when the junction box is open the bolts/nuts are not permitted, without extra effort, to come out of the lower portion of the clamshell. The junction box shall be sized accordingly to permit the installation of surge protection for all wiring. The lower portion of the junction box shall not weigh more than 10 pounds so that minimal effort is required to hold the camera and lower portion into position when fastening the lower junction box in the closed, sealed position. A raised neck shall be incorporated into the junction box so that any moisture that accumulates in the junction box does not flow into the camera. The lower junction box shall not allow water to pass directly through the enclosure and into the camera. Cable shall also be routed in a manner that prohibits water from traveling along the cable path through the junction box.

G. Materials
All pulleys for the camera lowering device and portable lowering tool will have sealed, self-lubricated bearings, oil tight bronze bearings, or sintered bronze bushings. The lowering cable will be a minimum 1/8-inch (3 mm) diameter stainless steel aircraft cable with a minimum breaking strength of 1,740 pounds with 7 strands of 19 wires each.

All electrical and video connections between the fixed and lowerable portion of the outdoor-rated contact block will be protected from exposure to the weather by a waterproof seal to prevent degradation of the electrical contacts. The electrical connections between the fixed and movable lowering device components will be designed to conduct high frequency data bits and one (1) volt peak-to-peak video signals as well as the power requirements for operation of dome environmental controls.

The interface and locking components will be made of stainless steel or aluminum. All external components of the lowering device will be made of corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

The camera manufacturer, if needed, will provide either weights or counterweights as necessary to assure that the alignment of pins and connectors are proper for the camera support to be raised into position without binding. The lowering unit will have sufficient weight to disengage the camera and its control components in order that it can be lowered properly.
The camera manufacturer, if needed, will provide the appropriate length, type of power and signal cable to the lowering system manufacturer so that same can be pre-wired to the female connector and strain-relieved at the lowering device factory prior to shipment.

The camera manufacturer will provide a mounting flange sufficient for mounting their respective camera assembly to the bottom of the camera connection box.

1401.4 Method of Measurement
The Department will measure CCTV Lowering Units by the number each, up to 130 feet of composite cable, and all necessary hardware needed to attach the new lowering unit to a new or existing pole.

1401.5 Basis of Payment
The Department will pay for accepted quantities at the contract prices as follows:

<table>
<thead>
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<td>809</td>
<td>Each</td>
<td>CCTV Lowering Unit</td>
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1402 Concrete Closed Circuit Television (CCTV) Pole With Lowering Unit

ITEM 809E61000: CCTV CONCRETE POLE WITH LOWERING UNIT, 70 FEET
ITEM 809E61010: CCTV CONCRETE POLE WITH LOWERING UNIT, 50 FEET

1402.1 Description
This work consists of furnishing and installing closed circuit television poles with lowering unit systems, complete and ready for service.

1402.2 Materials
Furnish materials and equipment that are new, top quality, of current design, and free from defects. The CCTV pole of specified height above ground shall meet all requirements of Section 1400 Concrete Closed Circuit Television (CCTV) Pole. The Lowering Unit System shall meet all requirements of Section 1401 Closed Circuit Television (CCTV) Lowering Unit. The two separate items, pole and lowering unit system, shall be bid as one complete item.

1402.3 Method of Measurement
The Department will measure CCTV CONCRETE POLE WITH LOWERING UNIT by the number each, and will include anchor bolts, conduit ells furnished for the foundation, foundation, up to 130 feet of composite cable, lowering tool, and camera lowering device, equipment, labor, and miscellaneous materials.

1402.4 Basis of Payment
The Department will pay for accepted quantities at the contract prices as follows:

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<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>809</td>
<td>Each</td>
<td>CCTV CONCRETE POLE WITH LOWERING UNIT, _____ Feet</td>
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</table>
SECTION 1500 - DYNAMIC MESSAGE SIGNS
1500 Dynamic Message Signs – Full-size DMS

ITEM 809E63000: DYNAMIC MESSAGE SIGN (DMS), FULL-SIZE WALK-IN
ITEM 809E63010: DYNAMIC MESSAGE SIGN (DMS), FRONT-ACCESS
(FRONT-ACCESS SIGN ONLY TO BE USED WITH PRIOR OFFICE OF TRAFFIC OPERATIONS APPROVAL)

1500.1 GENERAL DESCRIPTION

This section defines furnishing and installing a Light Emitting Diode (LED) type of Dynamic Message Signs (DMS) with walk-in-cabinet. The DMS shall be installed as detailed in the plans. The DMS shall still conform to the following Dynamic Message Sign Specification.

A. General Specifications. The DMS housing shall provide walk-in access for all Light Emitting Diode (LED) display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components.

The DMS shall contain a full display matrix measuring a minimum of 27 rows high by 105-pixel columns wide. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

Each display pixel shall be composed of multiple monochrome amber LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, and incandescent lamp, will not be accepted.

The pixel matrix shall be capable of displaying alphanumeric character fonts measuring a minimum of 18 inches (460 mm) high to a maximum of the display matrix height.

The DMS shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols, and graphic images across multiple frames.

One (1) controller unit shall be provided to ODOT for testing prior to any equipment approvals being made by ODOT. The MANUFACTURER shall provide off-site technical assistance to ODOT during initial testing and configuration of ODOT’s software with the MANUFACTURER’s equipment. The control software and communication interface shall be compatible with the ODOT platform for controlling the messages and must be approved by ODOT before the DMS sign and controller will be accepted.

The MANUFACTURER shall provide 24 hours of on-site technical service and support for one year after installation of all units.

B. Legibility. DMS messages shall be legible within a distance range of 150 to minimum of 1000 feet (45 to minimum of 360 m) from the DMS display face under the following conditions:

When the DMS is mounted so its bottom side is positioned between 17 feet (1.5 m) and 20 feet (6 m) above a level roadway surface
Whenever the DMS is displaying alphanumeric text that is 18-inches (460 mm) high
24 hours per day and in most normally encountered weather conditions
During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DMS
When viewed by motorists and travelers that have 20-20 corrected vision
When the motorist eye level is 3 to 12 feet (0.9 to 3.6 m) above the roadway surface.
C. Documentation. NTCIP documentation shall be provided on a CD-ROM and will contain ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

The relevant version of each official standard MIB modules referenced by the device functionality. If the device does not support the full range of any given object within a standard MIB Module, a manufacturer specific version of the official standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module except that it will have the extension "man".

A MIB module in ASN.1 format containing any and all manufacturer specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.

A MIB containing any other objects supported by the device.

D. Acceptance Testing. The vendor will provide certification of NTCIP-compliance as part of the vendor's submittal documentation. This certification shall be in the form of a comprehensive test plan and completed test report as performed by either the vendor or a third-party testing agency. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon’s NTester, Intelligent Devices’ Device Tester, and/or Frontline’s FTS for NTCIP. Data capture files from the FTS software during the performance of the above testing shall be furnished.

E. Experience and Reference Requirements. To be valid for these experience requirements, a walk-in LED DMS must meet this specification and be a State Highway or Interstate Highway, permanently mounted, overhead, LED dynamic message sign. Non-LED DMS, neon signs, hybrid DMS, lift-face DMS, non-highway DMS, portable DMS, indoor DMS, DMS smaller than three lines of fifteen 7x5 characters per line while having a character height smaller than 18-inches (460mm) and commercial DMS will not satisfy these experience requirements.

The dynamic message sign manufacturer for this contract shall:

Have been in the business of manufacturing large outdoor permanently mounted LED DMS, which are used to manage vehicular roadway traffic, for minimum period of five (5) years prior to the contract bid date. An "LED" DMS contains display pixels constructed solely of high-intensity discrete LEDs. 2. Have in operation a minimum of one hundred (100) walk-in large outdoor permanently mounted LED DMS as defined above. Each of these DMS shall have successfully operated for a minimum period of one (1) year prior to the contract bid date.

Have in operation as of the contract bid date a minimum of ten (10) independently owned and operated LED DMS systems. Each of the ten (10) systems shall contain a minimum of ten (10) permanently mounted DMS that use the National Transportation Communications ITS Protocol (NTCIP) as their primary communication protocol. Each of the DMS signs shall be communicating over dial-up telephone, cellular telephone, spread spectrum radio, or fiber optic networks.

F. Testing. The DMS vendor shall use the supplied Traceability Matrix.

G. Test Procedures. The DMS vendor shall prepare and submit test procedures and test data forms for the Department’s approval at least 30 working days before the scheduled testing as required. Test procedures shall be developed specifically in response to these specifications. Do not submit test procedures developed in response to other procurement documents, specifications or for other customers and projects. The Department will review submitted test procedures. At a minimum, the test procedures and data forms shall include the following:

A step-by-step outline of the test sequence to be followed, showing a test of every function of the equipment or system to be tested. For each test, clearly identify in the test procedure the specific function or requirement being addressed.
A description of the expected operation, output and test results.
An estimate of the test duration and a proposed test schedule.
A data form to be used to record all data and quantitative results obtained during the test.
A description of any special equipment, setup, manpower, or conditions required for the test.

**H. Test Equipment and Software.** As part of the testing requirements, except as otherwise noted, the DMS vendor shall be responsible for furnishing all test facilities, including software, required to complete the required testing. The DMS vendor shall provide documentation and user instructions for use of any required test equipment and test software unless otherwise directed by the Department.

**1500.2 Enclosure**

**A. Dimensions.** DMS housing dimensions shall not exceed 8 feet 6 inches (2.6 m) high by 26 feet 1 inch (7.9 m) wide. The front-to-back housing depth shall not exceed 3 feet 11 inches (1.2 m) at its widest point, including the rear ventilation hoods.

DMS weight shall not exceed 4300 pounds (1900 kg)

**B. Sign Construction.** The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum).

The DMS housing bottom side shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes and ventilation/exhaust hoods shall be screened to prevent the entrance of insects and small animals. Weep holes and ventilation/exhaust hood screens shall be replaceable.

DMS and sign controller components shall operate in a minimum temperature range of −30 to +165 °F (−34 to +74 °C) and a relative humidity range of 0 to 99 percent, non-condensing. DMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of −40 to +185 °F (−40 to +85 °C).

External DMS component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the roadway signage application.

DMS and sign controller components shall be 100 percent solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DMS and the sign controller shall be UL (Underwriter's Laboratory) listed and meet all local National Electric Code (NEC) codes applicable to DMS applications.

The presence of ambient electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DMS system. The DMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DMS and its sign controller. Manufacturer shall provide certification showing the DMS system passes standard Electromagnetic Compatibility (EMC) guidelines.

The DMS housing structural frame shall consist of aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. All sides of the DMS housing exterior, except the front, shall be covered with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework by continuous welding.
LED display modules shall be mounted parallel to the front face, so they are capable of 3 degrees tilt forward toward the viewing motorists at the angle at which the sign is installed and use of the legible LED viewing area is optimized.

DMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be stainless steel or galvanized A325 high-strength steel and shall be appropriately sized for the application.

C. Welding. The aluminum skin shall be welded to the DMS cabinet frame. All exterior sheet seams shall be continuously seam welded to the DMS frame to form a single structure. Stitch welding shall be used on the interior of the cabinet to attach the aluminum skin sheets to the aluminum extrusion frame. The DMS housing shall be welded and inspected in accordance with the requirements of ANSI/AWS D1.2-97 Structural Welding Code-Aluminum (1997). Compliance with this standard shall include, but shall not be limited to, the following:

Welding shall be performed according to documented in-house welding procedures
Personnel who perform welding on the DMS housing shall be certified to AWS D1.2-97 for all weld types required for housing fabrication
A Certified Welding Inspector (CWI) shall inspect DMS welding on a daily basis and shall complete written reports that document welding progress, weld integrity, and any corrective action taken. The DMS manufacturer shall archive these reports and make them available for review, upon request of the Engineer.

D. Mounting Brackets. Multiple mounting brackets in the form of I-beam or Z-bar extrusions shall be bolted to the DMS housing exterior rear wall to facilitate attachment of the DMS to the support structure. Mounting brackets shall be:

Designed such that the front face can achieve a 3-degree viewing angle
Extruded from aluminum alloy number 6061-T6 or equivalent
Attached to the DMS structural frame members, not just the exterior sheet metal
Installed at the DMS manufacturer’s factory
Attached to the DMS using stainless steel or mechanically galvanized A325 high-strength steel bolts
Attached to the DMS using direct tension indicators to verify that mounting hardware is tightened with the proper amount of force
Installed such that all bracket-to-DMS attachment points are sealed and water-tight
Designed and fabricated such that the installing Contractor can drill into them without penetrating the DMS housing and compromising the housing’s ability to shed water

The hardware used to attach the mounting brackets (nuts, bolts, washers, and direct tension indicators) to the DMS cabinet shall be stainless steel or galvanized A325 high-strength steel and shall be appropriately sized for the application.

E. Lifting Hardware. For moving and installation purposes, multiple galvanized steel lifting eyebolts shall be attached to the top of the DMS housing. Hardware shall attach directly to the DMS housing structural frame and be installed at the DMS factory. All mounting points for eyebolts shall be sealed to prevent water from entering the DMS housing. Lifting hardware, as well as the housing frame, shall be designed such that the DMS can be shipped and handled without damage or excessive stress being applied to the housing prior to or during DMS installation on its support structure.

The lifting hardware shall be easily removed, if necessary by one individual without opening or entering the display and without any risk of compromising water-tightness. Special tools shall not be required. Removal of the hardware shall not create holes and no replacement bolts or other hardware shall be necessary to seal the cabinet.

F. Front Face Construction. Front face panels shall provide a high-contrast background for the DMS display matrix. If an aluminum mask is used, it shall be painted flat black and shall contain an
opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Face panels shall be attached to each other using stainless steel hardware. Seams that separate adjacent panels shall be sealed. Panels shall not be welded or otherwise permanently mounted to the DMS housing. Panels shall be mounted in such a way that they are removable from the interior of the DMS housing.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The polycarbonate sheet shall be Lexan XL10 or equivalent approved by the Engineer.

LED display modules shall mount to the inside of the DMS front face panels. Common hand tools shall be used for removal and replacement.

DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

G. Exterior Finish. DMS front face panels and front face border pieces shall be coated with semi-gloss black Kynar 500 which has an expected outdoor service life of 20 years.

All other DMS housing surfaces, including the access doors and DMS mounting brackets, shall be natural mill-finish aluminum.

H. Service Access. The DMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DMS housing. All of those internal components shall be removable and replaceable by a single technician. The DMS front face panels shall also be removable and replaceable from inside the DMS cabinet.

One vertically hinged door shall be located on each end (left and right side) of the DMS housing. Each access door shall be mounted to an integral doorframe, which bolts to the DMS housing using stainless steel hardware. A continuous vertical stainless-steel hinge shall support each door, and all doors shall open outward. In the closed position, each door shall latch to its frame with a three-point draw-roller mechanism. The latching mechanism shall include an internal handle and release lever. Door release levers shall be located so that a person with no key and no tools cannot become trapped inside the housing.

Doorframes shall be double flanged on all sides to shed water. Each door shall close around its flanged frame and compress against a closed-cell foam gasket, which adheres to the door. All doors shall contain a stop that retains the door in a 90-degree open position. When a door is open, the door and its stop shall not be damaged by a 40 mph (64 km/h) wind.

Each door shall be furnished with a lock that is keyed to Corbin Number 2.
The DMS shall be equipped with an OSHA compliant safety rail assembly, which prevents service personnel from falling out of the DMS when closed across an open access door. A rail assembly shall be provided for each door in the display. The safety rail shall consist of a top rail that extends 42-inches (1067 mm) above the interior walkway, and a mid-rail that extends 21-inches (530 mm) above the interior walkway. The rail assembly shall require no tools to open and close.

I. Interior Housing Area. Minimum headroom of 72-inches (1800 mm) shall be provided. This free space shall be maintained across the entire width of the DMS housing, with the exception of structural frame members. Structural members shall be designed not to obstruct the free movement of maintenance personnel throughout the DMS interior.

A walkway shall be installed in the bottom of the DMS housing such that the walkway will be level at the angle the sign is installed. The walkway shall be a minimum of 24-inches (610 mm) wide, and it shall run the entire length of the housing, from access door to access door. The walkway's top surface shall be non-slip and shall be free of obstructions that could trip service personnel. The walkway shall support a load of 300 pounds per linear foot (130 kg per meter), and it shall be constructed of multiple, removable panels.

1500.3 Illumination.

A. LED Display Modules.
The DMS shall contain LED display modules that include a LED pixel array, LED driver circuitry, and mounting hardware. Each LED display module shall be constructed as follows:

Each LED display module shall be mounted to the rear of the display’s front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel’s pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels. LED display module power and signal connections shall be a quickdisconnect locking connector type. Removal of a display module from the DMS, or a pixel board or driver circuit board from its display module, shall not require a soldering operation. Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.

It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DMS display matrix.

All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the DMS.

B. LED Pixel Boards.

Each LED pixel board shall be composed of a printed circuit board to which LED pixels are soldered. The LED pixel boards shall conform to the following specifications:

LED pixel boards shall be manufactured using a laminated fiberglass printed circuit board. Each LED pixel circuit board shall contain a maximum of forty-five LED pixels configured in a two-dimensional array. The pixel array shall be a maximum of nine pixels high by five pixels wide. The distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be a minimum of 2.57-inches (65.27 mm). Each pixel shall consist of a minimum of two independent strings of discrete LEDs. All pixels shall contain an equal quantity of LED strings. The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DMS.

Each pixel shall contain the quantity of discrete amber LEDs needed to output a minimum luminous intensity of 9,200 candelas per square meter when operated within the forward current limits defined in these specifications. Each LED pixel shall not consume more than 1.5 watts.
The circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

All exposed metal on both sides of the LED pixel board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual pixels, including discrete LED replacement and acrylic/silicone conformal coating repair, shall be possible.

All LED pixel boards shall be identical and interchangeable throughout the DMS.

C. Discrete LEDs.
DMS pixels shall be constructed with surface mount or through hole discrete LEDs manufactured by Agilent / Avago Technologies, Toshiba Corporation, or Nichia Corporation. Substitutes will not be accepted. Discrete LEDs shall conform to the following specifications:

Through hole LEDs shall be non-diffused, high-intensity, solid-state lamps in T1-3/4-style LED packages.
Surface mount LEDs shall be non-diffused, high-intensity, solid-state lamps.

All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 3 degrees.

The LED lenses shall be fabricated from UV light resistant epoxy.
Amber LEDs shall utilize AlInGaP semiconductor technology and shall emit amber light that has a peak wavelength of 590 ± 5 nm.
The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two consecutive luminous intensity “bins” as defined by the LED manufacturer.
The LED manufacturer shall perform color sorting of the bins. LEDs shall be obtained from no more than two consecutive color “bins” as defined by the LED manufacturer.
The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.
All LEDs used in all DMS provided for a contract shall be from the same manufacturer and of the same part number.
The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 70 percent of the original brightness.
The LEDs shall not be driven with a forward current that exceeds the manufacturer’s recommendations to maintain the minimum 100,000-hour lifetime requirement.

D. Pixel Drive Circuitry.
The driver circuit boards shall conform to the following specifications:

LED driver boards shall be manufactured using a laminated fiberglass printed circuit board.
All exposed metal on both sides of the LED driver board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual components, including conformal coating repair, shall be possible.

Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.
Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer’s recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer’s recommendations for the 100,000-hour lifetime requirement.
The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be
modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.
The LED driver boards shall receive updated display data at a minimum rate of ten frames per second from the sign controller.
Each LED driver board shall be powered by 24 VDC from external regulated DC power supplies. Each driver board shall receive separate power feeds from a minimum of two independent power supplies.
Each LED driver board shall contain a microprocessor-controlled power regulation circuit that controls the voltage applied to the LED strings. The power circuit shall automatically adjust the forward voltage of the LEDs to optimize power consumption efficiency as the temperature changes. Indicator LEDs shall be provided to indicate the status of power to each driver board.
Each LED driver board shall contain a temperature sensor and shall report the temperature to the sign controller upon request.
The LED driver circuitry shall be able to detect that individual LED strings or pixels are non-responsive and shall report the pixel status to the sign controller upon request.
All driver circuit boards shall be identical and interchangeable throughout the DMS.
Removal or failure of a single driver circuit board shall not affect the performance of any other LED display module in the DMS.
Individual addressing of each driver circuit shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.
The redundant LED power supply system shall be designed to illuminate every character on the sign with any allowable alphanumeric character at full power, at 165°F (74°C). Power supplies shall be switching power supplies, which must be at least 80% efficient at nominal voltage, and include a self-resetting internal thermal protection device that switches off the output in case of an overload. In the event of a failure of one of the power supplies, the controller will detect the loss of power from the failed supplies.

E. Regulated DC Power Supplies.
The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the DMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two physically and electrically independent supplies. Each pair of power supplies shall be parallel but shall not be wired in a current sharing configuration.

Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100 percent of the pixels in that display region at 100 percent brightness when the internal DMS air temperature is +140°F (60°C) or less.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The output of each power supply will be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DMS.

Regulated DC power supplies shall conform to the following specifications:
Nominal output voltage of 24 VDC +/- 10 percent
Nominal maximum output power rating of 1000 watts
Operating input voltage range shall be a minimum of 90 to 260 VAC
Operating temperature range shall be a minimum of -30 to +165 °F (-34 to +74 °C)
Maximum output power rating shall be maintained over a minimum temperature range of -30 to +140 °F (-34 to +60 °C)
Power supply efficiency shall be a minimum of 80 percent
Power factor rating shall be a minimum of 0.95
Power supply input circuit shall be fused
Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
Power supplies shall be UL listed
Printed circuit boards shall be protected by an acrylic or silicone conformal coating

1500.4 Wiring and Power Distribution

A. Maximum Power. Maximum AC power shall not exceed 6000 watts, when the following circuits are operational and fully loaded:

LED display pixel matrix, with 100 percent of the pixels operating at their maximum possible drive current
DMS environmental control system
Utility outlet circuit
DMS sign controller

Typical DMS AC operating power shall not exceed 3000 watts with the following circuit loadings:

LED display pixel matrix, with 25 percent of the pixels operating at their maximum possible drive current
DMS sign controller

DMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground.

B. Power and Signal Entrances.
Two threaded conduit hubs shall be located on the rear wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

C. Load Center.
The DMS shall contain a power load center and circuit breakers that meet the following minimum requirements:

Service entrance-rated
Minimum of twenty circuit breaker mounting positions
Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
UL listed load center and circuit breakers

D. Internal Wiring.
Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.
**E. Earth Grounding.**
The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing’s rear wall. The DMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

**F. Convenience Outlets.**
The DMS housing shall contain a utility outlet circuit consisting of a minimum of three 15-A NEMA 15-R, 120 VAC duplex outlets, with ground-fault circuit interrupters. One outlet shall be located near each end of DMS housing interior, and the third outlet shall be located near the housing’s center.

**G. Site AC Power.**
The AC power feed for all equipment shall be protected at the load center by a parallel-connection surge suppressor rated for a minimum surge of 10 kA.

**H. Control Equipment AC Power.**
A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment in the ITS cabinet and sign housing. This device shall conform to the following requirements:

- Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form
- Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
- Series inductance of 200 micro henrys (nominal)
- Temperature range of -40 to +158 °F (-40 to +70 ºC)
- Approximate dimensions of 3-inches (76 mm) wide by 5-inches (127 mm) long by 2-inches (50 mm) high or shall be rack-mounted to fit in a standard EIA 19-inch rack
- The device shall be UL-1449 recognized
- UL 1449 surge rating of 400 V or less
- Minimum of 8 NEMA 15-R outlets, if equipment is to be hardwired in DMS Sign Housing a unit specified for the hardwiring application shall be used.

**I. Communication Signals.**
Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

**1500.5 Control Systems.**

**A. Internal Lighting.**
The DMS housing shall contain a minimum of one 4-foot (1.2 m), 60-watt fluorescent lamp fixture for every 8 feet (2.4 m) of DMS housing width. Lamps shall be evenly spaced across the housing ceiling, so they provide uniform light distribution for maintenance purposes. Wire cages shall protect lamps. Lamp ballasts shall be rated for cold weather operation down to 0 °F (-17 °C). A timer switch shall be located just inside each access door to activate the lighting system. The switch shall be adjustable from 0 to 4 hours.

**B. Environmental Monitoring Systems.**
The DMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.
C. Ambient Light Measurement.
Sensors that measure the outdoor ambient light level and the outdoor ambient temperature at the DMS site shall be mounted in-line with the DMS housing walls. This ambient light and temperature measurement system shall consist of three electronic light sensors.

Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DMS. The third light sensor shall be mounted to the floor or top of the DMS housing and shall face the ground. The DMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DMS face.

D. Ambient Temperature Measurement.
A minimum of one ambient temperature sensor shall be mounted to either the rear wall or bottom side of the DMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

E. Internal Temperature Measurement.
The DMS shall contain a minimum of one temperature sensor that is mounted near the top of the DMS interior. The sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40 to +176 ºF (-40 to +80 ºC). The internal temperature sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

F. Internal Humidity Measurement.
The DMS shall contain one sensor that measures the relative humidity of the air inside the DMS cabinet. The sensor shall monitor the humidity from 0 to 100 percent. The humidity sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

G. Interior DMS Environmental Control.
The DMS shall contain systems for cabinet ventilation, face panel fog and frost prevention, and safe over-temperature shutdown.

H. Housing Ventilation System.
The DMS shall contain a thermostatically controlled ventilation system designed to keep the internal DMS air temperature lower than +140 ºF (+60 ºC), when the outdoor ambient temperature is +115 ºF (+46 ºC) or less.

The ventilation system shall consist of two or more air intake ports. Intake ports shall be located near the bottom of the DMS rear wall. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger. One or more ball bearing-type fans shall be mounted at each intake port located after the air filters to limit the amount of dust directly contacting the fans. These fans shall positively pressure the DMS cabinet.

Fans and air filters shall be removable and replaceable from inside the DMS housing. To ease serviceability, the fans shall be mounted no more than 4 feet (1.2 m) from the floor of the DMS cabinet.

Air shall be transferred from the intake ports to the front of the cabinet using ductwork that shall be installed beneath the walkway. The ductwork shall not prohibit or hinder movement of service personnel through the cabinet. The ductwork shall not diverge into a series of smaller airways in a manifold style distribution system.
After moving air through the ductwork, the ventilation system shall move air across the rear of the LED modules in a manner such that heat is dissipated from the LED’s. The airflow shall move from the bottom of the cabinet towards the top to work with natural convection to move heat away from the modules.

Each exhaust port shall be located near the top of the rear DMS wall. One exhaust port shall be provided for each air intake port. All exhaust port openings shall be screened to prevent the entrance of insects and small animals.

An aluminum hood attached to the rear wall of the DMS shall cover each air intake and exhaust port. All intakes and exhaust hoods shall be thoroughly sealed to prevent water from entering the DMS.

The ventilation system shall include a thermostat to control the activation of the system. The thermostat shall be located near the top of the DMS interior.

Manual override timer switches shall be located just inside the access doors to manually activate the ventilation system. The switches shall be adjustable from 0 to 4 hours.

I. Front Face Panel Defog/Defrost System.
The DMS shall contain a defog/defrost system that automatically warms the DMS front face when the internal DMS relative humidity is near condensation levels. This system shall keep the front face polycarbonate panel free of frost and condensation. The heat generated by the defog/defrost system shall not damage any part of the DMS. A thermostat shall automatically activate the defog/defrost system.

J. Over Temperature Safety Shutdown.
The DMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and shall have a default factory setting of +140 °F (+60 °C).

K. Sign Controller Signal Interface.
The auxiliary controller shall be mounted inside the DMS housing, the main DMS controller to auxiliary control panel sign interface shall use shielded Category Five copper cable. The communication between the ODOT ITS cabinet Ethernet switch and the DMS sign controller shall be provide by a shielded Category Five copper cable.

1500.6 Controllers.
This section describes the minimum specifications for the dynamic message sign (DMS) controllers and auxiliary control panels. Each DMS shall include a sign controller, auxiliary control panel, and associated equipment. Provide all the materials, software, and services necessary to install DMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

A. General Requirements.
Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following operational requirements:

Communicate using the NTCIP protocol
Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
Include a front panel user interface with LCD and keypad for direct operation and diagnostics as described herein
Contain a minimum of three NTCIP-compliant RS232 communication ports
Contain a minimum of one NTCIP-compliant Ethernet port with RJ45 connector
Contain a built-in Hayes-compatible modem with standard RJ11 connector
Contain DMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DMS controller. External protocol converter or translator devices shall not be allowed.

B. Controller Location.
The main DMS sign controller and associated communication equipment shall be installed inside the ODOT ITS Cabinet. A local auxiliary control panel shall be installed in the DMS housing. An Ethernet Category five cable shall be installed between the ODOT ITS cabinet network switch and the DMS sign controller for network control of the DMS. The actual connection will be made by ODOT.

C. Environmental.
The sign controller shall meet the environmental requirements defined in NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements.

D. Mechanical and Electrical.
The sign controller shall meet the following electrical and mechanical requirements:

Mount in a standard EIA 19-inch (480-mm) equipment rack with a maximum 4U space requirement
Weigh no more than 10 pounds (4.5 kg), including its enclosure
Consume no more than 30 watts of power
Powered by an internal regulated DC power supply capable of operating on 120 VAC or 240 VAC at both 50 Hz and 60 Hz

1500.7 Operational Requirements

A. Front Panel User Interface
The sign controller's front panel shall include a keypad and LCD. These devices shall be used to perform the following functions with the sign controller and DMS:

Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face
Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
Activate messages stored in memory
Configure display parameters including display size
Configure communications port settings and NTCIP options

The front panel interface shall also include:

Power switch to turn the controller on and off
LED power “on” indicator
“Local/remote” switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
LED to indicate state of the “local/remote” mode switch
Reset switch to quickly restart the controller
LED “Active” indicator that blinks when the controller is operating correctly
LED to indicate when any of the NTCIP communication channels are active
B. Memory
The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or non-battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of one hundred changeable messages in non-volatile RAM.

C. Internal Clock
The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 5 years without external power. The clock shall take its time from the network or central control.

D. Communications
All remote communication ports shall be NTCIP-compatible as defined in the section 9 of these specifications. All cables (Ethernet, or any other proposed conductive cable shall be equipped with surge suppression capable of withstanding a minimum 1 kA surge current. The cost of this surge suppression shall be incidental to the bid price of the sign.

E. Communication Modes
The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

Remotely via direct communications with a remotely located computer over Ethernet.

Locally via direct connection with a laptop computer that is connected directly to the sign controller using Ethernet.

F. Ethernet Port
The DMS sign controller shall contain a minimum of one 10/100Base-T Ethernet communication port. This port shall be available for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

G. Controller Addressing
The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

H. Transient Protection
The Ethernet communication ports in the DMS sign controller shall be protected with surge protection between each signal line and ground. This surge protection shall be integrated internally within the controller.

A series/parallel two-stage suppression device shall protect the modem communication port from over-voltage and over-current conditions. This surge protection shall be integrated internally within the controller.
I. DMS Control Outputs
The DMS sign controller shall transmit and receive data packets to and from the DMS via dedicated armored outdoor-rated fiber optic cables or via Ethernet Cat5E cable or better. Core-aligned fusion splicing is the only acceptable method of placing pigtailed fiber optic cable. Copper cables may be used in instances where the controller needs to be located within the sign housing, as directed by the engineer. This network will communicate with all sensors, drivers, and other devices utilizing a CAN (controller area network) bus running throughout the DMS. Two spare outdoor-rated, shielded, armored category 5e Ethernet cables (per ODOT Supplemental Specification 809) shall be installed from the ITS cabinet to the sign housing (20 feet of slack shall be left in each location) to be used as spares in case of damage inflicted by rodents to the cables.

Data transferred shall include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data shall include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED drivers.

J. Messaging
The DMS sign controller shall have the ability to display messages on the DMS display face as required herein.

K. Message Presentation on the DMS Display Matrix
The DMS sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the DMS sign controller shall support the following features as described in the DMS specification:

- Display of alpha numeric characters, including letters, numbers, and punctuation
- Selection of particular character fonts style
- Horizontal alignment of text on the display, including left, center, and right justification
- Vertical alignment of text on the display, including top, middle, and bottom justification
- Adjusting the spacing horizontally between characters or vertically between lines of text
- Alternating between pages of a multiple-page message
- Display of graphic bitmaps of various sizes ranging from very small to the size of the entire DMS matrix

L. Message Effects
The DMS shall be able to display messages using the following types of effects:

- Static Message – The selected message is displayed continuously on the sign face until the DMS sign controller blanks the sign or causes the display of another message
- Flashing Message – All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
- Scrolling Message – The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
- Multiple-Page Message – A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page’s display time is user programmable from 0.1 to 25.5 seconds, and adjustable in increments of 0.1 seconds.

M. Message Activation
Messages shall be activated on a DMS in three ways:

- Manual – An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.
- Schedule – The internal time-based scheduler in the DMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.
- Events – Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.
A displayed message shall remain on the sign until one of the following occurs:

The message’s duration timeout expires
The controller receives a command to change the message
The controller receives a command to blank the sign
The schedule stored in the controller’s memory indicates that it is time to activate a different message
A special event, such as a loss of communication, occurs that is linked to message activation

It shall be possible to confer a "priority" status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

N. Schedule Activation
The DMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall be per the NTCIP 1201 and NTCIP 1203 standards.

O. Display of Alphanumeric Text
The DMS sign controller shall support the storage and use of a minimum of twenty-four (24) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. The DMS sign controller shall have the ability to display subscripts and superscripts. All text font files shall include the following characters:

The letters “A” through “Z”, in both upper and lower case
Decimal digits “0” through “9”
A blank space
Eight (8) directional arrows
Punctuation marks, such as: . , ! ? – ’ “ : ;
Special characters, such as: # & * + / ( ) [ ] < > @

ODOT uses the 07X04_1_CP1252 font style as the default font in the ODOT control software. The DMS will be tested using this font.

The DMS supplier shall provide the DMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

Table 1: Font Table

<table>
<thead>
<tr>
<th>Font Name</th>
<th>Character Height</th>
<th>Character Width (avg.)</th>
<th>Variable or Fixed Width</th>
<th>Stroke Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>7x4</td>
<td>7</td>
<td>4</td>
<td>Variable</td>
<td>Single (1)</td>
</tr>
<tr>
<td>7x5</td>
<td>7</td>
<td>5</td>
<td>Fixed</td>
<td>Single (1)</td>
</tr>
<tr>
<td>7x6</td>
<td>7</td>
<td>6</td>
<td>Variable</td>
<td>Double (2)</td>
</tr>
<tr>
<td>Graphic 7</td>
<td>7</td>
<td>N/A</td>
<td>Variable</td>
<td>N/A</td>
</tr>
<tr>
<td>8x4</td>
<td>8</td>
<td>4</td>
<td>Variable</td>
<td>Single (1)</td>
</tr>
<tr>
<td>8x6</td>
<td>8</td>
<td>6</td>
<td>Variable</td>
<td>Double (2)</td>
</tr>
<tr>
<td>9x6</td>
<td>9</td>
<td>6</td>
<td>Variable</td>
<td>Double (2)</td>
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<td>11x7</td>
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<td>Fixed</td>
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<td>10</td>
<td>Variable</td>
<td>Triple (3)</td>
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<td>16</td>
<td>8</td>
<td>Variable</td>
<td>Double (2)</td>
</tr>
<tr>
<td>16x10</td>
<td>16</td>
<td>10</td>
<td>Variable</td>
<td>Triple (3)</td>
</tr>
</tbody>
</table>
P. Display of Graphic Images
The DMS control software shall support the inclusion of graphics in messages. The vendor shall support graphics using NTCIP 1203 V3.

Q. DMS Intensity Control
The DMS sign controller shall provide means to change the brightness of the display matrix manually or automatically. The manual control will allow the user to select one of at least 100 intensity levels, which will be communicated to the LED drivers in the DMS. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

The automatic intensity control mode will monitor the ambient light sensors of the DMS and will use a mathematical algorithm to automatically select one of the one hundred or more intensity levels. The intensity level will then be transmitted to the LED drivers in the DMS. The algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The intensity control mode, manual or automatic, shall be settable via NTCIP using the control software or via the front panel interface. The manual brightness level shall be settable via the software or front panel. The mode and brightness level shall be monitored from both the software or front panel interfaces.

R. System Status Monitoring and Diagnostic Testing
The DMS sign controller shall be capable of monitoring the status of many of the DMS components and subsystems in real-time and/or manual modes, depending on the component or system. The following sections detail the status and diagnostic information that shall be provided by the controller. All of this status and diagnostic data shall be available via the front panel LCD screen and shall be transmitted via NTCIP to control software upon request.

S. Message Display Status
The DMS sign controller shall be capable of monitoring and displaying the currently active message (if any) on the controller's front panel LCD display. This display shall be in a WYSIWYG format.

T. LED Pixel Testing
Upon command from either the front panel control interface or via NTCIP from remote control software, the DMS sign controller shall direct all of the LED modules to perform diagnostic tests of all their pixels. The controller shall then collect and report the results of the pixel testing. The controller shall also be capable of automatically detecting in real-time the status of each of the display’s pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the DMS face.

U. Power Supply Operation
The DMS sign controller shall monitor and report the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output fuse. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.

V. Door States
The DMS enclosure shall be equipped with access door sensors to monitor, via the controller, their open/closed status.

W. Environmental Conditions
The DMS sign controller shall monitor the readings of all light, temperature, and humidity sensors installed in the DMS housing.
X. Error Notification
The DMS sign controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and a central control system (via NTCIP communication) of the occurrence of important events and subsystem failures.

All major component and subsystem errors shall be indicated on the controller’s LCD front panel.

The controller shall be capable of sending event notifications to the central control system via SNMP “traps” as allowed by NTCIP. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards. The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The following sections list errors and events that the controller shall report as defined above.

Y. Over Temperature Shutdown
The DMS sign controller shall continuously monitor the DMS housing’s temperature sensors and shall automatically shut down the DMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +140 °F (60 °C) and shall be configurable at the controller.

If the temperature approaches the threshold, the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.

The sign controller shall employ an algorithm to control the above brightness reductions and increases utilizing hysteresis to ensure that the display face does not visibly flicker as the temperature changes.

The event notifications sent for over temperature situations will include visual indication on the controller’s front panel LCD, as well as a trap notification sent to the central control system.

Z. Controller Restart
When the DMS sign controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate the NTCIP reset message if it is configured to do so.

AA. Power Loss
When the DMS sign controller detects that it has lost power it shall send a trap notification to the central system and activate the NTCIP power loss message if configured to do so.

BB. Power System Failure
The DMS sign controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap.

CC. Door Opened
When the DMS sign controller detects that one of the sign cabinet or control cabinet doors has been opened, it will transmit a trap to the central system indicating which door has opened.
DD. Communication Loss
The DMS sign controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP.

EE. Auxiliary Control Panel
The DMS shall include an auxiliary control panel or laptop interface port that will provide a secondary user interface panel for DMS sign control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DMS controller. It shall be powered independently from a 120 VAC outlet.

FF. DMS Control Interface
The auxiliary control panel / local laptop software shall include an identical menu system to the DMS sign controller with all of its features and functionality.

GG. Location
The auxiliary control panel / local laptop port shall be located in the DMS sign housing. If a local laptop port is provided, a drop-down shelf shall also be provided near the port and shall support a laptop computer when utilized by maintenance personnel.

HH. Controller Signal Interface
The auxiliary control panel shall interface to the DMS sign controller using Category 5E copper cable. It shall be capable of operating up to 330 feet from the DMS controller.

II. Queue Warning System Interface
A Mini DC I/O Board shall be installed in each cabinet and shall have the capability of accepting up to four contact closure inputs that when closed will activate certain messages in the controller’s message library.

1500.8 DMS Control Software
This section describes the minimum specifications for the DMS sign control software. Provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

A. General Specifications
DMS control software shall:

Operate on most current production version business desktop and laptop computers with Intel® Pentium® Pentium 4 system running Microsoft® Windows XP Professional™, Vista™, or latest commercial version of Microsoft® Windows operating system.
Provide a user-friendly multi-color graphical user interface
Be written as a native 32-bit Windows® program using Microsoft-certified software development tools (compilers, etc.)
Control a network of at least two hundred and fifty dynamic message signs
Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks (LAN and WAN)
Support DMS communications via any combination of dedicated hardwired ethernet network, fiber-optic network, cellular modem, spread spectrum radio, Ethernet, or other as specified.
Support DMS control, monitoring, and diagnostic functions as specified.
Control DMS both remotely from a central location, and locally at the DMS site using a laptop computer
Be accompanied by an easy-to-use software installation utility
Include an operation manual that includes detailed instructions for configuring and using all parts of the software.

Contain an on-line help system that includes documentation for every screen or dialog box present in the software. It shall also be context sensitive such that pressing the help button or [F1] key on any screen will launch the help page for that particular screen.

Be fully compliant with the communications protocol requirements of the NTCIP Special Provision.

**B. Software Security**

DMS control software shall support the creation of user IDs and passwords for up to one hundred system users. Only a "System Administrator" shall assign user creation, as well as individual user access rights.

Before a system operator can use the DMS control software, the software shall request a "user name" and user "password." If the correct user name and password are not provided, access to the software shall be declined.

**C. Client-Server Architecture**

The software shall be of a modular design including a server and multiple client modules. The server shall handle all DMS communication and shall store all configuration data, messages, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Separate clients shall be provided for each of the following software functions:

- Shell client that handles user login and logout, as well as launching the other clients
- Display control client for controlling DMS messaging, monitoring system status, and performing DMS diagnostics
- Message editor client for creating DMS messages
- Message scheduler client for creating time and date schedules for activating messages
- Administration client for DMS system configuration and administration

**D. DMS Control**

The DMS control software shall provide a user interface that presents the system's DMS in both list and graphical formats. The software will allow the DMS to be grouped as needed by the administrator. The DMS list and map interfaces will include only the signs for the group currently selected.

**E. List and Map Interfaces**

The DMS list shall clearly display the following information about each DMS:

- DMS ID number, as “1” through “250”
- DMS name, in a descriptive text format
- Iconic representation of the type of communication network used for the DMS (i.e. direct or dial-up)
- Name and priority level of message file being displayed
- Date and time of last communication between the control software and the DMS sign controller
- Error and warning status, including pixel errors, power failures, communication error, etc.

The graphical interface shall include the following:

- Configurable bitmaps that may be used to show all or parts of the system geographically
- Icons for each sign that may be placed anywhere on the map
- Icon color changes to indicate the status of the DMS (i.e., yellow for warnings or red for errors)
- Icon flashes if a message is running on the DMS
- Sign name is visible if mouse is placed over a DMS icon
F. Direct Control Operations
The user interface shall provide a means for users to directly perform the following tasks for each sign:

Send and activate stored messages from the libraries
Blank the display
Activate an ad-hoc quick message that is created immediately, not loaded from a library
Send and activate schedules
Retrieve both messages and schedules from the sign
Perform diagnostics of DMS subsystems, such as power supplies, sensors, etc.
Perform tests of pixels
Monitor the sign's event log

G. Polling
The software shall have a feature to poll all or a set of DMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

H. Scenarios
The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:

Send and activate stored messages from the libraries
Blank the display
Send and activate schedules
Perform diagnostics of DMS subsystems, such as power supplies, sensors, etc.
Perform tests of pixels

The scenarios shall be saved to libraries where users may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

I. System Monitoring
The software shall be capable of monitoring and displaying to the user the contents of any communications in progress with DMS. The status of all outgoing and incoming data packets will be visible.

J. Multi-Vendor Sign Control
The software shall be capable of controlling any NTCIP-compatible DMS regardless of the manufacturer. The software shall support all mandatory and optional features typical in LED DMS. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

K. Message Creation and Editing
A DMS user shall be able to use the DMS control software to create, edit, name, and store message files.

The message editor GUI shall present a scaled image of the DMS display matrix, including a complete and accurate representation of the display matrix type (full or line) and the number of display pixels. The DMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the user with the ability to program:

The number of pages that the message is to contain (shall be a minimum of three (3))
Message text
Message graphics, including pixel-by-pixel editing, lines, area fill, block move, etc.
Character font type(s) used to construct the message
The amount of inter-line spacing, measured in pixels
Horizontal message justification on the DMS display matrix including left, center, and right
Vertical message justification on the DMS display matrix including top, middle, and bottom
The type of entry effect, as "static" or "scrolling"
Message page on time and off time
Message scroll rate, if a scrolling message
The flash rate of all or part of a message page
Message priority status
The display status of any flashing beacons mounted to the DMS

The message editor shall provide a method of incorporating data fields into a DMS message. The following data fields shall be provided:

Time, in 12-hour format
Time, in 24-hour format
Temperature, in degrees Fahrenheit and Celsius
Speed, kilometers per hour and miles per hour (vehicle speed, for DMS sites that contain speed measurement equipment)
Day of week (Monday, Tuesday, etc.)
Day of the month (1,2, ...31)
Month of the year (1,2, ...12)
Calendar year, in both two-digit and four-digit formats

The message editor shall provide a convenient means for the user to:

Insert, add, or delete, message text
Paste graphics from other programs using the Windows clipboard
Clear the content of the editing page
Save the message file under its existing name or a new name
Delete a message file
Save all new changes

It shall be possible to store message files in both the DMS control computer memory and the DMS sign controller memory.

The users shall have the ability to print any message or library of messages.

L. Message Libraries
DMS control software shall support the creation and storage of message libraries (file directories), which allow the user to categorize message files by:

DMS matrix size
Message subject matter

The library editor shall allow a user to:

Create a new library
Store the same message in multiple libraries
Select a message from an existing library and edit the message contents
Search message libraries for messages with specified text in message name or contents
Copy/Paste a message from one library to another
Delete a message file from a library
Rename a library
Delete a library
Save all new changes

**M. Schedule Creation and Editing**
DMS control software shall support the creation of message schedules, which instruct the DMS sign controller to run specific messages at pre-determined times and dates.

Software shall contain an editor, which allows messages to be scheduled via:

- Month of the year (January, February, etc.)
- Day of the week (Monday, Tuesday, etc.)
- Day of the month (1, 2, ..., 31)
- Time of day

The schedule editor shall provide a convenient means for the operator to:

- Create a new schedule
- Rename an existing schedule
- Delete a schedule
- Save all new changes

It shall be possible to store schedule files in both the DMS control computer memory and the DMS sign controller memory.

**N. Display Fonts**
The software shall support a minimum of twelve fonts for each model of DMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of twenty-four fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DMS model configuration.

The software shall include a font editor to allow the user to create custom fonts. The font editor shall allow the user to create new fonts or modify existing fonts. The user shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner.

Any of the fonts provided by the software vendor or created/modified by the administrator shall be downloadable to the DMS.

**O. Event Logging**
The software shall include an event logging system that logs all significant system events. Each logged event shall include the following fields at a minimum:

- Event ID number
- User that initiated the event
- Time and date that the event occurred
- Description of the event (i.e., “Diagnostic Test Performed”)
- Source of the event (i.e., DMS sign name)
- Additional data relevant to the event (i.e., “Failed pixel: (4, 73)"

The events logged shall include, but not be limited to, the following:

- User login/logout
- Failed login attempts
- Communication failures
- Message and schedule activation or display blanking
- Diagnostics test results
Warning events sent from the sign  
Other system errors  

The users will have the ability to view, sort by category, and print the log file at any time.

**P. System Configuration**  
The DMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:

- Sign models and individual signs  
- Communication networks  
- System error/warning alarms  
- User security rights  
- System maps and sign icon placement  
- Default system option settings  
- Default message parameters  
- Message priority settings  

**Q. Sign Configuration**  
Each sign in the DMS control software shall be configured with the following parameters:

- Sign viewing area height and width (for full-matrix signs)  
- Number of lines and each line’s height and width (for line-matrix signs)  
- Site name  
- DMS ID number  
- Network address  
- Communication parameters  

**R. Communication Settings**  
Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:

- Network type - Ethernet  
- NTCIP subnetwork and transport protocols  
- Communication retries and timeouts  

**S. System Alarms**  
Configurable settings shall allow the system administrator to determine which of the following events will trigger an audio and visual (on-screen) alarm:

- Communication failure  
- Priority status conflict  
- Sign restart  
- Power supply failure  
- Door open  
- Pixel error and Pixel module failures  
- Fan status and failure  

**T. User Administration**  
The administrator shall have the ability to add, remove and modify users. The access rights of each user shall be configurable to allow or deny access to each major software feature.

**U. System Maps**  
It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which
can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

V. Message Editor Defaults
The message editor shall automatically utilize the following default settings during the creation of new message files:

- Pixel spacing between adjacent lines of text
- Pixel spacing between adjacent text characters
- Display duration of a given message page
- Beacon activation status (for DMS that contain flashing beacons)
- Effect to be applied to text (i.e., static, scrolling, etc.)
- Effect rate, which shall determine the speed of scrolling messages
- Flash rate, which shall determine the speed of flashing messages
- Message priority classification
- Horizontal text justification supporting left, center, or right
- Vertical text justification supporting top, middle, and bottom

W. Message Priorities
User-definable defaults shall allow messages to be assigned a priority classification of:

- Emergency
- High
- Normal
- Low
- Minimal

A numeric priority range shall be assigned to each of these five priority classifications. The priority shall allow two different message files to be assigned the same classification, but within that classification, one message can be identified as having higher priority.

X. Software Use and Reproduction Rights
The DMS manufacturer shall provide the latest version DMS control software site license with the DMS supplied. Ten copies of the DMS control software shall be provided to the Engineer on CD-ROM within thirty days of contract award. The Engineer shall have the right to request or reproduce an unlimited number of software copies for use on the DMS system.

Y. Requirements for NTCIP Conformance
This section describes the minimum specifications for the NTCIP communication capabilities of the DMS controller and DMS control software. Provide all the software, firmware, and services necessary to operate a dynamic message sign (DMS) system that fully complies with the NTCIP functional requirements, including incidental items that may have been inadvertently omitted.

Z. References
These specifications reference standards through their NTCIP designated names. The following list provides the current versions of each of these standards.

Each NTCIP device covered by these specifications shall implement the version of the standard that is specified in the following table. Refer to the NTCIP library at www.ntcip.org for information on the current status of NTCIP standards.

Table 1: NTCIP Document References
### AA. Subnetwork Profiles

Each Ethernet port on the NTCIP device shall comply with NTCIP 2104.

The NTCIP device(s) may support additional Subnet Profiles at the manufacturer’s option. At any one time, only one subnet profile shall be active on a given port of the NTCIP device. All response datagram packets shall use the same transport profile used in the request. The NTCIP device shall be configurable to allow a field technician to activate the desired subnet profile and shall provide a visual indication of the currently selected subnet profile.

### BB. Transport Profiles

Each Ethernet port on the NTCIP device shall comply with NTCIP 2202.

The NTCIP device(s) may support additional transport profiles at the manufacturer’s option. Response datagrams shall use the same transport profile used in the request. Each NTCIP device shall support the receipt of datagrams conforming to any of the supported transport profiles at any time.

### CC. Application Profiles

Each NTCIP device shall comply with NTCIP 2301 and shall meet the requirements for Conformance Level 1.
An NTCIP device may support additional application profiles at the manufacturer's option. Responses shall use the same application profile used by the request. Each NTCIP device shall support the receipt of application data packets at any time allowed by the subject standards.

**DD. Object Support**

Each NTCIP device shall support all mandatory objects of all mandatory conformance groups as defined in NTCIP 1201 and NTCIP 1203.

Each NTCIP device shall support all mandatory objects in all optional conformance groups required herein. All optional objects listed in these specifications shall be supported.

The NTCIP device(s) shall be required to support the following optional conformance groups.

*Table 2: Required Optional Conformance Groups*

<table>
<thead>
<tr>
<th>Conformance Group</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Management</td>
<td>NTCIP 1201</td>
</tr>
<tr>
<td>Timebase Event Schedule</td>
<td>NTCIP 1201</td>
</tr>
<tr>
<td>Report</td>
<td>NTCIP 1201</td>
</tr>
<tr>
<td>PMPP</td>
<td>NTCIP 1201</td>
</tr>
<tr>
<td>Font Configuration</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>DMS Configuration</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>MULTI Configuration</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>MULTI Error Configuration</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Illumination/Brightness Control</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Scheduling</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Sign Status</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Status Error</td>
<td>NTCIP 1203</td>
</tr>
<tr>
<td>Pixel Error Status</td>
<td>NTCIP 1203</td>
</tr>
</tbody>
</table>

The following table indicates objects that are considered optional in the NTCIP standards but are required by this specification. It also indicates modified object value ranges for certain objects. Each NTCIP device shall provide the full, standardized object range support (FSORS) of all objects required by these specifications unless otherwise indicated below.

*Table 3: Modified Object Ranges and Required Optional Objects*

<table>
<thead>
<tr>
<th>Object</th>
<th>Reference</th>
<th>Project Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>moduleTable</td>
<td>NTCIP 1201 Clause 2.2.3</td>
<td>Shall contain at least one row with moduleType equal to 3 (software).</td>
</tr>
<tr>
<td>maxTimeBaseScheduleEntries</td>
<td>NTCIP 1201 Clause 2.4.3.1</td>
<td>Shall be at least 28</td>
</tr>
<tr>
<td>maxDayPlans</td>
<td>NTCIP 1201 Clause 2.4.4.1</td>
<td>Shall be at least 20</td>
</tr>
<tr>
<td>maxDayPlanEvents</td>
<td>NTCIP 1201 Clause 2.4.4.2</td>
<td>Shall be at least 12</td>
</tr>
<tr>
<td>maxEventLogConfig</td>
<td>NTCIP 1201 Clause 2.5.1</td>
<td>Shall be at least 50</td>
</tr>
<tr>
<td>eventConfigMode</td>
<td>NTCIP 1201 Clause 2.4.3.1</td>
<td>The NTCIP Component shall Support the following Event Configuration: onChange,</td>
</tr>
<tr>
<td>Event</td>
<td>NTCIP Clause</td>
<td>Requirement</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>eventConfigLogOID</td>
<td>2.5.2.7</td>
<td>greaterThanValue, smallerThanValue</td>
</tr>
<tr>
<td>eventConfigAction</td>
<td>2.5.2.8</td>
<td>FSORS</td>
</tr>
<tr>
<td>maxEventLogSize</td>
<td>2.5.3</td>
<td>Shall be at least 200</td>
</tr>
<tr>
<td>maxEventClasses</td>
<td>2.5.5</td>
<td>Shall be at least 16</td>
</tr>
<tr>
<td>eventClassDescription</td>
<td>2.5.6.4</td>
<td>FSORS</td>
</tr>
<tr>
<td>maxGroupAddresses</td>
<td>2.7.1</td>
<td>Shall be at least 1</td>
</tr>
<tr>
<td>communityNamesMax</td>
<td>2.8.2</td>
<td>Shall be at least 3</td>
</tr>
<tr>
<td>numFonts</td>
<td>2.4.1.1.1.1</td>
<td>Shall be at least 12</td>
</tr>
<tr>
<td>maxFontCharacters</td>
<td>2.4.1.1.3</td>
<td>Shall be at least 255</td>
</tr>
<tr>
<td>defaultFlashOn</td>
<td>2.5.1.1.1.3</td>
<td>The DMS shall support flash “on” times ranging from 0.1 to 9.9 seconds in 0.1 second increments</td>
</tr>
<tr>
<td>defaultFlashOff</td>
<td>2.5.1.1.4</td>
<td>The DMS shall support flash “off” times ranging from 0.1 to 9.9 seconds in 0.1 second increments</td>
</tr>
<tr>
<td>defaultBackgroundColor</td>
<td>2.5.1.1.1</td>
<td>The DMS shall support the black background color</td>
</tr>
<tr>
<td>defaultForegroundColor</td>
<td>2.5.1.1.2</td>
<td>The DMS shall support the amber foreground color</td>
</tr>
<tr>
<td>defaultJustificationLine</td>
<td>2.5.1.1.6</td>
<td>The DMS shall support the following forms of line justification: left, center, and right</td>
</tr>
<tr>
<td>defaultJustificationPage</td>
<td>2.5.1.1.7</td>
<td>The DMS shall support the following forms of page justification: top, middle, and bottom</td>
</tr>
<tr>
<td>defaultPageOnTime</td>
<td>2.5.1.1.8</td>
<td>The DMS shall support page “on” times ranging from 0.1 to 25.5 seconds in 0.1 second increments</td>
</tr>
<tr>
<td>defaultPageOffTime</td>
<td>2.5.1.1.9</td>
<td>The DMS shall support page “off” times ranging from 0.1 to 25.5 seconds in 0.1 second increments</td>
</tr>
<tr>
<td>defaultCharacterSet</td>
<td>2.5.1.1.10</td>
<td>The DMS shall support the eight bit character set</td>
</tr>
<tr>
<td>dmsMaxChangeableMsg</td>
<td>2.6.1.1.4</td>
<td>Shall be at least 11500.</td>
</tr>
<tr>
<td>dmsMessageMultiString</td>
<td>2.6.1.1.8.3</td>
<td>The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 3 (below)</td>
</tr>
<tr>
<td>Variable</td>
<td>Clause Reference</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>dmsControlMode</td>
<td>NTCIP 1203 Clause 2.7.1.1.1</td>
<td>Shall support at least the following modes: local, central, and centralOverride</td>
</tr>
<tr>
<td>dmsSWReset</td>
<td>NTCIP 1203 Clause 2.7.1.1.2</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsMessageTimeRemaining</td>
<td>NTCIP 1203 Clause 2.7.1.1.4</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsShortPowerRecoveryMessage</td>
<td>NTCIP 1203 Clause 2.7.1.1.8</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsLongPowerRecoveryMessage</td>
<td>NTCIP 1203 Clause 2.7.1.1.19</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsShortPowerLossTime</td>
<td>NTCIP 1203 Clause 2.7.1.1.10</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsResetMessage</td>
<td>NTCIP 1203 Clause 2.7.1.1.12</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsCommunicationsLossMessage</td>
<td>NTCIP 1203 Clause 2.7.1.1.12</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsTimeCommLoss</td>
<td>NTCIP 1203 Clause 2.7.1.1.12</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsEndDurationMessage</td>
<td>NTCIP 1203 Clause 2.7.1.1.15</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsMemoryMgmt</td>
<td>NTCIP 1203 Clause 2.7.1.1.16</td>
<td>The DMS shall support the following Memory management Modes: normal and clearChangeableMessages</td>
</tr>
<tr>
<td>dmsMultiOtherErrorDescription</td>
<td>NTCIP 1203 Clause 2.4.1.1.20</td>
<td>If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error</td>
</tr>
<tr>
<td>dmsIllumControl</td>
<td>NTCIP 1203 Clause 2.8.1.1.1</td>
<td>The DMS shall support the following illumination control modes: Photocell, and Manual</td>
</tr>
<tr>
<td>dmsIllumNumBrightLevels</td>
<td>NTCIP 1203 Clause 2.8.1.1.4</td>
<td>Shall be at least 100</td>
</tr>
<tr>
<td>dmsIllumLightOutputStatus</td>
<td>NTCIP 1203 Clause 2.8.1.1.9</td>
<td>FSORS</td>
</tr>
<tr>
<td>numActionTableEntries</td>
<td>NTCIP 1203 Clause 2.9.1.1.1</td>
<td>Shall be at least 200</td>
</tr>
<tr>
<td>watchdogFailureCount</td>
<td>NTCIP 1203 Clause 2.11.1.1.1.5</td>
<td>FSORS</td>
</tr>
<tr>
<td>dmsStatDoorOpen</td>
<td>NTCIP 1203 Clause 2.11.1.1.6</td>
<td>FSORS</td>
</tr>
<tr>
<td>fanFailures</td>
<td>NTCIP 1203 Clause 2.11.2.1.1.8</td>
<td>FSORS</td>
</tr>
<tr>
<td>fanTestActivation</td>
<td>NTCIP 1203 Clause 2.11.2.1.1.9</td>
<td>FSORS</td>
</tr>
<tr>
<td>tempMinCtrlCabinet</td>
<td>NTCIP 1203 Clause 2.11.4.1.1.1</td>
<td>FSORS</td>
</tr>
<tr>
<td>tempMaxCtrlCabinet</td>
<td>NTCIP 1203 Clause 2.11.4.1.1.2</td>
<td>FSORS</td>
</tr>
</tbody>
</table>
EE. MULTI Tags
Each NTCIP device shall support the following message formatting MULTI tags. The manufacturer may choose to support additional standard or manufacturer-specific MULTI tags.

<table>
<thead>
<tr>
<th>MULTI Tag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>f1</td>
<td>Field 1-time (12 hr)</td>
</tr>
<tr>
<td>f2</td>
<td>Field 2-time (24 hr)</td>
</tr>
<tr>
<td>f8</td>
<td>Field 8-day of month</td>
</tr>
<tr>
<td>f9</td>
<td>Field 9-month</td>
</tr>
<tr>
<td>f10</td>
<td>Field 10-2 digit year</td>
</tr>
<tr>
<td>f11</td>
<td>Field 11-4 digit year</td>
</tr>
<tr>
<td>fl (and /fl)</td>
<td>Flashing text on a line-by-line basis with flash rates controllable in 0.1-second increments.</td>
</tr>
<tr>
<td>Fo</td>
<td>Font</td>
</tr>
<tr>
<td>jl2</td>
<td>Justification-line-left</td>
</tr>
<tr>
<td>jl3</td>
<td>Justification-line-center</td>
</tr>
<tr>
<td>jl4</td>
<td>Justification-line-right</td>
</tr>
<tr>
<td>jp2</td>
<td>Justification-page-top</td>
</tr>
<tr>
<td>jp3</td>
<td>Justification-page-middle</td>
</tr>
<tr>
<td>jp4</td>
<td>Justification-page-bottom</td>
</tr>
<tr>
<td>mv</td>
<td>Moving text</td>
</tr>
<tr>
<td>nl</td>
<td>New line</td>
</tr>
<tr>
<td>np</td>
<td>New page up to 5 instances in a message (i.e. up to 6 pages/frame in a message counting first page)</td>
</tr>
</tbody>
</table>

1500.9 Method Of Measurement
Measurement will be made as a HAR site defined above and as follows:

1500.10 Basis Of Payment
The payment for this item will be made for the accepted number of quantities at the contract unit price.
1501 Destination Dynamic Message Signs – DDMS, Freeway

ITEM 809E63020: DESTINATION DYNAMIC MESSAGE SIGN, DDMS – FREEWAY - TWO-LINE
ITEM 809E63030: DESTINATION DYNAMIC MESSAGE SIGN, DDMS – FREEWAY - THREE-LINE

1501.1 General
The Contractor shall furnish and install a travel-time system including a quantity, as specified in the plans, of message boards on a ground-mounted extrusheet sign. The system shall include all components of the Travel-time system including pole mounted cabinet (w/ brackets), power supplies, controller, auxiliary controller, terminal strips, and all other items needed to provide a functional system. These cabinets and enclosed electronic parts shall be manufactured and pre-assembled by Daktronics.

A. General Specifications

The DDMS housing shall provide front flip-down access for all Light Emitting Diode (LED) display modules, electronics, environmental control equipment, air filters, wiring, and other internal DDMS components.

Each display pixel shall be composed of multiple monochrome amber LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, and incandescent lamp, will not be accepted.

The pixel matrix shall be capable of displaying alphanumeric character fonts measuring a minimum of 18 inches (460 mm) high to a maximum of the display matrix height.

The DDMS shall be able to display messages composed of any combination of alphanumeric text and punctuation symbols.

The MANUFACTURER shall provide 24 hours of on-site technical service and support for five years after installation of all units.

B. Legibility.
DDMS messages shall be legible within a distance range of 150 to minimum of 1000 feet (45 to minimum of 360 m) from the DDMS display face under the following conditions:

1. When the DDMS is mounted so it is on a ground mounted sign no more than 55 feet from edge of traveled lane.
2. Whenever the DDMS is displaying alphanumeric text that is 18-inches (460 mm) high
3. 24 hours per day and in most normally encountered weather conditions
4. During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DDMS
5. When viewed by motorists and travelers that have 20-20 corrected vision
6. When the motorist eye level is 3 to 12 feet (0.9 to 3.6 m) above the roadway surface.

C. Documentation.
NTCIP documentation shall be provided on a CD-ROM and will contain ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

1. The relevant version of each official standard MIB modules referenced by the device functionality.
2. If the device does not support the full range of any given object within a standard MIB Module, a manufacturer specific version of the official standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module except that it will have the extension “man”.
3. A MIB module in ASN.1 format containing any and all manufacturer specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
4. A MIB containing any other objects supported by the device.
D. **Test Procedures.**

The DDMS vendor shall prepare and submit test procedures and test data forms for the Department’s approval at least 30 working days before the scheduled testing as required. Test procedures shall be developed specifically in response to these specifications. Do not submit test procedures developed in response to other procurement documents, specifications or for other customers and projects. The Department will review submitted test procedures. At a minimum, the test procedures and data forms shall include the following:

1. A step-by-step outline of the test sequence to be followed, showing a test of every function of the equipment or system to be tested. For each test, clearly identify in the test procedure the specific function or requirement being addressed.
2. A description of the expected operation, output and test results.
3. An estimate of the test duration and a proposed test schedule.
4. A data form to be used to record all data and quantitative results obtained during the test.
5. A description of any special equipment, setup, manpower, or conditions required for the test.

E. **Test Equipment and Software.**

As part of the testing requirements, except as otherwise noted, the DDMS vendor shall be responsible for furnishing all test facilities, including software, required to complete the required testing. The DDMS vendor shall provide documentation and user instructions for use of any required test equipment and test software unless otherwise directed by the Department.

1501.2. **Enclosure**

**A. Dimensions.**

DDMS housing dimensions shall not exceed 1 foot 10 inches high by 3 feet 7 inches wide. The front-to-back housing depth shall not exceed 2.5 inches at its widest point, including the ventilation hoods. DDMS single panel weight shall not exceed 35 pounds.

**B. Sign Construction.**

The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum). DDMS and sign controller components shall operate in a minimum temperature range of −34 to +115 ºF and a relative humidity range of 0 to 99 percent, non-condensing. DDMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of −34 to +115 ºF.

External DDMS component hardware (nuts, bolts, screws, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, or other durable corrosion-resistant materials suitable for the roadway signage application. Standoffs may be nylon.

DDMS and sign controller components shall be 100 percent solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DDMS and the sign controller shall be UL (Underwriter’s Laboratory) listed and meet all local National Electric Code (NEC) codes applicable to DDMS applications.

The presence of ambient electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DDMS system. The DDMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DDMS and its sign controller. Manufacturer shall provide certification showing the DDMS system passes standard Electromagnetic Compatibility (EMC) guidelines.

The DDMS housing structural frame shall consist of aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. All sides of the DDMS housing exterior, except the front, shall be covered
with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework by continuous welding.

LED display modules shall be mounted parallel to the front face, so they are capable of 3 degrees tilt forward toward the viewing motorists at the angle at which the sign is installed and use of the legible LED viewing area is optimized. DDMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be stainless steel or galvanized A325 high-strength steel and shall be appropriately sized for the application.

C. Front Face Construction.
Front face panels shall provide a high-contrast background for the DDMS display matrix. If an aluminum mask is used, it shall be painted flat black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Face panels shall be attached to each other using stainless steel hardware. Seams that separate adjacent panels shall be sealed. Panels shall not be welded or otherwise permanently mounted to the DDMS housing. Panels shall be mounted in such a way that they are removable from the interior of the DDMS housing.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DDMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The polycarbonate sheet shall be Lexan XL10 or equivalent approved by the Engineer.

LED display modules shall mount to the inside of the DDMS front face panels. Common hand tools shall be used for removal and replacement.

DDMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.

In the presence of wind, the DDMS front face shall not distort in a manner that adversely affects LED message legibility.

D. Exterior Finish.
DDMS front face panels and front face border pieces shall be coated with semi-gloss black Kynar 500 which has an expected outdoor service life of 20 years.

All other DDMS housing surfaces, including DDMS mounting brackets, shall be natural mill-finish aluminum.

E. Service Access.
The DDMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DDMS housing. All of those internal components shall be removable and replaceable by a single technician. The DDMS front face panels shall also be removable and replaceable from inside the DDMS housing.

One horizontally bottom-hinged door shall be located on the DDMS housing. In the closed position, each door shall latch to its frame with an allen or hex head screw.

1501.3. Illumination.

A. LED Display Modules.
The DDMS shall contain LED display modules that include a LED pixel array, LED driver circuitry, and mounting hardware. Each LED display module shall be constructed as follows:
1. Each LED display module shall be mounted to the rear of the display's front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel's pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels.

2. LED display module power and signal connections shall be a quick-disconnect locking connector type. Removal of a display module from the DDMS, or a pixel board or driver circuit board from its display module, shall not require a soldering operation.

3. Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.

4. It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DDMS display matrix.

5. All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the DDMS.

B. LED Pixel Boards.

Each LED pixel board shall be composed of a printed circuit board to which LED pixels are soldered. The LED pixel boards shall conform to the following specifications:

1. LED pixel boards shall be manufactured using a laminated fiberglass printed circuit board.

2. Each pixel shall consist of a minimum of two independent strings of discrete LEDs. All pixels shall contain an equal quantity of LED strings.

3. The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DDMS.

4. Each pixel shall contain the quantity of discrete amber LEDs needed to output a minimum luminous intensity of 9,200 candelas per square meter when operated within the forward current limits defined in these specifications.

5. Each LED pixel shall not consume more than 1.5 watts.

6. The circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

7. All exposed metal on both sides of the LED pixel board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual pixels, including discrete LED replacement and acrylic/silicone conformal coating repair, shall be possible.

8. All LED pixel boards shall be identical and interchangeable throughout the DDMS.

C. Discrete LEDs.

DDMS pixels shall be constructed with surface mount or through hole discrete LEDs manufactured by Agilent / Avago Technologies, Toshiba Corporation, or Nichia Corporation. Substitutes will not be accepted. Discrete LEDs shall conform to the following specifications:

1. Through hole LEDs shall be non-diffused, high-intensity, solid-state lamps in T1-3/4-style LED packages.

2. Surface mount LEDs shall be non-diffused, high-intensity, solid-state lamps.

3. All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 3 degrees.

4. The LED lenses shall be fabricated from UV light resistant epoxy.

5. Amber LEDs shall utilize AlInGaP semiconductor technology and shall emit amber light that has a peak wavelength of 590 ± 5 nm.

6. The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two consecutive luminous intensity "bins" as defined by the LED manufacturer.
7. The LED manufacturer shall perform color sorting of the bins. LEDs shall be obtained from no more than two consecutive color “bins” as defined by the LED manufacturer.

8. The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.

9. All LEDs used in all DDMS provided for a contract shall be from the same manufacturer and of the same part number.

10. The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 70 percent of the original brightness.

11. The LEDs shall not be driven with a forward current that exceeds the LED manufacturer’s recommendations to maintain the minimum 100,000-hour lifetime requirement.

D. Pixel Drive Circuitry.
The driver circuit boards shall conform to the following specifications:

1. LED driver boards shall be manufactured using a laminated fiberglass printed circuit board.

2. All exposed metal on both sides of the LED driver board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual components, including conformal coating repair, shall be possible.

3. Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.

4. Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer’s recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer’s recommendations for the 100,000-hour lifetime requirement.

5. The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.

6. The LED driver boards shall receive updated display data at a minimum rate of ten frames per second from the sign controller.

7. Each LED driver board shall be powered by 24 VDC from external regulated DC power supplies. Each driver board shall receive separate power feeds from a minimum of two independent power supplies.

8. Each LED driver board shall contain a microprocessor-controlled power regulation circuit that controls the voltage applied to the LED strings. The power circuit shall automatically adjust the forward voltage of the LEDs to optimize power consumption efficiency as the temperature changes. Indicator LEDs shall be provided to indicate the status of power to each driver board.

9. Each LED driver board shall contain a temperature sensor and shall report the temperature to the sign controller upon request.

10. The LED driver circuitry shall be able to detect that individual LED strings or pixels are non-responsive and shall report the pixel status to the sign controller upon request.

11. All driver circuit boards shall be identical and interchangeable throughout the DDMS.

12. Removal or failure of a single driver circuit board shall not affect the performance of any other LED display module in the DDMS.

13. Individual addressing of each driver circuit shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.

14. The redundant LED power supply system shall be designed to illuminate every character on the sign with any allowable alphanumeric character at full power, at 165°F (74º C). Power supplies shall be switching power supplies, which must be at least 80% efficient at nominal voltage, and include a self-resetting internal thermal protection device that switches off the
output in case of an overload. In the event of a failure of one of the power supplies, the controller will detect the loss of power from the failed supplies.

E. Regulated DC Power Supplies.
The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the DDMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two physically and electrically independent supplies. Each pair of power supplies shall be parallel but shall not be wired in a current sharing configuration.

Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100 percent of the pixels in that display region at 100 percent brightness when the internal DDMS air temperature is +140 ºF (60 ºC) or less.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The output of each power supply will be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DDMS.

Regulated DC power supplies shall conform to the following specifications:

1. Nominal output voltage of 24 VDC +/- 10 percent
2. Nominal maximum output power rating of 1000 watts
3. Operating input voltage range shall be a minimum of 90 to 260 VAC
4. Operating temperature range shall be a minimum of -30 to +165 ºF (-34 to +74 ºC)
5. Maximum output power rating shall be maintained over a minimum temperature range of -30 to +140 ºF (-34 to +60 ºC)
6. Power supply efficiency shall be a minimum of 80 percent
7. Power factor rating shall be a minimum of 0.95
8. Power supply input circuit shall be fused
9. Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
10. Power supplies shall be UL listed
11. Printed circuit boards shall be protected by an acrylic or silicone conformal coating

1501.4. Wiring and Power Distribution

A. Maximum Power.
Maximum AC power shall not exceed 6000 watts, when the following circuits are operational and fully loaded:

1. LED display pixel matrix, with 100 percent of the pixels operating at their maximum possible drive current
2. DDMS environmental control system
3. Utility outlet circuit
4. DDMS sign controller

Typical DDMS AC operating power shall not exceed 3000 watts with the following circuit loadings:

1. LED display pixel matrix, with 25 percent of the pixels operating at their maximum possible drive current
2. DDMS sign controller

DDMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground.

B. Power and Signal Entrances.
Two threaded conduit hubs shall be located on the rear wall of the DDMS housing. One hub shall be for incoming AC power and the other shall be for incoming DDMS signal cabling or a communications line.

C. Load Center.
The DDMS shall contain a power load center and circuit breakers that meet the following minimum requirements:

1. Service entrance-rated
2. Minimum of twenty circuit breaker mounting positions
3. Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
4. UL listed load center and circuit breakers

D. Internal Wiring.
Wiring for LED display module control, environmental control circuits, and other internal DDMS components shall be installed in the DDMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

E. Earth Grounding.
The DDMS manufacturer shall provide one earth ground lug that is electrically bonded to the DDMS housing. The lug shall be installed near the power entrance location on the DDMS housing's rear wall. The DDMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DDMS. All earth grounding shall conform to the National Electrical Code.

F. Convenience Outlets.
The DDMS cabinet housing shall contain a utility outlet circuit consisting of a minimum of one 15-A NEMA 15-R, 120 VAC duplex outlets and one 15-A NEMA 15-R, 120 VAC GFCI duplex outlet.

G. Site AC Power.
The AC power feed for all equipment shall be protected at the load center by a parallel-connection surge suppresser rated for a minimum surge of 10 kA.

H. Control Equipment AC Power.
A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment in the ITS cabinet and sign housing. This device shall conform to the following requirements:

1. Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form
2. Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
3. Series inductance of 200 micro henrys (nominal)
4. Temperature range of −40 to +158 °F (-40 to +70 ºC)
5. Approximate dimensions of 3-inches (76 mm) wide by 5-inches (127 mm) long by 2-inches (50 mm) high or shall be rack-mounted to fit in a standard EIA 19-inch rack
6. The device shall be UL-1449 recognized
7. UL 1449 surge rating of 400 V or less

I. Communication Signals.
Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

1501.5 Control Systems.

A. Internal Lighting.
The DDMS cabinet shall contain a minimum of one door-activated LED light bars mounted at the top front of cabinet in a way that no cabinet rack space is used for lighting (minimum 12 inches in length, minimum 110-degree beam angle, cool white, minimum 300 lumens per unit, on/off switch, maximum 0.75 inches in width, 24 volt).

B. Environmental Monitoring Systems.
The DDMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.

C. Ambient Light Measurement.
Sensors that measure the outdoor ambient light level and the outdoor ambient temperature at the DDMS site shall be mounted in-line with the DDMS housing walls. This ambient light and temperature measurement system shall consist of three electronic light sensors.

Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DDMS. The third light sensor shall be mounted to the floor or top of the DDMS housing and shall face the ground. The DDMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DDMS face.

D. Ambient Temperature Measurement.
A minimum of one ambient temperature sensor shall be mounted to either the rear wall or bottom side of the DDMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

E. Internal Temperature Measurement.
The DDMS shall contain a minimum of one temperature sensor that is mounted near the top of the DDMS interior. The sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40 to +176 °F (-40 to +80 °C). The internal temperature sensor output shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

F. Internal Humidity Measurement.
The DDMS shall contain one sensor that measures the relative humidity of the air inside the DDMS cabinet. The sensor shall monitor the humidity from 0 to 100 percent. The humidity sensor output shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

G. Interior DDMS Environmental Control.
The DDMS shall contain systems for cabinet ventilation, face panel fog and frost prevention, and safe over-temperature shutdown.
H. Housing Ventilation System.
The DDMS shall contain a passive ventilation system.

The ventilation system shall consist of two or more air intake ports. Intake ports shall be located near the bottom of the DDMS rear wall. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger.

I. Over Temperature Safety Shutdown.
The DDMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and shall have a default factory setting of +140 °F (+60 °C).

1501.6 Controllers.
This section describes the minimum specifications for the dynamic message sign (DDMS) controllers and auxiliary control panels. Each DDMS shall include a sign controller, auxiliary control panel, and associated equipment. Provide all the materials, software, and services necessary to install DDMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

A. General Requirements.
Each DDMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DDMS control software in order to perform most DDMS control functions.
The sign controller and auxiliary controller shall meet the following operational requirements:

1. Communicate using the NTCIP protocol
2. Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
3. Include a front panel user interface with LCD and keypad for direct operation and diagnostics as described herein with auxiliary controller
4. Contain a NTCIP-compliant RS232 communication ports
5. Contain a minimum of one NTCIP-compliant Ethernet port with RJ45 connector
6. Contain DDMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DDMS controller. External protocol converter or translator devices shall not be allowed.

B. Environmental.
The sign controller shall meet the environmental requirements defined in NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DDMS), with NTCIP Requirements.

C. Mechanical and Electrical.
The sign controller shall meet the following electrical and mechanical requirements:

1. Mount in a standard EIA 19-inch (480-mm) equipment rack with a maximum 4U space requirement
2. Weigh no more than 10 pounds (4.5 kg), including its enclosure
3. Consume no more than 30 watts of power
4. Powered by an internal regulated DC power supply capable of operating on 120 VAC or 240 VAC at both 50 Hz and 60 Hz
1501.7 Operational Requirements

A. Front Panel User Interface
The auxiliary sign controller’s front panel shall include a keypad and LCD. These devices shall be used to perform the following functions with the sign controller and DDMS:

1. Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face
2. Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
3. Activate messages stored in memory
4. Configure display parameters including display size
5. Configure communications port settings and NTCIP options

The front panel interface shall also include:
1. Power switch to turn the controller on and off
2. LED power “on” indicator
3. “Local/remote” switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
4. LED to indicate state of the “local/remote” mode switch
5. Reset switch to quickly restart the controller
6. LED “Active” indicator that blinks when the controller is operating correctly
7. LED to indicate when any of the NTCIP communication channels are active

B. Memory
The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or non-battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of one hundred changeable messages in non-volatile RAM.

C. Internal Clock
The DDMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 5 years without external power. The clock shall take it’s time from the network or central control.

D. Communications
All remote communication ports shall be NTCIP-compatible as defined in the section 9 of these specifications. All cables (Ethernet, or any other proposed conductive cable shall be equipped with surge suppression capable of withstanding a minimum 1 kA surge current. The cost of this surge suppression shall be incidental to the bid price of the sign.

E. Communication Modes
The DDMS sign controller shall be able to receive instructions from and provide information to a computer containing DDMS control software using the following communication modes:
Remotely via direct communications with a remotely located computer over Ethernet.
Locally via direct connection with a laptop computer that is connected directly to the sign controller using Ethernet.

F. Ethernet Port
The DMS sign controller shall contain a minimum of one 10/100Base-T Ethernet communication port. This port shall be available for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.
Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

**G. Controller Addressing**

The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

**H. Transient Protection**

The Ethernet communication ports in the DMS sign controller shall be protected with surge protection between each signal line and ground. This surge protection shall be integrated internally within the controller.

A series/parallel two-stage suppression device shall protect the modem communication port from over-voltage and over-current conditions. This surge protection shall be integrated internally within the controller.

**I. DMS Control Outputs**

The DMS sign controller shall transmit and receive data packets to and from the DMS via dedicated armored outdoor-rated fiber optic cables or via Ethernet Cat5E cable or better. Core-aligned fusion splicing is the only acceptable method of placing pigtailed on fiber optic cable. Copper cables may be used in instances where the controller needs to be located within the sign housing as directed by the engineer. This network will communicate with all sensors, drivers, and other devices utilizing a CAN (controller area network) bus running throughout the DMS. Two spare outdoor-rated, shielded, armored category 5e Ethernet cables (per ODOT Supplemental Specification 809) shall be installed from the ITS cabinet to the sign housing (20 feet of slack shall be left in each location) to be used as spares in case of damage inflicted by rodents to the cables.

Data transferred shall include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data shall include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED drivers.

**J. Messaging**

The DMS sign controller shall have the ability to display messages on the DMS display face as required herein.

**K. Message Presentation on the DMS Display Matrix**

The DMS sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the DMS sign controller shall support the following features as described in the DMS specification:

- Display of alpha numeric characters, including letters, numbers, and punctuation
- Selection of particular character fonts style
- Horizontal alignment of text on the display, including left, center, and right justification
- Vertical alignment of text on the display, including top, middle, and bottom justification
- Adjusting the spacing horizontally between characters or vertically between lines of text
- Alternating between pages of a multiple-page message
- Display of graphic bitmaps of various sizes ranging from very small to the size of the entire DMS matrix


L. Message Effects
The DMS shall be able to display messages using the following types of effects:

Static Message – The selected message is displayed continuously on the sign face until the DMS sign controller blanks the sign or causes the display of another message.

Flashing Message – All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds.

Scrolling Message – The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left.

Multiple-Page Message – A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page’s display time is user programmable from 0.1 to 25.5 seconds, and adjustable in increments of 0.1 seconds.

M. Message Activation
Messages shall be activated on a DMS in three ways:

Manual – An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.

Schedule – The internal time-based scheduler in the DMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.

Events – Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.

A displayed message shall remain on the sign until one of the following occurs:

The message’s duration timeout expires
The controller receives a command to change the message
The controller receives a command to blank the sign
The schedule stored in the controller’s memory indicates that it is time to activate a different message
A special event, such as a loss of communication, occurs that is linked to message activation

It shall be possible to confer a "priority" status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

N. Schedule Activation
The DMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall be per the NTCIP 1201 and NTCIP 1203 standards.

O. Display of Alphanumeric Text
The DMS sign controller shall support the storage and use of a minimum of twenty-four (24) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. The DMS sign controller shall have the ability to display subscripts and superscripts. All text font files shall include the following characters:

The letters “A” through “Z”, in both upper and lower case
Decimal digits “0” through “9”
A blank space
Eight (8) directional arrows
Punctuation marks, such as: . , ! ? ‘ ” : ;
Special characters, such as: # & * + ( ) [ ] < > @

ODOT uses the 07X04_1_CP1252 font style as the default font in the ODOT control software. The DMS will be tested using this font.
The DMS supplier shall provide the DMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

Table 1: Font Table

<table>
<thead>
<tr>
<th>Font Name</th>
<th>Character Height</th>
<th>Character Width (avg.)</th>
<th>Variable or Fixed Width</th>
<th>Stroke Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>7x4</td>
<td>7</td>
<td>4</td>
<td>Variable</td>
<td>Single (1)</td>
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<td>5</td>
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<td>Variable</td>
<td>Double (2)</td>
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<td>7</td>
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<td>Variable</td>
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<td>8</td>
<td>4</td>
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<td>16</td>
<td>10</td>
<td>Variable</td>
<td>Triple (3)</td>
</tr>
</tbody>
</table>

P. Display of Graphic Images
The DMS control software shall support the inclusion of graphics in messages. The vendor shall support graphics using NTCIP 1203 V3.

Q. DMS Intensity Control
The DMS sign controller shall provide means to change the brightness of the display matrix manually or automatically. The manual control will allow the user to select one of at least 100 intensity levels, which will be communicated to the LED drivers in the DMS. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

The automatic intensity control mode will monitor the ambient light sensors of the DMS and will use a mathematical algorithm to automatically select one of the one hundred or more intensity levels. The intensity level will then be transmitted to the LED drivers in the DMS. The algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The intensity control mode, manual or automatic, shall be settable via NTCIP using the control software or via the front panel interface. The manual brightness level shall be settable via the software or front panel. The mode and brightness level shall be monitored from both the software or front panel interfaces.

R. System Status Monitoring and Diagnostic Testing
The DMS sign controller shall be capable of monitoring the status of many of the DMS components and subsystems in real-time and/or manual modes, depending on the component or system. The following sections detail the status and diagnostic information that shall be provided by the controller. All of this status and diagnostic data shall be available via the front panel LCD screen and shall be transmitted via NTCIP to control software upon request.

S. Message Display Status
The DMS sign controller shall be capable of monitoring and displaying the currently active message (if any) on the controller’s front panel LCD display. This display shall be in a WYSIWYG format.
T. LED Pixel Testing
Upon command from either the front panel control interface or via NTCIP from remote control software, the DMS sign controller shall direct all of the LED modules to perform diagnostic tests of all their pixels. The controller shall then collect and report the results of the pixel testing. The controller shall also be capable of automatically detecting in real-time the status of each of the display’s pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the DMS face.

U. Power Supply Operation
The DMS sign controller shall monitor and report the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output fuse. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.

V. Door States
The DMS enclosure shall be equipped with access door sensors to monitor, via the controller, their open/closed status.

W. Environmental Conditions
The DMS sign controller shall monitor the readings of all light, temperature, and humidity sensors installed in the DMS housing.

X. Error Notification
The DMS sign controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and a central control system (via NTCIP communication) of the occurrence of important events and subsystem failures. All major component and subsystem errors shall be indicated on the controller’s LCD front panel.

The controller shall be capable of sending event notifications to the central control system via SNMP “traps” as allowed by NTCIP. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards. The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The following sections list errors and events that the controller shall report as defined above.

Y. Over Temperature Shutdown
The DMS sign controller shall continuously monitor the DMS housing’s temperature sensors and shall automatically shut down the DMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +140 °F (60 °C) and shall be configurable at the controller.

If the temperature approaches the threshold, the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.

The sign controller shall employ an algorithm to control the above brightness reductions and increases utilizing hysteresis to ensure that the display face does not visibly flicker as the temperature changes.
The event notifications sent for over temperature situations will include visual indication on the controller’s front panel LCD, as well as a trap notification sent to the central control system.

Z. Controller Restart
When the DMS sign controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate the NTCIP reset message if it is configured to do so.

AA. Power Loss
When the DMS sign controller detects that it has lost power it shall send a trap notification to the central system and activate the NTCIP power loss message if configured to do so.

BB. Power System Failure
The DMS sign controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap.

CC. Door Opened
When the DMS sign controller detects that one of the sign cabinet or control cabinet doors has been opened, it will transmit a trap to the central system indicating which door has opened.

DD. Communication Loss
The DMS sign controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP.

EE. Auxiliary Control Panel
The DMS shall include an auxiliary control panel or laptop interface port that will provide a secondary user interface panel for DMS sign control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DMS controller. It shall be powered independently from a 120 VAC outlet.

FF. DMS Control Interface
The auxiliary control panel / local laptop software shall include an identical menu system to the DMS sign controller with all of its features and functionality.

GG. Location
The auxiliary control panel / local laptop port shall be located in the DMS sign housing. If a local laptop port is provided, a drop-down shelf shall also be provided near the port and shall support a laptop computer when utilized by maintenance personnel.

HH. Controller Signal Interface
The auxiliary control panel shall interface to the DMS sign controller using Category 5E copper cable. It shall be capable of operating up to 330 feet from the DMS controller.

1501.8 DDMS Control Software
This section describes the minimum specifications for the DDMS sign control software. Provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DDMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

A. General Specifications
DDMS control software shall:
1. Operate on most current production version business desktop and laptop computers with
Intel® Pentium® Pentium 4 system running the Microsoft® Windows 7 Professional™ or latest commercial version of Microsoft® Windows operating system.

2. Provide a user-friendly multi-color graphical user interface
3. Be written as a native 32-bit or 64-bit Windows® program using Microsoft-certified software development tools (compilers, etc.)
4. Control a network of at least two hundred and fifty dynamic message signs
5. Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks (LAN and WAN)
6. Support DDMS communications via any combination of dedicated hardwired ethernet network, fiber-optic network, cellular modem, spread spectrum radio, Ethernet, or other as specified. Support DDMS control, monitoring, and diagnostic functions as specified.
7. Control DDMS both remotely from a central location, and locally at the DDMS site using a laptop computer
8. Be accompanied by an easy-to-use software installation utility
9. Include an operation manual that includes detailed instructions for configuring and using all parts of the software
10. Contain an on-line help system that includes documentation for every screen or dialog box present in the software. It shall also be context sensitive such that pressing the help button or [F1] key on any screen will launch the help page for that particular screen
11. Be fully compliant with the communications protocol requirements of the NTCIP Special Provision

B. Software Security
DDMS control software shall support the creation of user IDs and passwords for up to one hundred system users. Only a “System Administrator” shall assign user creation, as well as individual user access rights.

Before a system operator can use the DDMS control software, the software shall request a “user name” and user “password.” If the correct user name and password are not provided, access to the software shall be declined.

C. Client-Server Architecture
The software shall be of a modular design including a server and multiple client modules. The server shall handle all DDMS communication and shall store all configuration data, messages, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Separate clients shall be provided for each of the following software functions:

1. Shell client that handles user login and logout, as well as launching the other clients
2. Display control client for controlling DDMS messaging, monitoring system status, and performing DDMS diagnostics
3. Message editor client for creating DDMS messages
4. Message scheduler client for creating time and date schedules for activating messages
5. Administration client for DDMS system configuration and administration

D. DDMS Control
The DDMS control software shall provide a user interface that presents the system’s DDMS in both list and graphical formats. The software will allow the DDMS to be grouped as needed by the administrator. The DDMS list and map interfaces will include only the signs for the group currently selected.

E. List and Map Interfaces
The DDMS list shall clearly display the following information about each DDMS:

1. DDMS ID number, as “1” through “250”
2. DDMS name, in a descriptive text format
3. Iconic representation of the type of communication network used for the DDMS (i.e. direct or dial-up)
4. Name and priority level of message file being displayed
5. Date and time of last communication between the control software and the DDMS sign controller
6. Error and warning status, including pixel errors, power failures, communication error, etc.

The graphical interface shall include the following:
1. Configurable bitmaps that may be used to show all or parts of the system geographically
2. Icons for each sign that may be placed anywhere on the map
3. Icon color changes to indicate the status of the DDMS (i.e., yellow for warnings or red for errors)
4. Icon flashes if a message is running on the DDMS
5. Sign name is visible if mouse is placed over a DDMS icon

F. Direct Control Operations
The user interface shall provide a means for users to directly perform the following tasks for each sign:
1. Send and activate stored messages from the libraries
2. Blank the display
3. Activate an ad-hoc quick message that is created immediately, not loaded from a library
4. Send and activate schedules
5. Retrieve both messages and schedules from the sign
6. Perform diagnostics of DDMS subsystems, such as power supplies, sensors, etc.
7. Perform tests of pixels
8. Monitor the sign’s event log

G. Polling
The software shall have a feature to poll all or a set of DDMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

H. Scenarios
The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:
1. Send and activate stored messages from the libraries
2. Blank the display
3. Send and activate schedules
4. Perform diagnostics of DDMS subsystems, such as power supplies, sensors, etc.
5. Perform tests of pixels
The scenarios shall be saved to libraries where users may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

I. System Monitoring
The software shall be capable of monitoring and displaying to the user the contents of any communications in progress with DDMS. The status of all outgoing and incoming data packets will be visible.

J. Multi-Vendor Sign Control
The software shall be capable of controlling any NTCIP-compatible DDMS regardless of the manufacturer. The software shall support all mandatory and optional features typical in LED DDMS. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

K. Message Creation and Editing
A DDMS user shall be able to use the DDMS control software to create, edit, name, and store message files.
The message editor GUI shall present a scaled image of the DDMS display matrix, including a complete and accurate representation of the display matrix type (full or line) and the number of display pixels.
The DDMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the user with the ability to program:

1. The number of pages that the message is to contain (shall be a minimum of three (3))
2. Message text
3. Message graphics, including pixel-by-pixel editing, lines, area fill, block move, etc.
4. Character font type(s) used to construct the message
5. The amount of inter-line spacing measured in pixels
6. Horizontal message justification on the DDMS display matrix including left, center, and right
7. Vertical message justification on the DDMS display matrix including top, middle, and bottom
8. The type of entry effect, as “static” or “scrolling”
9. Message page on time and off time
10. Message scroll rate, if a scrolling message
11. The flash rate of all or part of a message page
12. Message priority status
13. The display status of any flashing beacons mounted to the DDMS

The message editor shall provide a method of incorporating data fields into a DDMS message. The following data fields shall be provided:

1. Time, in 12-hour format
2. Time, in 24-hour format
3. Temperature, in degrees Fahrenheit and Celsius
4. Speed, kilometers per hour and miles per hour (vehicle speed, for DDMS sites that contain speed measurement equipment)
5. Day of week (Monday, Tuesday, etc.)
6. Day of the month (1, 2, …31)
7. Month of the year (1, 2, …12)
8. Calendar year, in both two-digit and four-digit formats

The message editor shall provide a convenient means for the user to:

1. Insert, add, or delete, message text
2. Paste graphics from other programs using the Windows clipboard
3. Clear the content of the editing page
4. Save the message file under its existing name or a new name
5. Delete a message file
6. Save all new changes

It shall be possible to store message files in both the DDMS control computer memory and the DDMS sign controller memory.

The users shall have the ability to print any message or library of messages.

L. Message Libraries

DDMS control software shall support the creation and storage of message libraries (file directories), which allow the user to categorize message files by:

1. DDMS matrix size
2. Message subject matter

The library editor shall allow a user to:

1. Create a new library
2. Store the same message in multiple libraries
3. Select a message from an existing library and edit the message contents
4. Search message libraries for messages with specified text in message name or contents
5. Copy/Paste a message from one library to another
6. Delete a message file from a library
7. Rename a library
8. Delete a library
9. Save all new changes
M. Schedule Creation and Editing
DDMS control software shall support the creation of message schedules, which instruct the DDMS sign controller to run specific messages at pre-determined times and dates.
Software shall contain an editor, which allows messages to be scheduled via:
1. Month of the year (January, February, etc.)
2. Day of the week (Monday, Tuesday, etc.)
3. Day of the month (1, 2, ..., 31)
4. Time of day
The schedule editor shall provide a convenient means for the operator to:
1. Create a new schedule
2. Rename an existing schedule
3. Delete a schedule
4. Save all new changes
It shall be possible to store schedule files in both the DDMS control computer memory and the DDMS sign controller memory.

N. Display Fonts
The software shall support a minimum of twelve fonts for each model of DDMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of twenty-four fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DDMS model configuration.
The software shall include a font editor to allow the user to create custom fonts. The font editor shall allow the user to create new fonts or modify existing fonts. The user shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner.
Any of the fonts provided by the software vendor or created/modified by the administrator shall be downloadable to the DDMS.

O. Event Logging
The software shall include an event logging system that logs all significant system events. Each logged event shall include the following fields at a minimum:
1. Event ID number
2. User that initiated the event
3. Time and date that the event occurred
4. Description of the event (i.e., “Diagnostic Test Performed”)
5. Source of the event (i.e., DDMS sign name)
6. Additional data relevant to the event (i.e., “Failed pixel: (4, 73)”) 
The events logged shall include, but not be limited to, the following:
1. User login/logout
2. Failed login attempts
3. Communication failures
4. Message and schedule activation or display blanking
5. Diagnostics test results
6. Warning events sent from the sign
7. Other system errors
The users will have the ability to view, sort by category, and print the log file at any time.

P. System Configuration
The DDMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:
1. Sign models and individual signs
2. Communication networks
3. System error/warning alarms
4. User security rights
5. System maps and sign icon placement
6. Default system option settings
7. Default message parameters
8. Message priority settings

Q. Sign Configuration
Each sign in the DDMS control software shall be configured with the following parameters:
1. Sign viewing area height and width (for full-matrix signs)
2. Number of lines and each line’s height and width (for line-matrix signs)
3. Site name
4. DDMS ID number
5. Network address
6. Communication parameters

R. Communication Settings
Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:
Network type - Ethernet
NTCIP subnetwork and transport protocols
Communication retries and timeouts

S. System Alarms
Configurable settings shall allow the system administrator to determine which of the following events will trigger an audio and visual (on-screen) alarm:
1. Communication failure
2. Priority status conflict
3. Sign restart
4. Power supply failure
5. Door open
6. Pixel error and Pixel module failures
7. Fan status and failure

T. User Administration
The administrator shall have the ability to add, remove and modify users. The access rights of each user shall be configurable to allow or deny access to each major software feature.

U. System Maps
It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

V. Message Editor Defaults
The message editor shall automatically utilize the following default settings during the creation of new message files:
1. Pixel spacing between adjacent lines of text
2. Pixel spacing between adjacent text characters
3. Display duration of a given message page
4. Beacon activation status (for DDMS that contain flashing beacons)
5. Effect to be applied to text (i.e., static, scrolling, etc.)
6. Effect rate, which shall determine the speed of scrolling messages
7. Flash rate, which shall determine the speed of flashing messages
8. Message priority classification
9. Horizontal text justification supporting left, center, or right
10. Vertical text justification supporting top, middle, and bottom
W. Message Priorities
User-definable defaults shall allow messages to be assigned a priority classification of:

1. Emergency
2. High
3. Normal
4. Low
5. Minimal

A numeric priority range shall be assigned to each of these five priority classifications. The priority shall allow two different message files to be assigned the same classification, but within that classification, one message can be identified as having higher priority.

X. Software Use and Reproduction Rights
The DDMS manufacturer shall provide a DDMS control software site license with the DDMS supplied. Ten copies of the DDMS control software shall be provided to the Engineer on CD-ROM within thirty days of contract award. The Engineer shall have the right to request or reproduce an unlimited number of software copies for use on the DDMS system.

Y. Requirements for NTCIP Conformance
This section describes the minimum specifications for the NTCIP communication capabilities of the DDMS controller and DDMS control software. Provide all the software, firmware, and services necessary to operate a dynamic message sign (DDMS) system that fully complies with the NTCIP functional requirements, including incidental items that may have been inadvertently omitted.
1502 Destination Dynamic Message Signs – DDMS, Arterial

ITEM 809E63040: DESTINATION DYNAMIC MESSAGE SIGN, DDMS – ARTERIAL - TWO-LINE
ITEM 809E63050: DESTINATION DYNAMIC MESSAGE SIGN, DDMS – ARTERIAL - THREE-LINE

1502.1 General
The Contractor shall furnish and install a travel-time system including a quantity, as specified in the plans, of message boards on a ground-mounted extrusheet sign. The system shall include all components of the Travel-time system including pole mounted cabinet (w/ brackets), power supplies, controller, auxiliary controller, terminal strips, and all other items needed to provide a functional system. These cabinets and enclosed electronic parts shall be manufactured and pre-assembled by Daktronics.

A. General Specifications
The DDMS housing shall provide front flip-down access for all Light Emitting Diode (LED) display modules, electronics, environmental control equipment, air filters, wiring, and other internal DDMS components.
Each display pixel shall be composed of multiple monochrome amber LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, and incandescent lamp, will not be accepted.
The pixel matrix shall be capable of displaying alphanumeric character fonts measuring a minimum of 18 inches (460 mm) high to a maximum of the display matrix height.
The DDMS shall be able to display messages composed of any combination of alphanumeric text and punctuation symbols.
The MANUFACTURER shall provide 24 hours of on-site technical service and support for five years after installation of all units.

B. Legibility.
DDMS messages shall be legible within a distance range of 150 to minimum of 1000 feet (45 to minimum of 360 m) from the DDMS display face under the following conditions:
1. When the DDMS is mounted so it is on a ground mounted sign no more than 55 feet from edge of traveled lane.
2. Whenever the DDMS is displaying alphanumeric text that is 18-inches (460 mm) high
3. 24 hours per day and in most normally encountered weather conditions
4. During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DDMS
5. When viewed by motorists and travelers that have 20-20 corrected vision
6. When the motorist eye level is 3 to 12 feet (0.9 to 3.6 m) above the roadway surface.

C. Documentation.
NTCIP documentation shall be provided on a CD-ROM and will contain ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:
1. The relevant version of each official standard MIB modules referenced by the device functionality.
2. If the device does not support the full range of any given object within a standard MIB Module, a manufacturer specific version of the official standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module except that it will have the extension “man”.
3. A MIB module in ASN.1 format containing any and all manufacturer specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
4. A MIB containing any other objects supported by the device.
D. Test Procedures.
The DDMS vendor shall prepare and submit test procedures and test data forms for the Department’s approval at least 30 working days before the scheduled testing as required. Test procedures shall be developed specifically in response to these specifications. Do not submit test procedures developed in response to other procurement documents, specifications or for other customers and projects. The Department will review submitted test procedures. At a minimum, the test procedures and data forms shall include the following:
1. A step-by-step outline of the test sequence to be followed, showing a test of every function of the equipment or system to be tested. For each test, clearly identify in the test procedure the specific function or requirement being addressed.
2. A description of the expected operation, output and test results.
3. An estimate of the test duration and a proposed test schedule.
4. A data form to be used to record all data and quantitative results obtained during the test.
5. A description of any special equipment, setup, manpower, or conditions required for the test.

E. Test Equipment and Software.
As part of the testing requirements, except as otherwise noted, the DDMS vendor shall be responsible for furnishing all test facilities, including software, required to complete the required testing. The DDMS vendor shall provide documentation and user instructions for use of any required test equipment and test software unless otherwise directed by the Department.

1502.2. Enclosure

A. Dimensions.
DDMS housing dimensions shall not exceed 1 foot 10 inches high by 3 feet 7 inches wide. The front-to-back housing depth shall not exceed 2.5 inches at its widest point, including the ventilation hoods. DDMS single panel weight shall not exceed 35 pounds.

B. Sign Construction.
The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum). DDMS and sign controller components shall operate in a minimum temperature range of −34 to +115 °F and a relative humidity range of 0 to 99 percent, non-condensing. DDMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of −34 to +115 °F.

External DDMS component hardware (nuts, bolts, screws, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, or other durable corrosion-resistant materials suitable for the roadway sign application. Standoffs may be nylon.

DDMS and sign controller components shall be 100 percent solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DDMS and the sign controller shall be UL (Underwriter’s Laboratory) listed and meet all local National Electric Code (NEC) codes applicable to DDMS applications.

The presence of ambient electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DDMS system. The DDMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DDMS and its sign controller. Manufacturer shall provide certification showing the DDMS system passes standard Electromagnetic Compatibility (EMC) guidelines.

The DDMS housing structural frame shall consist of aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. All sides of the DDMS housing exterior, except the front, shall be covered with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework by continuous welding.
LED display modules shall be mounted parallel to the front face, so they are capable of 3 degrees tilt forward toward the viewing motorists at the angle at which the sign is installed and use of the legible LED viewing area is optimized.

DDMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be stainless steel or galvanized A325 high-strength steel and shall be appropriately sized for the application.

C. Front Face Construction.
Front face panels shall provide a high-contrast background for the DDMS display matrix. If an aluminum mask is used, it shall be painted flat black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Face panels shall be attached to each other using stainless steel hardware. Seams that separate adjacent panels shall be sealed. Panels shall not be welded or otherwise permanently mounted to the DDMS housing. Panels shall be mounted in such a way that they are removable from the interior of the DDMS housing.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DDMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The polycarbonate sheet shall be Lexan XL10 or equivalent approved by the Engineer.

LED display modules shall mount to the inside of the DDMS front face panels. Common hand tools shall be used for removal and replacement.

DDMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.

In the presence of wind, the DDMS front face shall not distort in a manner that adversely affects LED message legibility.

D. Exterior Finish.
DDMS front face panels and front face border pieces shall be coated with semi-gloss black Kynar 500 which has an expected outdoor service life of 20 years.

All other DDMS housing surfaces, including DDMS mounting brackets, shall be natural mill-finish aluminum.

E. Service Access.
The DDMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DDMS housing. All of those internal components shall be removable and replaceable by a single technician. The DDMS front face panels shall also be removable and replaceable from inside the DDMS housing.

One horizontally bottom-hinged door shall be located on the DDMS housing. In the closed position, each door shall latch to its frame with an allen or hex head screw.

1502.3. Illumination.

A. LED Display Modules.
The DDMS shall contain LED display modules that include a LED pixel array, LED driver circuitry, and mounting hardware. Each LED display module shall be constructed as follows:
1. Each LED display module shall be mounted to the rear of the display’s front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel’s pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels.

2. LED display module power and signal connections shall be a quick-disconnect locking connector type. Removal of a display module from the DDMS, or a pixel board or driver circuit board from its display module, shall not require a soldering operation.

3. Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.

4. It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DDMS display matrix.

5. All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the DDMS.

B. LED Pixel Boards.

Each LED pixel board shall be composed of a printed circuit board to which LED pixels are soldered. The LED pixel boards shall conform to the following specifications:

1. LED pixel boards shall be manufactured using a laminated fiberglass printed circuit board.
2. Each pixel shall consist of a minimum of two independent strings of discrete LEDs. All pixels shall contain an equal quantity of LED strings.
3. The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DDMS.
4. Each pixel shall contain the quantity of discrete amber LEDs needed to output a minimum luminous intensity of 9,200 candelas per square meter when operated within the forward current limits defined in these specifications.
5. Each LED pixel shall not consume more than 1.5 watts.
6. The circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.
7. All exposed metal on both sides of the LED pixel board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual pixels, including discrete LED replacement and acrylic/silicone conformal coating repair, shall be possible.
8. All LED pixel boards shall be identical and interchangeable throughout the DDMS.

C. Discrete LEDs.

DDMS pixels shall be constructed with surface mount or through hole discrete LEDs manufactured by Agilent / Avago Technologies, Toshiba Corporation, or Nichia Corporation. Substitutes will not be accepted. Discrete LEDs shall conform to the following specifications:

1. Through hole LEDs shall be non-diffused, high-intensity, solid-state lamps in T1-3/4-style LED packages.
2. Surface mount LEDs shall be non-diffused, high-intensity, solid-state lamps.
3. All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer’s product specifications and shall not exceed +/- 3 degrees.
4. The LED lenses shall be fabricated from UV light resistant epoxy.
5. Amber LEDs shall utilize AlInGaP semiconductor technology and shall emit amber light that has a peak wavelength of 590 ± 5 nm.
6. The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two consecutive luminous intensity “bins” as defined by the LED manufacturer.
7. The LED manufacturer shall perform color sorting of the bins. LEDs shall be obtained from no more than two consecutive color “bins” as defined by the LED manufacturer.
8. The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.

9. All LEDs used in all DDMS provided for a contract shall be from the same manufacturer and of the same part number.

10. The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 70 percent of the original brightness.

11. The LEDs shall not be driven with a forward current that exceeds the LED manufacturer’s recommendations to maintain the minimum 100,000-hour lifetime requirement.

D. Pixel Drive Circuitry.

The driver circuit boards shall conform to the following specifications:

1. LED driver boards shall be manufactured using a laminated fiberglass printed circuit board.

2. All exposed metal on both sides of the LED driver board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of acrylic or silicone conformal coating. Bench level repair of individual components, including conformal coating repair, shall be possible.

3. Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.

4. Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer’s recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer’s recommendations for the 100,000-hour lifetime requirement.

5. The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.

6. The LED driver boards shall receive updated display data at a minimum rate of ten frames per second from the sign controller.

7. Each LED driver board shall be powered by 24 VDC from external regulated DC power supplies. Each driver board shall receive separate power feeds from a minimum of two independent power supplies.

8. Each LED driver board shall contain a microprocessor-controlled power regulation circuit that controls the voltage applied to the LED strings. The power circuit shall automatically adjust the forward voltage of the LEDs to optimize power consumption efficiency as the temperature changes. Indicator LEDs shall be provided to indicate the status of power to each driver board.

9. Each LED driver board shall contain a temperature sensor and shall report the temperature to the sign controller upon request.

10. The LED driver circuitry shall be able to detect that individual LED strings or pixels are non-responsive and shall report the pixel status to the sign controller upon request.

11. All driver circuit boards shall be identical and interchangeable throughout the DDMS.

12. Removal or failure of a single driver circuit board shall not affect the performance of any other LED display module in the DDMS.

13. Individual addressing of each driver circuit shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.

14. The redundant LED power supply system shall be designed to illuminate every character on the sign with any allowable alphanumeric character at full power, at 165°F (74°C). Power supplies shall be switching power supplies, which must be at least 80% efficient at nominal voltage, and include a self-resetting internal thermal protection device that switches off the output in case of an overload. In the event of a failure of one of the power supplies, the controller will detect the loss of power from the failed supplies.
E. Regulated DC Power Supplies.
The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the DDMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two physically and electrically independent supplies. Each pair of power supplies shall be parallel but shall not be wired in a current sharing configuration.

Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100 percent of the pixels in that display region at 100 percent brightness when the internal DDMS air temperature is +140 ºF (60 ºC) or less.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The output of each power supply will be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DDMS.

Regulated DC power supplies shall conform to the following specifications:
1. Nominal output voltage of 24 VDC +/- 10 percent
2. Nominal maximum output power rating of 1000 watts
3. Operating input voltage range shall be a minimum of 90 to 260 VAC
4. Operating temperature range shall be a minimum of -30 to +165 ºF (-34 to +74 ºC)
5. Maximum output power rating shall be maintained over a minimum temperature range of -30 to +140 ºF (-34 to +60 ºC)
6. Power supply efficiency shall be a minimum of 80 percent
7. Power factor rating shall be a minimum of 0.95
8. Power supply input circuit shall be fused
9. Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
10. Power supplies shall be UL listed
11. Printed circuit boards shall be protected by an acrylic or silicone conformal coating

1502.4. Wiring and Power Distribution

A. Maximum Power.
Maximum AC power shall not exceed 6000 watts, when the following circuits are operational and fully loaded:

1. LED display pixel matrix, with 100 percent of the pixels operating at their maximum possible drive current
2. DDMS environmental control system
3. Utility outlet circuit
4. DDMS sign controller
Typical DDMS AC operating power shall not exceed 3000 watts with the following circuit loadings:

1. LED display pixel matrix, with 25 percent of the pixels operating at their maximum possible drive current
2. DDMS sign controller

DDMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground.

B. Power and Signal Entrances.
Two threaded conduit hubs shall be located on the rear wall of the DDMS housing. One hub shall be for incoming AC power and the other shall be for incoming DDMS signal cabling or a communications line.

C. Load Center.
The DDMS shall contain a power load center and circuit breakers that meet the following minimum requirements:

1. Service entrance-rated
2. Minimum of twenty circuit breaker mounting positions
3. Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
4. UL listed load center and circuit breakers

D. Internal Wiring.
Wiring for LED display module control, environmental control circuits, and other internal DDMS components shall be installed in the DDMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

E. Earth Grounding.
The DDMS manufacturer shall provide one earth ground lug that is electrically bonded to the DDMS housing. The lug shall be installed near the power entrance location on the DDMS housing’s rear wall. The DDMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DDMS. All earth grounding shall conform to the National Electrical Code.

F. Convenience Outlets.
The DDMS cabinet housing shall contain a utility outlet circuit consisting of a minimum of one 15-A NEMA 15-R, 120 VAC duplex outlets and one 15-A NEMA 15-R, 120 VAC GFCI duplex outlet.

G. Site AC Power.
The AC power feed for all equipment shall be protected at the load center by a parallel-connection surge suppressor rated for a minimum surge of 10 kA.

H. Control Equipment AC Power.
A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment in the ITS cabinet and sign housing. This device shall conform to the following requirements:

1. Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form
2. Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
3. Series inductance of 200 micro henrys (nominal)
4. Temperature range of −40 to +158 °F (-40 to +70 ºC)
5. Approximate dimensions of 3-inches (76 mm) wide by 5-inches (127 mm) long by 2-inches (50 mm) high or shall be rack-mounted to fit in a standard EIA 19-inch rack
6. The device shall be UL-1449 recognized
7. UL 1449 surge rating of 400 V or less
I. Communication Signals.
Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

1502.5 Control Systems.

A. Internal Lighting.
The DDMS cabinet shall contain a minimum of one door-activated LED light bars mounted at the top front of cabinet in a way that no cabinet rack space is used for lighting (minimum 12 inches in length, minimum 110-degree beam angle, cool white, minimum 300 lumens per unit, on/off switch, maximum 0.75 inches in width, 24 volt).

B. Environmental Monitoring Systems.
The DDMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.

C. Ambient Light Measurement.
Sensors that measure the outdoor ambient light level and the outdoor ambient temperature at the DDMS site shall be mounted in-line with the DDMS housing walls. This ambient light and temperature measurement system shall consist of three electronic light sensors. Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DDMS. The third light sensor shall be mounted to the floor or top of the DDMS housing and shall face the ground. The DDMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DDMS face.

D. Ambient Temperature Measurement.
A minimum of one ambient temperature sensor shall be mounted to either the rear wall or bottom side of the DDMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

E. Internal Temperature Measurement.
The DDMS shall contain a minimum of one temperature sensor that is mounted near the top of the DDMS interior. The sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40 to +176 °F (-40 to +80 °C). The internal temperature sensor output shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

F. Internal Humidity Measurement.
The DDMS shall contain one sensor that measures the relative humidity of the air inside the DDMS cabinet. The sensor shall monitor the humidity from 0 to 100 percent. The humidity sensor output shall be continuously monitored by the DDMS sign controller and shall be reported to the DDMS control software upon request.

G. Interior DDMS Environmental Control.
The DDMS shall contain systems for cabinet ventilation, face panel fog and frost prevention, and safe over-temperature shutdown.
H. Housing Ventilation System.
The DDMS shall contain a passive ventilation system. The ventilation system shall consist of two or more air intake ports. Intake ports shall be located near the bottom of the DDMS rear wall. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger.

I. Over Temperature Safety Shutdown.
The DDMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and shall have a default factory setting of +140 °F (+60 °C).

1502.6 Controllers.
This section describes the minimum specifications for the dynamic message sign (DDMS) controllers and auxiliary control panels. Each DDMS shall include a sign controller, auxiliary control panel, and associated equipment. Provide all the materials, software, and services necessary to install DDMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

A. General Requirements.
Each DDMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DDMS control software in order to perform most DDMS control functions. The sign controller and auxiliary controller shall meet the following operational requirements:
1. Communicate using the NTCIP protocol
2. Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
3. Include a front panel user interface with LCD and keypad for direct operation and diagnostics as described herein with auxiliary controller
4. Contain a minimum of one NTCIP-compliant Ethernet port with RJ45 connector
5. Contain DDMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DDMS controller. External protocol converter or translator devices shall not be allowed.

B. Environmental.
The sign controller shall meet the environmental requirements defined in NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DDMS), with NTCIP Requirements.

C. Mechanical and Electrical.
The sign controller shall meet the following electrical and mechanical requirements:
1. Mount in a standard EIA 19-inch (480-mm) equipment rack with a maximum 4U space requirement
2. Weigh no more than 10 pounds (4.5 kg), including its enclosure
3. Consume no more than 30 watts of power
4. Powered by an internal regulated DC power supply capable of operating on 120 VAC or 240 VAC at both 50 Hz and 60 Hz

1502.7 Operational Requirements

A. Front Panel User Interface
The auxiliary sign controller’s front panel shall include a keypad and LCD. These devices shall be used to perform the following functions with the sign controller and DDMS:
1. Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face
2. Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
3. Activate messages stored in memory
4. Configure display parameters including display size
5. Configure communications port settings and NTCIP options

The front panel interface shall also include:
1. Power switch to turn the controller on and off
2. LED power “on” indicator
3. “Local/remote” switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
4. LED to indicate state of the “local/remote” mode switch
5. Reset switch to quickly restart the controller
6. LED “Active” indicator that blinks when the controller is operating correctly
7. LED to indicate when any of the NTCIP communication channels are active

B. Memory
The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or non-battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of one hundred changeable messages in non-volatile RAM.

C. Internal Clock
The DDMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 5 years without external power. The clock shall take it’s time from the network or central control.

D. Communications
All remote communication ports shall be NTCIP-compatible as defined in the section 9 of these specifications. All cables (Serial, Ethernet, or any other proposed conductive cable shall be equipped with surge suppression capable of withstanding a minimum 1 kA surge current. The cost of this surge suppression shall be incidental to the bid price of the sign.

E. Communication Modes
The DDMS sign controller shall be able to receive instructions from and provide information to a computer containing DDMS control software using the following communication modes:
Remotely via direct communications with a remotely located computer over Ethernet.
Locally via direct connection with a laptop computer that is connected directly to the sign controller using Ethernet.

F. Ethernet Port
The DDMS sign controller shall contain a minimum of one 10/100Base-T Ethernet communication port. This port shall be available for communicating from the central control system to the DDMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.
Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

G. Dial-Up Modem Communication Port
The DDMS sign controller shall include one built-in Hayes-compatible dial-up modem. The modem port shall have a standard RJ11 connector.
This modem shall be configured to support either the NTCIP 2101 (PMPP) or the NTCIP 2103 (PPP) sub network profile. At least one of the following transport profiles shall also be available for configuration: NTCIP 2201 (Null) or NTCIP 2202 (Internet). Only one each of the transport and sub network profiles shall be active at any time on the port.

The modem shall be configurable to support both incoming and outgoing calls as supported by NTCIP. The modem shall support a minimum communication speed range from 1200 baud to 28,800 baud. The modem shall support the following protocols at a minimum: Hayes-compatible "AT" command set, MNP5, MNP10, and V.42bis.

H. Controller Addressing
The DDMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

I. Transient Protection
The Ethernet communication ports in the DDMS sign controller shall be protected with surge protection between each signal line and ground. This surge protection shall be integrated internally within the controller.

A series/parallel two-stage suppression device shall protect the modem communication port from over-voltage and over-current conditions. This surge protection shall be integrated internally within the controller.

J. DDMS Control Outputs
The DDMS sign controller shall transmit and receive data packets to and from the DDMS via dedicated fiber optic cables. Core-aligned fusion splicing is the only acceptable method of placing pigtailed on fiber optic cable. Copper cables may be used in instances where the controller needs to be located within the sign housing, as directed by the engineer. This network will communicate with all sensors, drivers, and other devices utilizing a CAN (controller area network) bus running throughout the DDMS. Two spare outdoor-rated, aluminum armored, category 5e cables shall be run from the ITS Cabinet to the DDMS Sign Housing with 10 feet of slack in each location. Two spare category 5e Ethernet cables shall be installed from the ITS cabinet to the sign housing to be used as spares in case of damage inflicted by rodents to the cables.

Data transferred shall include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data shall include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED drivers.

K. Messaging
The DDMS sign controller shall have the ability to display messages on the DDMS display face as required herein.

L. Message Presentation on the DDMS Display Matrix
The DDMS sign controller shall control the LED drivers in a manner that causes the desired message to display on the DDMS sign. At a minimum, the DDMS sign controller shall support the following features as described in the DDMS specification:
1. Display of alpha numeric characters, including letters, numbers, and punctuation
2. Selection of particular character fonts style
3. Horizontal alignment of text on the display, including left, center, and right justification
4. Vertical alignment of text on the display, including top, middle, and bottom justification
5. Adjusting the spacing horizontally between characters or vertically between lines of text
6. Alternating between pages of a multiple-page message
7. Display of graphic bitmaps of various sizes ranging from very small to the size of the entire DDMS matrix

M. Message Effects
The DDMS shall be able to display messages using the following types of effects:
1. Static Message – The selected message is displayed continuously on the sign face until the DDMS sign controller blanks the sign or causes the display of another message
2. Flashing Message – All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
3. Scrolling Message – The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
4. Multiple-Page Message – A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page’s display time is user programmable from 0.1 to 25.5 seconds, and adjustable in increments of 0.1 seconds.

N. Message Activation
Messages shall be activated on a DDMS in three ways:
1. Manual – An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.
2. Schedule – The internal time-based scheduler in the DDMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.
3. Events – Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.

A displayed message shall remain on the sign until one of the following occurs:
1. The message’s duration timeout expires
2. The controller receives a command to change the message
3. The controller receives a command to blank the sign
4. The schedule stored in the controller’s memory indicates that it is time to activate a different message
5. A special event, such as a loss of communication, occurs that is linked to message activation

It shall be possible to confer a “priority” status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

O. Schedule Activation
The DDMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall be per the NTCIP 1201 and NTCIP 1203 standards.

P. Display of Alphanumeric Text
The DDMS sign controller shall support the storage and use of a minimum of twenty-four (24) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. The DDMS sign controller shall have the ability to display subscripts and superscripts. All text font files shall include the following characters:
1. The letters “A” through “Z”, in both upper and lower case
2. Decimal digits “0” through “9”
3. A blank space
4. Eight (8) directional arrows
5. Punctuation marks, such as: . , ! ? ‘ ’ “ ” : ;
6. Special characters, such as: # & * + / ( ) [ ] < > @

ODOT uses the 07X04_1_CP1252 font style as the default font in the ODOT control software. The DDMS will be tested using this font.
The DDMS supplier shall provide the DDMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

Q. Display of Graphic Images
The DDMS control software shall support the inclusion of graphics in messages. If the NTCIP 1203 v2 standard has not reached a “recommended” or “approved” state by the time of contract award, the vendor shall support graphics using manufacturer-specific objects and MULTI tags.

If a manufacturer-specific means of supporting graphics is used, the vendor shall commit to provide NTCIP 1203 v2 firmware updates at no cost to the customer. These updates will include all current requirements of these specifications and also standard graphics support. The vendor shall install the updates no later than six months after the NTCIP 1203 v2 standard reaches the “approved” state.

R. DDMS Intensity Control
The DDMS sign controller shall provide means to change the brightness of the display matrix manually or automatically. The manual control will allow the user to select one of at least 100 intensity levels, which will be communicated to the LED drivers in the DDMS. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

The automatic intensity control mode will monitor the ambient light sensors of the DDMS and will use a mathematical algorithm to automatically select one of the one hundred or more intensity levels. The intensity level will then be transmitted to the LED drivers in the DDMS. The algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The intensity control mode, manual or automatic, shall be settable via NTCIP using the control software or via the front panel interface. The manual brightness level shall be settable via the software or front panel. The mode and brightness level shall be monitored from both the software or front panel interfaces.

S. System Status Monitoring and Diagnostic Testing
The DDMS sign controller shall be capable of monitoring the status of many of the DDMS components and subsystems in real-time and/or manual modes, depending on the component or system. The following sections detail the status and diagnostic information that shall be provided by the controller.

All of this status and diagnostic data shall be available via the front panel LCD screen and shall be transmitted via NTCIP to control software upon request.

T. Message Display Status
The DDMS sign controller shall be capable of monitoring and displaying the currently active message (if any) on the controller’s front panel LCD display. This display shall be in a WYSIWYG format.

U. LED Pixel Testing
Upon command from either the front panel control interface or via NTCIP from remote control software, the DDMS sign controller shall direct all of the LED modules to perform diagnostic tests of all their pixels. The controller shall then collect and report the results of the pixel testing.

The controller shall also be capable of automatically detecting in real-time the status of each of the display’s pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the DDMS face.

V. Power Supply Operation
The DDMS sign controller shall monitor and report the functional status of regulated DC power supplies located in the DDMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output fuse. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.
W. Door States
Each DDMS housing and cabinet shall be equipped with access door sensors to monitor, via the controller, their open/closed status.

X. Environmental Conditions
The DDMS sign controller shall monitor the readings of all light, temperature, and humidity sensors installed in the DDMS housing.

Y. Error Notification
The DDMS sign controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and a central control system (via NTCIP communication) of the occurrence of important events and subsystem failures.

All major component and subsystem errors shall be indicated on the controller's LCD front panel.

The controller shall be capable of sending event notifications to the central control system via SNMP "traps" as allowed by NTCIP. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards. The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The following sections list errors and events that the controller shall report as defined above.

Z. Over Temperature Shutdown
The DDMS sign controller shall continuously monitor the DDMS housing’s temperature sensors and shall automatically shut down the DDMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +140 °F (60 °C) and shall be configurable at the controller. If the temperature approaches the threshold, the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.

The sign controller shall employ an algorithm to control the above brightness reductions and increases utilizing hysteresis to ensure that the display face does not visibly flicker as the temperature changes. The event notifications sent for over temperature situations will include visual indication on the controller’s front panel LCD, as well as a trap notification sent to the central control system.

AA. Controller Restart
When the DDMS sign controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate the NTCIP reset message if it is configured to do so.

BB. Power Loss
When the DDMS sign controller detects that it has lost power, it shall automatically indicate that on the front panel LCD. It shall also send a trap notification to the central system and activate the NTCIP power loss message if configured to do so.

CC. Power System Failure
The DDMS sign controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap.

DD. Door Opened
When the DDMS sign controller detects that one of the sign cabinet or control cabinet doors has been opened, it will transmit a trap to the central system indicating which door has opened.
EE. Communication Loss
The DDMS sign controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP.

FF. Auxiliary Control Panel
The DDMS shall include an auxiliary control panel that will provide a secondary user interface panel for DDMS sign control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DDMS controller. It shall be powered independently from a 120 VAC outlet.

The auxiliary control panel must be composed of at least one interface which may be used to connect a laptop for local control AND configuration.

GG. Interface Panel
The auxiliary control panel shall have an LCD panel and keypad identical to those found on the DDMS sign controller. It shall also contain a local/remote switch, a reset switch, status LEDs, and one NTCIP compatible RS232 communication port that meet the same specifications as the DDMS sign controller.

HH. DDMS Control Interface
The auxiliary control panel shall include an identical menu system to the DDMS sign controller with all of its features and functionality.

II. Location
The auxiliary control panel shall be located in the DDMS cabinet.

JJ. Controller Signal Interface
The auxiliary control panel shall interface to the DDMS sign controller using Category five copper cable. It shall be capable of operating up to 400 feet from the DDMS controller.

1502.8 DDMS Control Software
This section describes the minimum specifications for the DDMS sign control software. Provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DDMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

A. General Specifications
DDMS control software shall:
1. Operate on most current production version business desktop and laptop computers with Intel® Pentium® Pentium 4 system running the Microsoft® Windows 7 Professional™ or latest commercial version of Microsoft® Windows operating system.
2. Provide a user-friendly multi-color graphical user interface
3. Be written as a native 32-bit or 64-bit Windows® program using Microsoft-certified software development tools (compilers, etc.)
4. Control a network of at least two hundred and fifty dynamic message signs
5. Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks (LAN and WAN)
6. Support DDMS communications via any combination of dedicated hardwired serial network, fiber-optic network, dial-up telephone lines, leased phone lines, cellular telephone, CDPD, spread spectrum radio, Ethernet, or other as specified.
7. Support DDMS control, monitoring, and diagnostic functions as specified.
8. Control DDMS both remotely from a central location, and locally at the DDMS site using a laptop computer
9. Be accompanied by an easy-to-use software installation utility
10. Include an operation manual that includes detailed instructions for configuring and using all parts of the software
11. Contain an on-line help system that includes documentation for every screen or dialog box present in the software. It shall also be context sensitive such that pressing the help button or [F1] key on any screen will launch the help page for that particular screen
12. Be fully compliant with the communications protocol requirements of the NTCIP Special Provision

**B. Software Security**

DDMS control software shall support the creation of user IDs and passwords for up to one hundred system users. Only a “System Administrator” shall assign user creation, as well as individual user access rights.

Before a system operator can use the DDMS control software, the software shall request a “user name” and user “password.” If the correct user name and password are not provided, access to the software shall be declined.

**C. Client-Server Architecture**

The software shall be of a modular design including a server and multiple client modules. The server shall handle all DDMS communication and shall store all configuration data, messages, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Separate clients shall be provided for each of the following software functions:
   1. Shell client that handles user login and logout, as well as launching the other clients
   2. Display control client for controlling DDMS messaging, monitoring system status, and performing DDMS diagnostics
   3. Message editor client for creating DDMS messages
   4. Message scheduler client for creating time and date schedules for activating messages
   5. Administration client for DDMS system configuration and administration

**D. DDMS Control**

The DDMS control software shall provide a user interface that presents the system’s DDMS in both list and graphical formats. The software will allow the DDMS to be grouped as needed by the administrator. The DDMS list and map interfaces will include only the signs for the group currently selected.

**E. List and Map Interfaces**

The DDMS list shall clearly display the following information about each DDMS:
   1. DDMS ID number, as “1” through “250”
   2. DDMS name, in a descriptive text format
   3. Iconic representation of the type of communication network used for the DDMS (i.e. direct or dial-up)
   4. Name and priority level of message file being displayed
   5. Date and time of last communication between the control software and the DDMS sign controller
   6. Error and warning status, including pixel errors, power failures, communication error, etc.

The graphical interface shall include the following:
   1. Configurable bitmaps that may be used to show all or parts of the system geographically
   2. Icons for each sign that may be placed anywhere on the map
   3. Icon color changes to indicate the status of the DDMS (i.e., yellow for warnings or red for errors)
   4. Icon flashes if a message is running on the DDMS
   5. Sign name is visible if mouse is placed over a DDMS icon
F. Direct Control Operations
The user interface shall provide a means for users to directly perform the following tasks for each sign:

1. Send and activate stored messages from the libraries
2. Blank the display
3. Activate an ad-hoc quick message that is created immediately, not loaded from a library
4. Send and activate schedules
5. Retrieve both messages and schedules from the sign
6. Perform diagnostics of DDMS subsystems, such as power supplies, sensors, etc.
7. Perform tests of pixels
8. Monitor the sign’s event log

G. Polling
The software shall have a feature to poll all or a set of DDMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

H. Scenarios
The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:

1. Send and activate stored messages from the libraries
2. Blank the display
3. Send and activate schedules
4. Perform diagnostics of DDMS subsystems, such as power supplies, sensors, etc.
5. Perform tests of pixels

The scenarios shall be saved to libraries where users may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

I. System Monitoring
The software shall be capable of monitoring and displaying to the user the contents of any communications in progress with DDMS. The status of all outgoing and incoming data packets will be visible.

J. Multi-Vendor Sign Control
The software shall be capable of controlling any NTCIP-compatible DDMS regardless of the manufacturer. The software shall support all mandatory and optional features typical in LED DDMS. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

K. Message Creation and Editing
A DDMS user shall be able to use the DDMS control software to create, edit, name, and store message files.

The message editor GUI shall present a scaled image of the DDMS display matrix, including a complete and accurate representation of the display matrix type (full or line) and the number of display pixels. The DDMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the user with the ability to program:

1. The number of pages that the message is to contain (shall be a minimum of three (3))
2. Message text
3. Message graphics, including pixel-by-pixel editing, lines, area fill, block move, etc.
4. Character font type(s) used to construct the message
5. The amount of inter-line spacing, measured in pixels
6. Horizontal message justification on the DDMS display matrix including left, center, and right
7. Vertical message justification on the DDMS display matrix including top, middle, and bottom
8. The type of entry effect, as “static” or “scrolling”
9. Message page on time and off time
10. Message scroll rate, if a scrolling message
11. The flash rate of all or part of a message page
12. Message priority status
13. The display status of any flashing beacons mounted to the DDMS

The message editor shall provide a method of incorporating data fields into a DDMS message. The following data fields shall be provided:

1. Time, in 12-hour format
2. Time, in 24-hour format
3. Temperature, in degrees Fahrenheit and Celsius
4. Speed, kilometers per hour and miles per hour (vehicle speed, for DDMS sites that contain speed measurement equipment)
5. Day of week (Monday, Tuesday, etc.)
6. Day of the month (1, 2, ...31)
7. Month of the year (1, 2, ...12)
8. Calendar year, in both two-digit and four-digit formats

The message editor shall provide a convenient means for the user to:

1. Insert, add, or delete, message text
2. Paste graphics from other programs using the Windows clipboard
3. Clear the content of the editing page
4. Save the message file under its existing name or a new name
5. Delete a message file
6. Save all new changes

It shall be possible to store message files in both the DDMS control computer memory and the DDMS sign controller memory.

The users shall have the ability to print any message or library of messages.

L. Message Libraries

DDMS control software shall support the creation and storage of message libraries (file directories), which allow the user to categorize message files by:

1. DDMS matrix size
2. Message subject matter

The library editor shall allow a user to:

1. Create a new library
2. Store the same message in multiple libraries
3. Select a message from an existing library and edit the message contents
4. Search message libraries for messages with specified text in message name or contents
5. Copy/Paste a message from one library to another
6. Delete a message file from a library
7. Rename a library
8. Delete a library
9. Save all new changes

M. Schedule Creation and Editing

DDMS control software shall support the creation of message schedules, which instruct the DDMS sign controller to run specific messages at pre-determined times and dates.

Software shall contain an editor, which allows messages to be scheduled via:

1. Month of the year (January, February, etc.)
2. Day of the week (Monday, Tuesday, etc.)
3. Day of the month (1, 2, ...31)
4. Time of day

The schedule editor shall provide a convenient means for the operator to:

1. Create a new schedule
2. Rename an existing schedule
3. Delete a schedule
4. Save all new changes
It shall be possible to store schedule files in both the DDMS control computer memory and the DDMS sign controller memory.

**N. Display Fonts**
The software shall support a minimum of twelve fonts for each model of DDMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of twenty-four fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DDMS model configuration.

The software shall include a font editor to allow the user to create custom fonts. The font editor shall allow the user to create new fonts or modify existing fonts. The user shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner. Any of the fonts provided by the software vendor or created/modified by the administrator shall be downloadable to the DDMS.

**O. Event Logging**
The software shall include an event logging system that logs all significant system events. Each logged event shall include the following fields at a minimum:

1. Event ID number
2. User that initiated the event
3. Time and date that the event occurred
4. Description of the event (i.e., “Diagnostic Test Performed”)
5. Source of the event (i.e., DDMS sign name)
6. Additional data relevant to the event (i.e., “Failed pixel: (4, 73)"

The events logged shall include, but not be limited to, the following:

1. User login/logout
2. Failed login attempts
3. Communication failures
4. Message and schedule activation or display blanking
5. Diagnostics test results
6. Warning events sent from the sign
7. Other system errors

The users will have the ability to view, sort by category, and print the log file at any time.

**P. System Configuration**
The DDMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:

1. Sign models and individual signs
2. Communication networks
3. System error/warning alarms
4. User security rights
5. System maps and sign icon placement
6. Default system option settings
7. Default message parameters
8. Message priority settings

**Q. Sign Configuration**
Each sign in the DDMS control software shall be configured with the following parameters:

1. Sign viewing area height and width (for full-matrix signs)
2. Number of lines and each line’s height and width (for line-matrix signs)
3. Site name
4. DDMS ID number
5. Network address
6. Communication parameters
R. Communication Settings
Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:
1. Network type (i.e., direct serial, dial-up)
2. Communication port (i.e., COM4)
3. Baud rate (ranging from 1200 to 115,200)
4. Hardware handshaking
5. NTCIP subnetwork and transport protocols
6. Communication retries and timeouts

S. System Alarms
Configurable settings shall allow the system administrator to determine which of the following events will trigger an audio and visual (on-screen) alarm:
1. Communication failure
2. Priority status conflict
3. Sign restart
4. Power supply failure
5. Door open
6. Pixel error and Pixel module failures
7. Fan status and failure

T. User Administration
The administrator shall have the ability to add, remove and modify users. The access rights of each user shall be configurable to allow or deny access to each major software feature.

U. System Maps
It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

V. Message Editor Defaults
The message editor shall automatically utilize the following default settings during the creation of new message files:
1. Pixel spacing between adjacent lines of text
2. Pixel spacing between adjacent text characters
3. Display duration of a given message page
4. Beacon activation status (for DDMS that contain flashing beacons)
5. Effect to be applied to text (i.e., static, scrolling, etc.)
6. Effect rate, which shall determine the speed of scrolling messages
7. Flash rate, which shall determine the speed of flashing messages
8. Message priority classification
9. Horizontal text justification supporting left, center, or right
10. Vertical text justification supporting top, middle, and bottom

W. Message Priorities
User-definable defaults shall allow messages to be assigned a priority classification of:
1. Emergency
2. High
3. Normal
4. Low
5. Minimal
A numeric priority range shall be assigned to each of these five priority classifications. The priority shall allow two different message files to be assigned the same classification, but within that classification, one message can be identified as having higher priority.
X. Software Use and Reproduction Rights
The DDMS manufacturer shall provide a DDMS control software site license with the DDMS supplied. Ten copies of the DDMS control software shall be provided to the Engineer on CD-ROM within thirty days of contract award. The Engineer shall have the right to request or reproduce an unlimited number of software copies for use on the DDMS system.

Y. Requirements for NTCIP Conformance
This section describes the minimum specifications for the NTCIP communication capabilities of the DDMS controller and DDMS control software. Provide all the software, firmware, and services necessary to operate a dynamic message sign (DDMS) system that fully complies with the NTCIP functional requirements, including incidental items that may have been inadvertently omitted.
1503 Dynamic Message Sign – Full Color Walk-In

ITEM Number to be determined

1503.0 GENERAL DESCRIPTION
This DMS item shall include all requirements from Section 1500 for ITEM 809E63000: DYNAMIC MESSAGE SIGN (DMS), FULL-SIZE WALK-IN, except for differences as described below

A. General Specifications. The DMS housing shall provide walk-in access for all Light Emitting Diode (LED) display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components. The DMS shall be capable of displaying full color messages using red, green, and blue LED assemblies for the pixels.

The DMS shall be able to display three rows of 18” characters with 17 characters per row. The DMS pixel pitch shall be 20mm or less to achieve high quality messaging and graphics with full color.

The DMS shall contain a full display matrix measuring a minimum of 96 rows high by 336-pixel columns wide. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

The DMS shall be capable of being controlled by an existing ODOT ATMS software platform. The manufacturer shall submit a DMS controller which has been preconfigured with the full color DMS characteristics to ODOT for testing to make sure it’s compatible.
SECTION 1600 - Fiber Optics
The following plan note is to be used only for ITS projects that occur in District 8 (ARTIMIS) of ODOT.

**1600 District 8 (ITS/ARTIMIS) Fiber Optic Cable General Note**

All specifications included in the ODOT Supplemental Specifications Section 804 & 904 shall be adhered to. Communication design elements can also be found in part 1300 of the ODOT Traffic Engineering Manual.
1601 Fiber Optic Splice Trays and Associated Cabinet Work

All specifications included in the ODOT Supplemental Specifications Section 804 & 904 shall be adhered to.
1602 Fiber Optic Termination Panel

All specifications included in the ODOT Supplemental Specifications Section 804 & 904 shall be adhered to.
SECTION 1700 - HIGHWAY ADVISORY RADIO
1700 Highway Advisory Radio (HAR)

ITEM 809E64000: HIGHWAY ADVISORY RADIO (HAR) ASSEMBLY

Permanent Highway Advisory Radio

1700.1 General Description: The Highway Advisory Radio (HAR) system shall include all equipment necessary to continually transmit and broadcast live, prerecorded, or synthesized messages.

1700.2 Materials: Materials and equipment furnished by the qualified provider shall meet all requirements in this specification.

1700.3 General: The transmitter, power supply, ground system and antenna shall all be furnished. An AM Radio receiver with its own external antenna shall also be included so that the broadcasted message can be transmitted via Ethernet through an audio output. The radio shall be field hardened to be able to withstand environmental conditions. If power is lost to the field cabinet, the radio shall restart upon regaining power and continue to be tuned into the same broadcast station without needing manual restart. The radio shall include an external audio jack. (i.e. headphone)

All components shall be modular and fit in a 19-inch rack-mounted chassis. HAR subsystems and components shall be programmable remotely and onsite via Ethernet. Proper contact protection shall be placed on all high voltage connections to prevent accidental contact with operators and operator’s tools and equipment. All of this equipment shall be placed in an ITS Cabinet, which shall be furnished under a separate Pay Item.

1700.4 Requirements

1700.4.01 Transmitter

The transmitter shall comply with the requirements of Code of Federal Regulations (CFR) Title 47, Section 90.242, “Travelers’ Information Stations”, and 47 CFR Section 2.901 et seqq. (Part 2, Subpart J), of the Federal Communications Commission (FCC) Rules and Regulations. The transmitter shall have a frequency range from 530-1700 AM. The transmitter frequency shall be set at the factory. The transmitter shall have a power efficiency of 80% or greater. The transmitter shall be adjustable from 0 to 30 watts. Transmitter RF output shall be a minimum of 20 watts. Transmitter RF output shall not exceed 10 watts while in normal use. At a distance of 1.5 km (0.93 miles), emission field strength shall not exceed 2mV/m. The transmitter module shall have audio distortion of less than 1.5% for an audio frequency response of 200 Hz to 3.5 kHz. The transmitter parameters shall be capable or local and remote monitoring. Transmitter shall be provided with a module including indicators or displays for power status, RF power output, and audio modulation level. The transmitter shall be equipped with a manually adjustable precision crystal oscillator. The transmitter shall be equipped with an audio input port. The transmitter shall accept a digital file in WAV file format. The WAV file shall be sent to the transmitter via the audio input port.

1700.4.02 Power/Voltage Standing Wave Ratio Meter

One radio frequency (RF) power/voltage standing wave ratio (VSWR) meter shall be integral or included with the transmitter. The power/VSWR meter shall have the following features and requirements:

- Meter: Displays forward RF power, reflected RF power and SWR.
- Function Switch: Selects measurement function between RF power and SWR.
- Calibration Knob: Sets RF power to full scale reading depending on transmitting RF power to measure SWR.
• Power Direction Switch: Selects RF power measurement between forward RF power and reflected RF power.

1700.4.03 Antenna Assembly: The antenna shall be a vertical center-loaded monopole, which propagates omni directional radio waves in a circular pattern. The contractor shall provide an antenna assembly with hardware and cables to pole mount the antenna. The antenna shall be mounted on a minimum thirty-foot pole (separate Pay Item). The antenna shall not exceed 49.2 feet (15.0 meters) in height from the tip of the antenna to ground level. The antenna shall be capable of being tuned to the transmission frequency either mechanically or electronically. The antenna shall be tuned to the same frequency as the transmitter. Antennas 1230 kHz and above, shall be able to withstand winds of 100 mph (161 km/h) and 80 mph (129 km/h) with 1/4 inch (6.35 mm) radial ice. Antennas below 1230 kHz, shall be able to withstand winds of 80 mph (129 km/h), 50 mph (80 km/h) with 1/4 (6.35 mm) radial ice.

1700.4.04 Grounding System: An electrolytic ground system shall be installed which includes six – 2 inch x 10 feet (50.8 mm x 3 m) copper pipes with weep holes every 6 to 8 inches (152.4 to 203.2 mm) along the length of the pipe. The pipes shall be filled with a slurry of copper sulfate and sand to increase conductivity with the surrounding soil. Three six-inch (152.4 mm) holes shall be drilled in the earth each 120 degrees apart, and approximately five feet (1.5 m), not exceeding six feet (1.8 m), from the base of the antenna mounting pole. Two pipes shall be inserted in each of the three holes with the top of each pipe being approximately six inches (152.4 mm) below grade. The hole shall be backfilled with bentonite. The bentonite backfill material shall be a natural volcanic, non-corrosive form of bentonite clay grout. The backfill material shall be capable of absorbing 53 liters of water per 23 kg to obtain optimal 30 percent solids density. The pH value shall be 8 to 10 with maximum resistivity of 3 Ω·m’s at 30 percent solids density. Each pipe shall be connected via #8 bare copper wire and terminated at the HAR electronics enclosure. All bonds below grade used in the construction of the ground plane shall be exothermically welded. All bonds above grade used the construction of the ground plane shall be mechanical.

1700.4.05 Surge Suppressor: Lightning protection shall be between the transmitter and the antenna. Transient voltage surge suppressors shall be between the HAR unit and all incoming electric signal and power lines. The transient/lightning (T/L) protection shall be provided for the power line, incoming electric signal lines, and antenna system. The T/L protection for the power line shall provide as a minimum protection the following:

| Turn-on voltage:         | 200 V                       |
| Clamping voltage:        | 340 Volts @ 20,000 Amps     |
| Peak current (minimum):  | 50,000 A                    |
| Response Time            | Voltage never to exceed 340 volts during surge |

The T/L protection for the incoming electric signal lines shall provide as a minimum protection the following:

| Clamping voltage:        | 200 V ±10%                  |
| Current Surge Max.:      | 36,000 Amps                 |
| Series resistance (max.):| 30 Ω                        |
| Response time (maximum): | 2 ns                        |

The T/L (lightning arrester) protection for the antenna system shall provide as a minimum protection the following:

| Clamping voltage:        | 40 to 90 V ±10%             |
| RF power (minimum):      | 40 W                        |
1700.4.06 Control Cabinet: The contractor shall provide an ITS Cabinet (per ODOT specification) for housing the transmitter, which shall be furnished under a separate Pay Item.

1700.4.07 Performance Requirements: The HAR system shall provide system failure remote alarms and indicates system status in the user interface.

1700.4.08 Environmental Specifications: The HAR system installed at the field site shall be able to withstand temperatures between -30° and 165° Fahrenheit (F) [-34° and 74° Celsius (C)] as per the NEMA TS 2 standard at 95% noncondensing humidity.

1700.4.09 FCC Licensing: The contractor shall provide all services to prepare an FCC license application package for the Highway Advisory Radio system in accordance with FCC Rules & Regulations Part/Section 90.242.

1700.4.10 Installation Requirements: The Contractor shall furnish all tools, equipment, materials, supplies, and manufactured hardware, and perform all operations and equipment integration necessary to provide a complete, fully operational HAR system as shown in the plans. All HAR equipment shall be installed according to the manufacturer’s recommendations or as directed by the Engineer.

1700.5 Testing: The following tests shall be performed on the HAR, after all equipment has been installed and initial adjustment is complete at the field site.

1700.5.01 Ground Plane Resistivity: Conduct ground plane resistivity measurements to verify efficiency desired. The testing shall utilize an earth resistance meter and be conducted in accordance with IEEE Standard 3-point fall of potential method. The Contractor shall provide all test equipment, take and document resistivity measurements on the grounding system as specified elsewhere in these special provisions and submit them to the Engineer for approval.

1700.5.02 Transmitter: Perform field measurements to verify compliance with Title 47 CFR Part 90.242. The Contractor shall tune the HAR with the impedance matching network of the coupling unit by adjusting the stainless-steel tip of the antenna. The HAR shall be considered tuned when the system's voltage standing wave ratio (VSWR) is at the lowest possible value as directed by the Engineer. After the HAR has been tuned, the Contractor shall record and transmit a test message with the output power level of the transmitter set at approximate 10 W or lower. Modulation shall be adjusted between 85 to 95 percent as specified by the FCC for the standard AM broadcast band. The Contractor shall make actual on-the-air field strength measurements. A sufficient number of points shall be selected in order to determine the distance at which the attenuated field of 2 mV/m exists, as measured with a calibrated standard field strength meter. This may be done in 5 to 8 radial directions facilitating a plot of a 2 mV/m at a distance of 1.5 km from the HAR antenna. If the measured field exceeds 2 mV/m at a distance of 1.5 km, the transmitter output power shall be decreased accordingly and if the measured field is less than 2 mV/m at the same distance then the power may be increased as directed by the Engineer. At the completion of all HAR testing, the Contractor shall submit a written report of all measurements to the Engineer for approval. The report shall include a map, with scale, showing a 2 mV/m contour based on the actual on-the-air field strength measurements. The VSWR percent modulation and transmitter output power measurements shall be tabulated.
1700.5.03 System Tests: Conduct approved HAR system tests on at least one HAR system, including the operations center, and one transmitter. Perform, at a minimum, all remote-control functions. The AM Radio shall be tested to be able to hear the live audio broadcast from the operations center. Testing of the live audio broadcast shall be performed with the cabinet door closed, to simulate a normal field condition. Complete approved data forms and turn them over to the Engineer for review, and as a basis for rejection or acceptance. If the system test fails because of any subsystem component, correct that component or substitute another in its place, then repeat the test. If a component has been modified as a result of a system test failure, prepare a report and deliver it to the Engineer prior to retesting.

1700.6 Method Of Measurement
Measurement will be made as a HAR site defined above and as follows:

1700.7 Basis Of Payment
The payment for this item will be made for the accepted number of quantities at the contract unit price.
1701 Highway Advisory Radio (HAR) – Flashing Beacon System

ITEM 809E64010: HIGHWAY ADVISORY RADIO (HAR) FLASHING BEACON SYSTEM

1701.1 General Description

This specification sets forth the minimum requirements for a Highway Advisory Radio Flashing Beacon System utilizing an Ethernet-based controller providing closed loop feedback. ODOT will establish the network communications to the modem.

The beacon system shall consist of the following components:
- 1 each cellular modem with digital output capability
- 1 each power regulating printed circuit board with enclosure
- 1 each flasher controller
- 1 each DIN mounted 12VDC relay
- 1 each DIN mounted fuse holder and fuse
- 1 each DIN mounted wire terminal assembly cable of handling 12 wire connections
- 1 each solar charge controller, 15 amp minimum
- 1 each local control switch
- 1 each enclosure, aluminum, NEMA 4X, sized to fit all components
- 2 each 92 Ahr GEL batteries designed for use in a solar power system
- 4 each battery cables with soldered ring terminals
- 2 each beacon cables
- 2 each 12” L.E.D. beacon assemblies including lens, polycarbonate housing, aluminum visors, mounting arms, and pole plates
- 1 each 80-watt solar panel
- 1 each solar panel mounting bracket
- 1 each solar panel cable

1701.2 Requirements

Highway Advisory Radio Flashing Beacon System with Ethernet Based Controller (HARFBCS)

A. The HARFBCS system shall allow network control of flashing beacon assembly(ies) and provide “closed loop” feedback to the central control software.
B. The HARFBCS system shall use a digital output to control a relay which will provide 12VDC to the flasher controller
C. The HARFBCS shall have a local ON/OFF switch for manual control and testing of the beacons while onsite.
D. The HARFBCS shall include a solar power charging system including a solar array, batteries and solar charge controller.
E. The HARFBCS shall include a single cabinet which sized to house the Beacon Controller, a network device (Cell modem or Ethernet switch), solar charge controller, flasher unit, DIN rail assembly, relay, fuse holder with fuse, batteries and cables.

1701.3 Components

1701.3.1 Ethernet Based Beacon Controller

A. The ethernet based controller shall have the capability to provide a digital output when prompted from the central control software
B. The ethernet based controller shall be “ruggedized” with an operating temperature range of -40°C to +75°C and a humidity range of 5% to 95% non-condensing
C. The ethernet based controller shall have a following certifications: EMC: FCC, part 15 and Industry Canada, ICES-003; Hazardous Locations: Class I, Div. 2, Groups A, B, C, D, UL1604; Electrical Safety: UL508/CSA22.2/14 (CUL)

D. The ethernet based controller shall operate in 8 – 30 Vdc (12Vdc nominal)

E. The ethernet based controller shall have the following Inputs and Outputs: 1 each RESET button, 1 each digital Input, 1 each digital Output

F. The ethernet based controller shall have the following LED Status Indicators: Power, Ethernet Link, and Activity

G. The ethernet based controller shall have 1 each RJ45 Ethernet Port 10/100 auto-sensing

H. Provide a controller that is compatible with ODOT’s current software system and meets all ODOT specifications for traffic signal and ITS equipment.

1701.3.2 Flasher Unit
A. The flasher unit shall operate using 11.4 – 30 Vdc
B. The flasher unit shall be designed using solid state circuitry
C. The flasher unit shall provide for 1 or 2 circuit flashing
D. The flasher unit shall a duty cycle of 40% ON/60% OFF (1 Beacon) or 50% ON/OFF (2 Beacons)
E. The flasher unit shall have a user programmable flash rate of 35-70 flashes per minute
F. The flasher unit shall have an operating temperature range of -20°C to +75°C

1701.3.3 Relay
A. The relay shall be a solid-state relay (SSR)
B. The relay shall be capable of being mounted on a DIN rail or BUS Bar
C. The relay shall operate using 12Vdc
D. The relay shall be designed as to allow the replacement of just the relay circuit while leaving the base in place
E. The relay shall have an operating temperature range of -20°C to +60°C
F. The relay shall be UL Listed

1701.3.4 Fuse and Fuse Holder
A. The fuse holder shall be a DIN mounted design and accommodate Class M fuses
B. The fuse shall be placed to protect the internal electronics of the CBFBC from the 12Vdc load from the battery
C. The fuse holder shall include a TouchSafe Design IEC Type IP2 design
D. The fuse shall be a Class M Midget 2-amp fuse

1701.3.5 DIN Rail Assembly
A. The DIN rail assembly shall consist of a minimum of 8 each “feed-thru” wire termination modules, two end stop modules and a 35mm DIN rail section
B. The DIN rail section shall be sized to accommodate the above modules as well as the fuse holder and relay

1701.3.6 Solar Charge Controller
A. The solar charge controller shall be rated at a minimum of 15 amps.
B. The solar charge controller shall operate on 12- or 24-volts DC
C. The solar charge controller shall utilize Low Voltage Disconnect (LVD) technology
D. The solar charge controller shall include a digital display meter displaying battery voltage, solar input voltage, and load current
E. The solar charge controller shall include a three-position battery selection switch including gel, sealed, or flooded
F. The solar charge controller shall be 100% solid state
G. The solar charge controller shall include the following electronic protections: short-circuit, overload, reverse polarity, reverse current at night, high voltage disconnect, high temperature disconnect, lightning and transient surge protection, loads protected from voltage spikes, and automatic recovery from all protections

1701.3.7 Battery
A. The battery(ies) shall be GEL type and designed for renewable energy applications
B. The battery bank shall have a minimum rating of 180-amp hours
C. The battery(ies) shall be a sealed construction and be “Non-Spillable” as defined by both the DOT and ICAO
D. The battery(ies) shall include handles
E. The battery(ies) shall have offset post with horizontal hole for 5/16 bolt

1701.3.8 Solar Module
A. The solar module shall have a minimum rating of 80 watts
B. The solar module shall be Polycrystalline silicon
C. The solar module shall have 36 cells in a series configuration
D. The solar module shall have a maximum power voltage of 17.3V
E. The solar module shall have a maximum size of 22” x 48” x 2.2”
F. The solar module shall have an integrated junction box to house all output terminals
G. The solar module shall be UL Listed 1703 and have a fire rating of Class C
H. Solar Module Mounting Bracket
I. The solar module mounting bracket shall be sized to fit the supplied solar module
J. The solar module mounting bracket shall be manufactured from aluminum or powder coated steel
K. The solar module mounting bracket shall be designed as to allow the installer to adjust the angle of the solar panel

1701.3.9 Enclosure
A. The enclosure shall be sized to house Beacon Controller, a network device (Cell modem or Ethernet switch), solar charge controller, flasher unit, DIN rail assembly, relay, fuse holder with fuse, batteries and cables.
B. The enclosure shall be aluminum and have a rating of NEMA 3R with ventilation
C. The enclosure shall be designed to house the battery(ies) in the lower section and the sub-panel with electronics in the upper section. Easy access shall be obtained by an easily removable lift off shelf separating the lower and upper sections of the cabinet. The enclosure shall include a back panel in which some of the equipment shall be capable of mounting.
D. The enclosure shall include a 3-point latch locking system with lever and Corbin #2 lock
E. The enclosure shall be a minimum of 30”H x 18”W x 15”D
F. The enclosure shall have a washable, reusable, louvered air vent with filter-retaining brackets and a washable re-useable filter element. One replacement filter of the same type shall also be supplied.
1701.3.10 L.E.D. Lens, 12”
A. The LED lens shall be amber in color
B. The LED lens shall have a typical power consumption of 5 watts
C. The LED lens shall have an operating voltage of 11-13VDC
D. The LED lens shall have an operation temperature range of -40°F to 165°F
E. The LED lens shall have a UV stabilized face
F. The LED lens shall be FCC Title 47 compliant
G. The LED lens shall meet MIL-STD-883 mechanical vibration standards
H. The LED lens shall meet MIL-STD-810F moisture resistance standards

1701.3.11 Beacon Housing and Support Arm Assembly (BHSA)
A. The beacon housing shall be polycarbonate in material and yellow in color
B. The beacon housing shall include the capacity to hold one (1) 12” L.E.D. lens with four (4) screw type mounting latches
C. The beacon housing shall include a minimum 8 position wire terminal
D. The beacon housing shall include a “tunnel” type aluminum visor, yellow in color
E. The support arms and pole plates (side of pole framework) shall be die cast aluminum and painted yellow
F. The pole plates shall be designed to have a flat mounting surface sufficient to mount to “I” beam structures
G. The pole plates shall have one (1) threaded hole for attaching to the side of pole framework pipe and one (1) ½” hole for attaching a watertight cable fitting
H. The side of pole framework shall be a minimum of 10.5” and include a 90° elbow for attaching to the beacon housing
I. The elbow shall include a rubber gasket and locking ring to create a watertight seal on the top side of the beacon housing
J. Each beacon housing shall have a side of pole assembly on the top and bottom

1701.3.12 Assembly
A. The supplier shall mount all components on a single aluminum or stainless-steel back panel
B. The supplier shall use the DIN rail assembly for all contractor supplied contacts, excluding the battery connections. All wire connections past the DIN rail assembly shall be made by the supplier prior to shipment.
C. All entrance points to the cabinets shall be installed using watertight fittings and then a bead of silicone applied to ensure a watertight seal.
D. All wire terminals and cables shall be numerically labeled and provided on a detailed wiring diagram.

1701.4 Maintenance/Spare Parts
The supplier shall maintain an adequate inventory of parts to support maintenance and repair of all systems under warranty or extended warranty agreement.

1701.5 Payment
Payment shall be bid per each unit, complete, installed in place fully functional including all wiring, components, harnesses, brackets, banding and all other items as specified herein.
SECTION 1800 - CABINETS
1800 ITS GROUND MOUNTED CABINET

ITEM 809E65000: ITS CABINET - GROUND MOUNTED

1800.0 GENERAL DESCRIPTION
The cabinet shall be a standard 334 Traffic Controller Cabinet per ODOT 2019 Construction and Materials Specification 733.03 and shall conform to the additional below specifications. In cases where the below specification conflicts with the ODOT 2019 Construction and Materials Specification 733.03, the below specification shall take precedence. The Power Distribution Assembly PDA-3 module requirement shall be removed from this specification.

Field cabinets shall be designed and furnished to house any combination of the following communications equipment or interface equipment to the following field devices:
- Closed Circuit Television (CCTV) Camera
- Changeable Message Sign (DMS)
- Highway Advisory Radio (HAR)
- Managed edge Ethernet switch
- Ethernet hub switch
- Non-intrusive microwave detection system
- Device server
- Uninterruptible power supply (UPS)
- Video encoder

Furnish and install a ground mounted cabinet with 12-inch cabinet riser on standard cabinet foundation with a 19-inch (480-mm) rack frame assembly at specified sites as shown on the plans. The GROUND mounted Cabinets shall be installed as shown on the plans.

Cabinets shall be ground mounted. All cabinets shall be provided with: dedicated space for future addition of fiber optic patch panel 36 inches from the top of cabinet riser with minimum dimension of 17 (W) x 14 (H) x 8 (D) in; grounding buss bar; 19-inch (480-mm) rack system for mounting of all devices in the cabinet; door-activated LED light bars mounted at the top (rear and front) of cabinet in a way that no cabinet rack space is used for lighting (minimum 12 inches in length, minimum 110 degree beam angle, cool white, minimum 300 lumens per unit, on/off switch, maximum 0.75 inches in width, 24 volt); pull-out shelf/drawer for laptop and maintenance use; ventilation fans; 120 volts alternating current (VAC) power supply; 120 VAC ground fault interrupted (GFI) protected duplex outlets for tools. All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to ODOT’s network switch. The cabinets shall be sized to ensure ease of access to equipment and provided with proper ventilation to maintain an internal operating environment that does not exceed the environmental operating ranges for devices placed within the cabinet. Furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, provisions, and requirements before the system is considered for acceptance. Each cabinet assembly shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling. The cabinet interior shall be completely insulated per this specification.

1800.1 MATERIALS
Materials and equipment furnished by the qualified provider shall meet all requirements in this provision. Equipment supplied shall be a standard production model; prototype equipment will not be acceptable. All equipment shall be warranted against defects and any failures which may occur through normal use for a minimum of five years from the date of successful completion of the equipment’s system test.
1800.2 GENERAL
The cabinets shall be complete with a prefabricated cabinet shell, and all internal components and equipment, back and side panels, front and back doors, terminal strips, cabling and harnesses, cable management, surge protection for power and communication circuits, power distribution blocks or assemblies, shelves, connectors and all mounting hardware necessary for installation of equipment. The cabinets shall be completely weatherproof to prevent the entry of water. The cabinet top shall be crowned 1/2 inch (13 mm) or slanted to the rear to prevent standing water.

1800.3 REQUIREMENTS

1800.3.1 Construction
The cabinet shall have minimum dimensions: 67 in H x 24 in W x 30 in D. The cabinet and doors shall be fabricated of 0.125-inch (3.2-mm) minimum thickness aluminum. All exterior seams for the cabinets and doors shall be continuously welded. Exterior welds shall be ground smooth. Edges shall be filed to a radius of 0.03-inch (0.76-mm), minimum.

1800.3.2 Locks
When the door is closed and latched, the door shall be locked. The handle shall have a minimum length of 7 inches (180 mm) and shall be provided with a 5/8-inch (16-mm), minimum, steel shank. The handle shall be fabricated of cast aluminum, stainless steel, or of zinc-plated or cadmium-plated steel. Cabinet locks shall be the solid brass and keyed to the ODOT master key Corbin Number 2, 6-pin tumbler rim type. The lock shall have rectangular, spring-loaded bolts. The locks shall be left hand, and rigidly mounted with stainless steel machine screws approximately 2 inches diagonally apart. The cabinet doors shall also be pad lockable. Keys shall be removable in the locked and unlocked positions, and two keys furnished with each cabinet. The front position of the lock shall extend 1/8 inch (3.2 mm) to 3/8 inch (9.5 mm) beyond the outside surface of the door.

1800.3.3 Doors
All cabinets shall have two full-size doors. GROUND mounted cabinets shall be designed so mounting brackets can be installed on the side so both doors are fully functional. The doors shall be provided a full-length stainless-steel piano or butt style hinge, with stainless steel pins spot-welded at the top. The hinges shall be mounted so that they cannot be removed from the door or cabinet without first opening the door. The door and hinges shall be braced to withstand a 100-pound per vertical foot (149 kg/m) of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. The door opening shall be double flanged on all four sides. Doorstops shall be included at 90 and 120-degree positions. The catches shall be 3/8-inch (9.5 mm) diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90 degrees in a 60 mph (96.5 km/h) wind at an angle perpendicular to the plane of the door. Both the door and the doorstop mechanism shall be of sufficient strength to withstand a simulated wind load of 5 pounds per square foot (24.4 kg/m²) of door area applied to both the inside and outside surfaces without failure, permanent deformation, or compromising of door position and normal operation. The cabinet door frame shall be designed so that the latching mechanism will hold tension on and form a firm seal between door gasket and door frame. The latching mechanism shall be a 3-point cabinet latch with nylon rollers. The center catch and pushrods shall be 6061 aluminum, or zinc-plated or cadmium-plated steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 x 3/4 in, (6.4 x 19 mm) minimum. The nylon rollers shall have a minimum diameter of 3/4 inch (19 mm) and shall be equipped with ball bearings. The doors shall be manufactured so that all internal components (locking mechanism, filter brackets, etc.) are welded to the door. (Nothing shall be fastened to the inside of either door by the method of inserting a bolt through the door.)

1800.3.4 Gaskets
Ensure that cabinet doors include a gasket to provide a dust and weather-resistant seal when closed. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging and shall ensure a
uniform dust and weather resistant seal around the entire door facing. Gasket shall be provided on all door openings and shall be dust-tight. Gaskets shall be permanently bonded to the metal. The mating surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating surface. All overlapping exterior seams and doors shall meet the requirements for Type 4 enclosures in the National Electrical Manufacturers Association (NEMA) enclosure standards.

**1800.3.5 Mounting**

All ground mounted cabinets shall include all necessary components required for secure connection to the foundation and riser including but not limited to the any mounting brackets and mounting hardware. 12-inch risers shall be included. The risers shall have a rodent proof vent that will allow any water to escape that may enter the cabinet.

**1800.3.6 Shelves**

Two substantial metal shelves shall be provided to support equipment at the middle of the 19-inch rack just above the power receptacles and circuit breakers. Machine screws and bolts shall not protrude beyond the outside wall of the cabinet. The shelves shall not require more than 2U of rack space.

**1800.3.7 Coating**

All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from general appearance. All cadmium plating shall conform to the requirements in Military Specification MIL-QQ-416b. All zinc plating shall conform to the requirements in Military Specification MIL-QQ-325b.

**1800.3.8 Ventilation**

Cabinets shall be provided with vent openings in the front door to allow convection cooling of electronic components. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per min (2.8 m³/min). The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 89.6 °F (32 °C) and 149 °F (65 °C) with a differential of not more than 10.8 °F (6 °C) between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the amperage of the fan motor installed. The manual adjustment shall be graded in 18 °F (10 °C) increments. The vent opening shall be located on the lower portion of the cabinet door and shall be covered fully on the inside with a commercially available filter. Removable air filter shall be housed behind the door vents. The filter shall be removeable, washable, and re-useable and a spare filter of the same type shall be provided per each filter in use on the cabinet. The filter filtration area shall cover the vent opening area. A filter shell shall be provided that fits over the filter, providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent over a minimum of 0.26 inches (6 mm) to house the filter. The filter and shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed to create a waterproof sump with drain holes to the outside housing. The filter shall trap particles 2 microns and larger.

**1800.3.9 Wiring**

Conductors used in cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mil (254µm) and shall be nylon jacketed polyvinyl chloride or shall be irradiated cross-link polyvinyl chloride, polyhalocarbon or polychloro-alkene, except that, at the Contractor’s option, conductors No. 14 and larger may be Underwriters Laboratories Incorporated (UL) Type Thermoplastic High Heat Resistant Nylon Coated (THHN). Conductor insulation shall be rated at 300 Volts (V) and shall be rated for use at 221 °F (105 °C). Cables shall be provided with strain relief. Wiring within cabinets shall be neatly arranged and laced or enclosed in plastic tubing or raceway. Conductors used in cabinet wiring shall conform to the following color-code requirements:

A: The grounded conductor of a circuit shall be identified by a continuous white or natural gray color.
B: The equipment grounding conductor shall be identified by a continuous green color or by a continuous green color with one or more yellow stripes.

C: The ungrounded conductors shall be identified by any color not specified in A or B above.

Conductors used in cabinet wiring shall terminate with properly sized captive or spring spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. Crimp-style connectors shall be applied with a proper tool which prevents opening of the handles until the crimp is completed. Equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet and shall be connected to the metal conduit system or other approved ground with a Number 8, or larger, grounding conductor. With all the cabinet equipment in place and connected, the resistance between the grounded conductor terminal bus and the equipment grounding conductor bus shall be 50 MegaOhms, minimum, when measured with an applied voltage of 150 volts-direct current (VDC). If direct current (DC) is to be grounded, it shall be connected to equipment ground only. Two or more terminal blocks shall be provided for field connections. Field terminals shall be installed within 22 inches (560 mm) of the face of the cabinet and shall be oriented for screwdriver operation from the door opening. All terminals shall be a minimum of 5 inches (127 mm) above the foundation. No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

Field connection shall be made for the conductors of signal cable, power cable, interconnect cable and wireless cable. Conductors shall be connected so the outgoing circuits shall be of the same polarity as the line side of the power supply. The circuit common return shall be of the same polarity as the ground side of the power supply. The grounded side of the power supply shall be grounded to the cabinet in an approved manner. All field wiring shall be neatly arranged and routed to the appropriate terminal blocks. Field wiring shall be identified in accordance with section 713.18 except that marking may be by indelible pen instead of embossed letters.

Field wiring entering the cabinet except power wiring shall be fitted with spade terminals to assure a good connection. Incoming power wiring may use space terminals; or the bare conductor wire may be connected to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completion of field wiring, the conduit entering the cabinet shall be completely sealed in an approved manner with a removable sealing compound or a molded plastic or rubber device, which is compatible with the cable jacket, the insulation and the conduit material.

1800.3.10 Labels
A permanent printed, engraved or silk-screened label shall be provided for all removable items of equipment; such as, receptacles for relays, switching devices, switches, fuses, and circuit breakers. Labels shall conform to the designations on the cabinet wiring diagram. Labels for all shelf-mounted equipment shall be on the face of the shelf below the item. Labels for wall-mounted equipment shall be below the item. All equipment in the cabinet, when required, shall be permanently and clearly labeled.

1800.3.11 Power Unit
A rack mounted power unit shall be mounted in the bottom front of the cabinet. The power unit shall contain the following requirements:

- Maximum Dimensions: 17 inches (W) x 7 inches (H) x 8 inches (D)
- Equipment Receptacle:
  - Shall be mounted on the rear of the power unit
  - Equipment receptacles shall be duplex, 3-prong, NEMA Type 5-20R grounding type outlet and shall conform to the requirements in UL Standard 943.
- Field Personnel Testing Outlet
  - One GFCI receptacle outlet on right front
- Surge Suppression:
• Shall be installed so that any LED indicators can be easily seen, and the unit can be easily replaced.
• Mounted on right front of unit with the following specifications
  o 100 kA per phase rating
  o 120 Single Phase
  o UL 1449 Listed
  o < 1 nanosecond response time
  o Normal Operating Temperature: -40 to +55 Celsius
  o Peak Operating Temperature: 80 Celsius
  o Maximum Dimensions: 8 inches (W) x 4 inches (H) x 4 inches (D)

- 3 Circuit Breakers mounted on left front of unit (1-50 AMP & 2-20 AMP)
  o Circuit breakers shall have a minimum interrupting capacity of 5000 A, root mean square (RMS).
  o The 50 AMP breaker (CB1) shall be the main breaker of the cabinet. Incoming power shall be wired through the following path:
  o One 20 AMP breaker (CB2) shall be utilized for all cabinet equipment.
  o One 20 AMP breaker (CB3) shall be utilized for the GFCI, LED lighting, and cabinet fans.
  o The Surge Suppression shall be wired to encompass both 20 AMP breakers.
  o The Noise Filter shall be wired to only encompass the equipment outlet.

- Power Distribution Blocks
  A Power Distribution Block shall be provided for the main power entering the cabinet. The power distribution block shall have the following minimum requirements:
  o Current Rating – 175 Amps
  o Voltage Rating – 600 Volts
  o 3 Pole
  o Primary Wire Range – 14 – 2 AWG Copper
  o Secondary Wire Range – 14 – 4 AWG Copper
  o Shall be equipped with a touch safe cover

A separate low voltage distribution unit shall also be incidental to the price of the cabinet for the purpose of remote management of 12VDC, 24VDC, 48 VDC, and 24 VAC power outputs. This unit shall be 19-inch rack-mountable and shall allow for remote management of a minimum of 5 separate DC power sources and one 24 VAC power source. There shall be a minimum of 3 alarm contact closure inputs, that when triggered will send an email to a user defined address. The unit shall also monitor the output states of all the power outputs.

1800.3.12 Terminal Blocks
Terminal blocks shall be rated 600 VAC, minimum, and shall be provided with nickel, silver or cadmium plated brass binder head screw terminals. Heavy duty terminal blocks shall be rated at 20 A and shall be provided with twelve poles with Number 10 x 5/16 in (250 x 7.9 mm) nickel plated brass binder head screws and nickel-plated brass inserts. Each pole position shall be provided with two terminal positions. The terminal blocks shall be the barrier type, with shorting bars in each of the twelve positions, and shall be provided with integral type marking strips. Light duty terminal blocks shall be rated at 5 A and shall be provided with twelve poles with Number 6 x 1/8 in (150 x 3.2 mm) binder head screws. Each pole position shall be provided with one terminal position. All terminal blocks shall be fitted with associated clear safety covers to protect against accident contact.

1800.3.13 Pullout Drawer Assembly
A pullout drawer shall be installed in the cabinet cage. The drawer shall be 16.92 inches (430 mm) long by 16.92 inches (430 mm) wide by 1.73 inches (44 mm) deep. It shall have a hinged top that covers the storage box area and also provides a smooth surface to write on. The top of the storage compartment shall be aluminum. The drawer shall be General Devices D4080-19W (or equal). The compartment shall have ball bearing telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartment shall open to provide storage space for cabinet documentation and other miscellaneous items. The storage compartment shall be of adequate
construction to support a weight of 20 pounds (9 kg) when extended without sagging. A plastic envelope with re-sealable opening shall be in each drawer to provide protection for cabinet and site detailed drawings. The size of the envelopes shall be big enough to accommodate the above drawings.

1800.3.14 Door Switches
All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to the AC Power Distribution Unit. The gauge of the wire connected to the switches shall be 16 AWG and a length of 5 feet to connect to the AC Power Distribution Unit as contact inputs to trigger SNMP notifications. Cartridge fuses shall be installed in panel mounted fuse holders. Fuse type and rating shall be as recommended by the fuse manufacturer for the type of load being protected.

1800.3.16 AC Power Distribution Unit
The cabinet shall include a managed power distribution unit with the following requirements to include cabinet monitoring functions:

- Shall be capable of remotely control individual outlets to reboot equipment remotely.
- Shall have a minimum of 8 – 120 VAC, 12 AMP outlets, 6 optically isolated inputs, 3 relay contacts of at least 10A at 120 VAC, and 1 analog input of up to 60 VDC.
- Shall have aCurrent (A) monitoring digital display.
- Shall have an Ethernet port, web-based GUI interface, and be capable of the following network protocols at a minimum:
  - IP, HTTP, NTP date/time, SNMP notifications, System Logging
  - The unit shall have password protection software/firmware shall be remotely upgradeable
- Shall have a temperature sensor and input for monitoring
- Shall be scrapable of scheduling reboots/resets of individual outlets and relay contacts on a once, daily, weekly, or monthly basis.
- Shall be able to send SNMP notifications individually for each outlet, input, relay, and temperature threshold

1800.3.17 Low Voltage Power Distribution Unit
The cabinet shall include a managed power distribution unit with the following requirements:

- Shall include one 12 VDC (2 - 1.0 AMP outputs)
- Shall include one 24 VDC (2 – 2.0 AMP outputs)
- Shall include one 48 VDC (2 – 2.0 AMP outputs)
- Shall include one 24 VAC transformer with minimum 96 VA power rating (1 – 4.0 AMP output)
- Shall be capable of remotely controlling individual 12VDC, 24 VDC, 48 VDC, and 24 VAC power supplies via the AC Power Distribution Unit.
- The maximum dimensions of this unit are 17 inches (W) x 7 inches (H) x 8 inches (D)
- This shall be an all-in-one enclosed unit which shall be 19” rack mounted.
- The circuit breakers and terminal block outputs should all be located on the front side of unit for easy access for wiring. The only means of overcurrent protection shall be accessible from the front side of the panel and there shall not be any internal breakers or fuses on the inside of the unit which would require disassembly to access.

1800.3.18 Network Device DIN Rail
The cabinet shall include a rack mount DIN Rail unit for mounting a Cisco IE3000-8TC network switch with Cisco IEM-3000-4SM Expansion Module. The DIN Rail shall be recessed and shall have access holes for network cabling on each side of the panel as well as cable management panels at the top of the cabinet front and back. The access holes shall have grommets installed to protect the cables from wearing on bare metal. The dimensions shall be approximately 17 inches (W) x 8 inches (H) x 10 inches (D) and shall have a louvered bottom to act as a shelf when IE3000 switches are not utilized. The center of the din rail strip shall be installed at a height of 4.5 inches above the bottom of the shelf so the network switch can fit in the location correctly.
1800.3.19 Generator Power Panel
The cabinet shall include a generator power panel per ODOT Plan Insert Sheet (PIS #203011).

1800.3.20 Device Locations
- **Power Unit** - A rack mounted power unit shall be mounted in the bottom front of the cabinet.
- **AC Power Distribution Unit** – The unit shall be mounted in the front of the cabinet directly above the Power Unit, not to exceed one rack unit of space and shall be mounted so that the bottom of the unit does not exceed a height of 25 inches from the foundation (Including a 12-inch cabinet riser).
- **Pull-Out Drawer** – the drawer shall be mounted to open to the rear of the cabinet at a height of approximately 38 inches from the foundation (including a 12-inch riser). An empty area of 7U shall be directly above the Pull-Out drawer and below the Network Device Din Rail unit. This empty space will be used to install a fiber termination panel if needed.
- **Shelves** – One shelf shall be included and shall be mounted in the following location:
  - Below the bottom of the Pull-Out Drawer with 3U of empty space between them
- **Network Device Din Rail** – This unit shall be mounted in the top front side of the cabinet, 7U above the top of the Pull-Out Drawer. There shall be 2U of empty space between the top of this unit and the lamp assembly which is mounted at the very top of the rack.
- **Low Voltage Power Distribution Unit** – This unit shall mount in the top back side of the cabinet, directly behind the Network Device Din Rail unit. There shall be enough space to connect wires easily to the outputs.
- **Generator Power Panel** – This panel shall be mounted in a manner so that it does not interfere with the placement of the other devices.

1800.3.21 Connectors
Connectors used for interconnecting various portions of circuits together shall be designed and constructed for the application involved. Connectors shall be designed to provide positive connection of all circuits, and easy insertion and removal of mating contacts. Connectors shall be permanently keyed to prevent improper connection of circuits. Connectors, or devices plugging into connectors, shall be provided with positive means to prevent any individual circuit from being broken due to vibration, pull on connecting cable or similar disruptive force.

1800.3.22 Cable Management
The cabinet shall include vertical plastic cable management strips on all 4 sides of the rack in order to organize and easily route power or communication cabling between devices within the cabinet. The cable management system shall easily allow for new cabling to be input and routed within the cabinet to new devices which are installed at a later time. The strips shall be positioned so that they do not interfere with the door operation opening/closing and so they don’t block the rack screw holes and it’s easy to install new devices into the 19” rack without removing the cable management strips. There shall not be any horizontal cable management strips.

1800.3.23 Conduits Entering Foundation
There shall be a total of 4 conduits entering the foundation. This includes two 4-inch Schedule 40 multicell conduits to be connected to 36-inch communications “TRAFFIC” pull box, one 2-inch Schedule 40 conduit to be connected to the 18-inch power “ELECTRIC” pull box, and one 3/4-inch galvanized steel conduit to be connected to the ground rod. The cost of these conduits shall be incidental to the cost of the ITS cabinet. It shall be the Contractor’s responsibility to place both the “ELECTRIC” and “TRAFFIC” pull boxes in locations as identified in the plans so as to get an accurate quantity of conduit to provide on a per site basis.

1800.3.24 Workpads
Work pads shall be installed per ODOT CMS 633.11 and shall be incidental to the price of the cabinet.
1800.4 ENVIRONMENTAL
The components such as surge suppressors and power distribution shall operate properly within the ambient temperature limits of 0 °F (-17.8 °C) to 120 °F (48.9 °C) and meet the ambient temperature range, relative humidity, applied power, shock and vibration range of NEMA TS-2.

1800.5 TESTING
General: Subject the equipment covered by these provisions to design approval test (DAT) and factory approval tests (FATs). The Department reserves the right to witness all FATs. Complete the tests within five calendar days. Ensure that the test plans demonstrate each and every feature available in the device or system under test and includes the tests discussed below. The Department will evaluate material and devices purchased under this contract to verify compliance with provisions and determine suitability for use. Sample material and devices must be submitted at no additional cost to the Department for evaluation and will be retained for operational testing as long as the material or device is approved for use.

DAT and FAT: Develop and submit a test plan for DAT's and FAT's to the Department for consideration and approval. The Department may accept certification by an independent testing laboratory in lieu of the DAT's to satisfy the requirement that certain features and functions have been witnessed and documented as performing satisfactorily. Arrange for and conduct the tests and is responsible for satisfying all inspection requirements prior to submission for the Department's inspection and acceptance. The Department reserves the right to witness all DAT’s and FAT’s. Complete the tests within five calendar days.

Transient, Temperature, Voltage, and Humidity Testing: The selected manufacturer will provide one cabinet of each type for testing and evaluation purposes at no cost to the Department. The units shall be tested and evaluated as indicated below. The Traffic operations Research Laboratory (TERL) will review the proposed products for compliance of the test procedures as noted within Section 2.2.7 of the NEMA TS 2-1998 standard and shall include the following tests:
- Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.
- Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).
- Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.
- Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.
- Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.
- Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.
- Test G: Test Termination (All Tests).
- Test H: Appraisal of Equipment under Test.

1800.6 METHOD OF MEASUREMENT
Measurement will be made as an ITS cabinet as defined above and as follows:
- ITEM 809E65000: ITS CABINET - GROUND MOUNTED furnished and installed in place, complete and accepted by the ENGINEER, including conduit and work pads as specified.

1800.7 BASIS OF PAYMENT
The payment for this item will be made for the accepted number of quantities at the contract unit price.

UNIT OF PAYMENT
Each
1801 ITS POLE MOUNTED CABINET

ITEM 809E65010: ITS CABINET - POLE MOUNTED

1801.0 GENERAL DESCRIPTION

Field cabinets shall be designed and furnished to house any combination of the following communications equipment or interface equipment to the following field devices:

- Closed Circuit Television (CCTV) Camera, Provision 2.0
- Changeable Message Sign (DMS), Provision 1.0
- Highway Advisory Radio (HAR), Provision 4.0
- Managed edge Ethernet switch
- Ethernet hub switch
- Non-intrusive microwave detection system
- Device server
- Uninterruptible power supply (UPS)
- Video encoder

Furnish and install a pole mounted cabinet 30 inches (762 mm) above the foundation with a 19-inch (480-mm) rack frame assembly at specified sites as shown on the plans. The pole mounted Cabinets shall be mounted by attachment to the poles as shown on the plans.

Cabinets shall be pole mounted. All cabinets shall be provided with: dedicated space for future addition of fiber optic patch panel with minimum dimension of 14 x 6 x 4 in (360 x 150 x 100 mm) (furnished and installed later by Contractor); grounding buss bar; 19-inch (480-mm) rack system for mounting of all devices in the cabinet; door-activated LED light bars mounted at the top (rear and front) of cabinet in a way that no cabinet rack space is used for lighting (minimum 12 inches in length, minimum 110 degree beam angle, cool white, minimum 300 lumens per unit, on/off switch, maximum 0.75 inches in width, 24 volt); pull-out shelf/drawer for laptop and maintenance use; ventilation fans; 120 volts-alternating current (VAC) power supply; 120 VAC ground fault interrupted (GFI) protected duplex outlets for tools. All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to ODOT’s network switch. The gauge of the wire connected to the switches shall be 16 AWG and a length of 5 feet to connect to ODOT’s network switch. The cabinets shall be sized to ensure ease of access to equipment and provided with proper ventilation to maintain an internal operating environment that does not exceed the environmental operating ranges for devices placed within the cabinet. There shall be a total of 2 conduits entering the bottom of the cabinet. This includes one 2-inch Schedule 40 conduit to be connected to the 32-inch communications "TRAFFIC" pull-box, one 2-inch Schedule 40 conduit to be connected to the 18-inch power "ELECTRIC" pull-box. The cost of these conduits shall be incidental to the cost of the ITS cabinet. Furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, provisions, and requirements before the system is considered for acceptance. Each cabinet assembly shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling. The cabinet interior shall be completely insulated per this specification.

1801.1 MATERIALS

Materials and equipment furnished by the qualified provider shall meet all requirements in this provision. Equipment supplied shall be a standard production model; prototype equipment will not be acceptable. Only equipment previously marketed and sold for at least six months prior to the advertising date will be acceptable. All equipment shall be warranted against defects and any failures which may occur through normal use for a minimum of one year from the date of successful completion of the equipment's system test.
1801.2 GENERAL
The cabinets shall be complete with a prefabricated cabinet shell, and all internal components and equipment, back and side panels, front and back doors, terminal strips, cabling and harnesses, surge protection for power and communication circuits, power distribution blocks or assemblies, shelves, connectors and all mounting hardware necessary for installation of equipment. The cabinets shall be completely weatherproof to prevent the entry of water. The cabinet top shall be crowned 1/2 inch (13 mm) or slanted to the rear to prevent standing water.

1801.3 REQUIREMENTS

1801.3.1 Construction
The cabinet shall have minimum dimensions: 44 in H x 24 in W x 22 in D (1100 mm H x 610 mm W x 560 mm D). The cabinet and doors shall be fabricated of 0.125-inch (3.2-mm) minimum thickness aluminum. All exterior seams for the cabinets and doors shall be continuously welded. Exterior welds shall be ground smooth. Edges shall be filed to a radius of 0.03-inch (0.76-mm), minimum.

1801.3.2 Locks
When the door is closed and latched, the door shall be locked. The handle shall have a minimum length of 7 inches (180 mm) and shall be provided with a 5/8-inch (16-mm), minimum, steel shank. The handle shall be fabricated of cast aluminum or of zinc-plated or cadmium-plated steel. Cabinet locks shall be the solid brass and keyed to the ODOT master key Corbin Number 2, 6-pin tumbler rim type. The lock shall have rectangular, spring-loaded bolts. The locks shall be left hand, and rigidly mounted with stainless steel machine screws approximately 2 inches diagonally apart. The cabinet doors shall also be pad lockable. Keys shall be removable in the locked and unlocked positions, and two keys furnished with each cabinet. The front position of the lock shall extend 1/8 inch (3.2 mm) to 3/8 inch (9.5 mm) beyond the outside surface of the door.

1801.3.3 Doors
All cabinets shall have two full-size doors. Pole mounted cabinets shall be designed so mounting brackets can be installed on the side so both doors are fully functional. The doors shall be provided a full-length stainless-steel piano hinge, with stainless steel pins spot-welded at the top. The hinges shall be mounted so that they cannot be removed from the door or cabinet without first opening the door. The door and hinges shall be braced to withstand a 100-pound per vertical foot (149 kg/m) of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. The door opening shall be double flanged on all four sides. Doorstops shall be included at 90 and 120-degree positions. The catches shall be 3/8-inch (9.5 mm) diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90 degrees in a 60 mph (96.5 km/h) wind at an angle perpendicular to the plane of the door. Both the door and the doorstop mechanism shall be of sufficient strength to withstand a simulated wind load of 5 pounds per square foot (24.4 kg/m²) of door area applied to both the inside and outside surfaces without failure, permanent deformation, or compromising of door position and normal operation. The cabinet door frame shall be designed so that the latching mechanism will hold tension on and form a firm seal between door gasket and door frame. The latching mechanism shall be a 3-point cabinet latch with nylon rollers. The center catch and pushrods shall be zinc-plated or cadmium-plated steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 x 3/4 in, (6.4 x 19 mm) minimum. The nylon rollers shall have a minimum diameter of 3/4 inch (19 mm) and shall be equipped with ball bearings. The doors shall be manufactured so that all internal components (locking mechanism, filter brackets, etc.) are welded to the door. (Nothing shall be fastened to the inside of either door by the method of inserting a bolt through the door.)

1801.3.4 Gaskets
Ensure that cabinet doors include a gasket to provide a dust and weather-resistant seal when closed. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging and shall ensure a uniform dust and weather resistant seal around the entire door facing. Gasket shall be provided on all
door openings and shall be dust-tight. Gaskets shall be permanently bonded to the metal. The mating surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating surface. All overlapping exterior seams and doors shall meet the requirements for Type 4 enclosures in the National Electrical Manufacturers Association (NEMA) enclosure standards.

1801.3.5 Mounting
All pole mount cabinets shall include all necessary components required for secure connection to any pole including but not limited to the pole mounting brackets and mounting hardware. The mounting height shall result in the bottom of the cabinet 30 inches (762 mm) above the foundation.

1801.3.6 Shelves
One substantial metal shelf shall be provided to support equipment at the bottom of the 19-inch rack just above the power receptacles and circuit breakers. Machine screws and bolts shall not protrude beyond the outside wall of the cabinet.

1801.3.7 Coating
All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from general appearance. All cadmium plating shall conform to the requirements in Military Specification MIL-QQ-416b. All zinc plating shall conform to the requirements in Military Specification MIL-QQ-325b.

1801.3.8 Ventilation
Cabinets shall be provided with vent openings in the front door to allow convection cooling of electronic components. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per min (2.8 m³/min). The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 89.6 °F (32 °C) and 149 °F (65 °C) with a differential of not more than 10.8 °F (6 °C) between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the ampacity of the fan motor installed. The manual adjustment shall be graded in 18 °F (10 °C) increments. The vent opening shall be located on the lower portion of the cabinet door and shall be covered fully on the inside with a commercially available filter. Removable air filter shall be housed behind the door vents. The filter shall be removable, washable, and re-useable and a spare filter of the same type shall be provided for each cabinet. The filter filtration area shall cover the vent opening area. A filter shell shall be provided that fits over the filter, providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent over a minimum of 0.26 inches (6 mm) to house the filter. The filter and shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed to create a waterproof sump with drain holes to the outside housing. The filter shall trap particles 2 microns and larger.

1801.3.9 Wiring
Conductors used in cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B or better. The insulation shall have a thickness of 10 mil (254µm) and shall be nylon jacketed polyvinyl chloride or shall be irradiated cross-link polyvinyl chloride, polyhalocarbon or polychloro-alkene, except that, at the Contractor’s option, conductors No. 14 and larger may be Underwriters Laboratories Incorporated (UL) Type Thermostatic High Heat Resistant Nylon Coated (THHN). Conductor insulation shall be rated at 300 Volts (V) and shall be rated for use at 221 °F (105 °C). Cables shall be provided with strain relief. Wiring within cabinets shall be neatly arranged and laced or enclosed in plastic tubing or raceway. Conductors used in cabinet wiring shall conform to the following color-code requirements:

A: The grounded conductor of a circuit shall be identified by a continuous white or natural gray color.

B: The equipment grounding conductor shall be identified by a continuous green color or by a continuous green color with one or more yellow stripes.

C: The ungrounded conductors shall be identified by any color not specified in A or B above.
Conductors used in cabinet wiring shall terminate with properly sized captive or spring spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. Crimp-style connectors shall be applied with a proper tool which prevents opening of the handles until the crimp is completed. Equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet and shall be connected to the metal conduit system or other approved ground with a Number 8, or larger, grounding conductor. With all the cabinet equipment in place and connected, the resistance between the grounded conductor terminal bus and the equipment grounding conductor bus shall be 50 MegaOhms, minimum, when measured with an applied voltage of 150 volts-direct current (VDC). If direct current (DC) is to be grounded, it shall be connected to equipment ground only. Two or more terminal blocks shall be provided for field connections. Field terminals shall be installed within 22 inches (560 mm) of the face of the cabinet and shall be oriented for screwdriver operation from the door opening. All terminals shall be a minimum of 5 inches (127 mm) above the foundation. No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

Field connection shall be made for the conductors of signal cable, power cable, interconnect cable and wireless cable. Conductors shall be connected so the outgoing circuits shall be of the same polarity as the line side of the power supply. The circuit common return shall be of the same polarity as the ground side of the power supply. The grounded side of the power supply shall be grounded to the cabinet in an approved manner. All field wiring shall be neatly arranged and routed to the appropriate terminal blocks. Field wiring shall be identified in accordance with section 713.18 except that marking may be by indelible pen instead of embossed letters.

Field wiring entering the cabinet except power wiring shall be fitted with spade terminals to assure a good connection. Incoming power wiring may use space terminals; or the bare conductor wire may be connected to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completion of field wiring, the conduit entering the cabinet shall be completely sealed in an approved manner with a removable sealing compound or a molded plastic or rubber device, which is compatible with the cable jacket, the insulation and the conduit material.

1801.3.10 Labels
A permanent printed, engraved or silk-screened label shall be provided for all removable items of equipment; such as, receptacles for relays, switching devices, switches, fuses, and circuit breakers. Labels shall conform to the designations on the cabinet wiring diagram. Labels for all shelf-mounted equipment shall be on the face of the shelf below the item. Labels for wall-mounted equipment shall be below the item. All equipment in the cabinet, when required, shall be permanently and clearly labeled.

1801.3.11 Convenience Receptacle
Four convenience receptacles shall be mounted in readily accessible locations inside the cabinet opposite the circuit breakers at the bottom of the cabinet. This configuration will let as much of the 19-inch rack in the cabinet to be used to mount equipment in the rack. Convenience receptacles shall be duplex, 3-prong, NEMA Type 5-15R grounding type outlet and shall conform to the requirements in UL Standard 943. All receptacles shall be wired through the cabinet surge arrester (per ODOT specification 733.03.C.5) and the 20 AMP circuit breakers. A supplemental surge suppressor shall be included in the price of the cabinet, wired in series with the cabinet surge arrester and shall meet the following specifications:
- Minimum dimensions: 3.75” (depth) x 7.8” (length) x 5.75” (width)
- Minimum Surge Current: 50,000 Amps
- Normal operating current: 15 Amps
1801.3.12 Terminal Blocks
Terminal blocks shall be rated 601 VAC, minimum, and shall be provided with nickel, silver or cadmium plated brass binder head screw terminals. Heavy duty terminal blocks shall be rated at 20 A and shall be provided with twelve poles with Number 10 x 5/16 in (250 x 7.9 mm) nickel plated brass binder head screws and nickel-plated brass inserts. Each pole position shall be provided with two terminal positions. The terminal blocks shall be the barrier type, with shorting bars in each of the twelve positions, and shall be provided with integral type marking strips. Light duty terminal blocks shall be rated at 5 A and shall be provided with twelve poles with Number 6 x 1/8 in (150 x 3.2 mm) binder head screws. Each pole position shall be provided with one terminal position. All terminal blocks shall be fitted with associated clear safety covers to protect against accident contact.

A Power Distribution Block shall be provided for the main power entering the cabinet. The power distribution block shall have the following minimum requirements:

- Current Rating – 175 Amps
- Voltage Rating – 600 Volts
- 3 Pole
- Primary Wire Range – 14 – 2 AWG Copper
- Secondary Wire Range – 14 – 4 AWG Copper
- Shall be equipped with a touch safe cover

1801.3.13 Pullout Drawer Assembly
A pullout drawer shall be installed in the cabinet cage. The drawer shall be 16.92 inches (430 mm) long by 16.92 inches (430 mm) wide by 1.73 inches (44 mm) deep. It shall have a hinged top that covers the storage box area and also provides a smooth surface to write on. The top of the storage compartment shall be aluminum. The drawer shall be General Devices D4080-19W (or equal). The compartment shall have ball bearing telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartment shall open to provide storage space for cabinet documentation and other miscellaneous items. The storage compartment shall be of adequate construction to support a weight of 20 pounds (9 kg) when extended without sagging. A plastic envelope with re-sealable opening shall be in each drawer to provide protection for cabinet and site detailed drawings. The size of the envelopes shall be big enough to accommodate the above drawings.

1801.3.14 Door Switches
All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to the AC Power Distribution Unit. The gauge of the wire connected to the switches shall be 16 AWG and a length of 5 feet to connect to the AC Power Distribution Unit as contact inputs to trigger SNMP notifications.

1801.3.15 Cartridge Fuses
Cartridge fuses shall be installed in panel mounted fuse holders. Fuse type and rating shall be as recommended by the fuse manufacturer for the type of load being protected.

1801.3.16 AC Power Distribution Unit
The cabinet shall include a managed power distribution unit with the following requirements to include cabinet monitoring functions:

- Shall be capable of remotely control individual outlets to reboot equipment remotely.
- Shall have a minimum of 8 – 120 VAC, 12 AMP outlets, 6 optically isolated inputs, 3 relay contacts of at least 10A at 120 VAC, and 1 analog input of up to 60 VDC
- Shall have a Current (A) monitoring digital display.
- Shall have an Ethernet port, web-based GUI interface, and be capable of the following network protocols at a minimum
  o IP, HTTP, NTP date/time, SNMP notifications, System Logging
  o The unit shall have password protection software/firmware shall be remotely upgradeable
- Shall have a temperature sensor and input for monitoring
- Shall be scrapable of scheduling reboots/resets of individual outlets and relay contacts on a once, daily, weekly, or monthly basis.
- Shall be able to send SNMP notifications individually for each outlet, input, relay, and temperature threshold

1801.3.17 Low Voltage Power Distribution Unit
The cabinet shall include a managed power distribution unit with the following requirements:
- Shall include one 24 VAC transformer with minimum 96 VA power rating (1 – 4.0 AMP output)
- Shall be capable of remotely controlling individual 24 VAC power supplies via the AC Power Distribution Unit
- The only means of overcurrent protection shall be accessible from the front side of the unit and there shall not be any internal breakers or fuses on the inside of the unit which would require disassembly to access.

1801.3.18 Circuit Breakers
Circuit breakers shall have a minimum interrupting capacity of 5000 A, root mean square (RMS). The cabinet shall have a minimum of 3 circuit breakers installed, one 50 AMP and two 20 AMP. The power company service shall be wired into the 50 AMP breaker. The two 20 AMP circuit breakers shall be wired through the 50 AMP circuit breaker. The required convenience receptacles shall be wire through the 20 AMP circuit breakers.

1801.3.19 Connectors
Connectors used for interconnecting various portions of circuits together shall be designed and constructed for the application involved. Connectors shall be designed to provide positive connection of all circuits, and easy insertion and removal of mating contacts. Connectors shall be permanently keyed to prevent improper connection of circuits. Connectors, or devices plugging into connectors, shall be provided with positive means to prevent any individual circuit from being broken due to vibration, pull on connecting cable or similar disruptive force.

1801.3.20 Cable Management
The cabinet shall include vertical plastic cable management strips on all 4 sides of the rack in order to organize and easily route power or communication cabling between devices within the cabinet. The cable management system shall easily allow for new cabling to be input and routed within the cabinet to new devices which are installed at a later time. The strips shall be positioned so that they do not interfere with the door operation opening/closing and so they don’t block the rack screw holes and it’s easy to install new devices into the 19” rack without removing the cable management strips. There shall not be any horizontal cable management strips.

1801.4 ENVIRONMENTAL
The components such as surge suppressors and power distribution shall operate properly within the ambient temperature limits of 0 °F (-17.8 °C) to 120 °F (48.9 °C) and meet the ambient temperature range, relative humidity, applied power, shock and vibration range of NEMA TS-2.

1801.5 TESTING
General: Subject the equipment covered by these provisions to design approval test (DAT) and factory approval tests (FAT’s). The Department reserves the right to witness all FAT’s. Complete the tests within five calendar days. Ensure that the test plans demonstrate each and every feature available in the device or system under test and includes the tests discussed below. The Department will evaluate material and devices purchased under this contract to verify compliance with provisions and determine suitability for use. Sample material and devices must be submitted at no additional cost to the Department for evaluation and will be retained for operational testing as long as the material or device is approved for use.

DAT and FAT: Develop and submit a test plan for DAT’s and FAT’s to the Department for consideration and approval. The Department may accept certification by an independent testing laboratory in lieu of
the DAT’s to satisfy the requirement that certain features and functions have been witnessed and documented as performing satisfactorily. Arrange for and conduct the tests and is responsible for satisfying all inspection requirements prior to submission for the Department’s inspection and acceptance. The Department reserves the right to witness all DAT’s and FAT’s. Complete the tests within five calendar days.

Transient, Temperature, Voltage, and Humidity Testing: The selected manufacturer will provide one cabinet of each type for testing and evaluation purposes at no cost to the Department. The units shall be tested and evaluated as indicated below. The Traffic operations Research Laboratory (TERL) will review the proposed products for compliance of the test procedures as noted within Section 2.2.7 of the NEMA TS 2-1998 standard and shall include the following tests:

- Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.
- Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).
- Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.
- Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.
- Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.
- Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.
- Test G: Test Termination (All Tests).
- Test H: Appraisal of Equipment under Test.

1801.6 METHOD OF MEASUREMENT
Measurement will be made as an ITS cabinet as defined above and as follows:

- ITEM 809E65010: ITS CABINET - POLE MOUNTED furnished and installed in place, complete and accepted by the ENGINEER.

1801.7 BASIS OF PAYMENT
The payment for this item will be made for the accepted number of quantities at the contract unit price.

UNIT OF PAYMENT

Each
1802 POWER DISTRIBUTION CABINET (PDC)

ITEM 809E65020: ITS CABINET – POWER DISTRIBUTION CABINET (PDC)

1802.0 GENERAL DESCRIPTION
The Contractor shall furnish and install a Power Distribution Cabinet rated NEMA 3R with the minimum dimensions of 50 inches (height), 30 inches (width), and 17 inches (depth). The cabinet shall have the following specifications:

1802.1 CONSTRUCTION
The cabinet and door shall be fabricated of 0.125-inch (3.2-mm) minimum thickness aluminum. All exterior seams for the cabinets and doors shall be continuously welded. Exterior welds shall be ground smooth. Edges shall be filed to a radius of 0.03-inch (0.76-mm), minimum. The cabinet shall also contain Aluminum back and side panels.

1802.2 LOCKS
When the door is closed and latched, the door shall be locked. The handle shall have a minimum length of 7 inches (180 mm) and shall be provided with a 5/8-inch (16-mm), minimum, steel shank. The handle shall be fabricated of cast aluminum or of zinc-plated or cadmium-plated steel. Cabinet locks shall be the solid brass and keyed to the ODOT master key Corbin Number 2, 6-pin tumbler rim type. The lock shall have rectangular, spring-loaded bolts. The locks shall be left hand, and rigidly mounted with stainless steel machine screws approximately 2 inches diagonally apart. The cabinet door shall also be pad lockable. Keys shall be removable in the locked and unlocked positions, and two keys furnished with each cabinet. The front position of the lock shall extend 1/8 inch (3.2 mm) to 3/8 inch (9.5 mm) beyond the outside surface of the door.

1802.3 DOORS
All cabinets shall have one full-size door. The door shall be provided a full-length stainless-steel piano hinge, with stainless steel pins spot-welded at the top. The hinge shall be mounted so that they cannot be removed from the door or cabinet without first opening the door. The door and hinge shall be braced to withstand a 100-pound per vertical foot (149 kg/m) of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. The door opening shall be double flanged on all four sides. Doorstops shall be included at 90 and 180-degree positions. The catches shall be 3/8-inch (9.5 mm) diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90 degrees in a 60 mph (96.5 km/h) wind at an angle perpendicular to the plane of the door. Both the door and the doorstop mechanism shall be of sufficient strength to withstand a simulated wind load of 5 pounds per square foot (24.4 kg/m²) of door area applied to both the inside and outside surfaces without failure, permanent deformation, or compromising of door position and normal operation. The cabinet door frame shall be designed so that the latching mechanism will hold tension on and form a firm seal between door gasket and door frame. The latching mechanism shall be a 3-point cabinet latch with nylon rollers. The center catches and pushrods shall be zinc-plated or cadmium-plated steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 x 3/4 in, (6.4 x 19 mm) minimum. The nylon rollers shall have a minimum diameter of 3/4 inch (19 mm) and shall be equipped with ball bearings. The doors shall be manufactured so that all internal components (locking mechanism, filter brackets, etc.) are welded to the door. (Nothing shall be fastened to the inside of either door by the method of inserting a bolt through the door.)

1802.4 GASKETS
Ensure that cabinet door includes a gasket to provide a dust and weather-resistant seal when closed. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging and shall ensure a uniform dust and weather resistant seal around the entire door facing. Gasket shall be provided on all door openings and shall be dust-tight. Gaskets shall be permanently bonded to the metal. The mating
surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating surface. All overlapping exterior seams and doors shall meet the requirements for Type 3R enclosures in the National Electrical Manufacturers Association (NEMA) enclosure standards.

1802.5 MOUNTING
All ground mounted cabinets shall include all necessary components required for secure connection to the foundation and 6-inch riser including but not limited to the any mounting brackets and mounting hardware.

1802.6 COATING
All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from general appearance. All cadmium plating shall conform to the requirements in Military Specification MIL-QQ-416b. All zinc plating shall conform to the requirements in Military Specification MIL-QQ-325b.

1802.7 VENTILATION
Cabinets shall be provided with vent openings in the door to allow convection cooling of electronic components. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per min (2.8 m³/min). The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 89.6 °F (32 °C) and 149 °F (65 °C) with a differential of not more than 10.8 °F (6 °C) between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the ampacity of the fan motor installed. The manual adjustment shall be graded in 18 °F (10 °C) increments. The vent opening shall be located on the lower portion of the cabinet door and shall be covered fully on the inside with a commercially available filter. Removable air filter shall be housed behind the door vents. The filter shall be removeable, washable, and re-useable and a spare filter of the same type shall be provided for each cabinet. The filter filtration area shall cover the vent opening area. A filter shall be provided that fits over the filter, providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell shall be bent over a minimum of 0.26 inches (6 mm) to house the filter. The shell and shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed to create a waterproof sump with drain holes to the outside housing. The filter shall trap particles 2 microns and larger.

1802.8 WIRING
Conductors used in cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mil (254µm) and shall be nylon jacketed polyvinyl chloride or shall be irradiated cross-link polyvinyl chloride, polyhalocarbon or polychloro-alkene, except that, at the Contractor's option, conductors No. 14 and larger may be Underwriters Laboratories Incorporated (UL) Type Thermoplastic High Heat Resistant Nylon Coated (THHN). Conductor insulation shall be rated at 300 Volts (V) and shall be rated for use at 221 °F (105 °C). Cables shall be provided with strain relief. Wiring within cabinets shall be neatly arranged and laced or enclosed in plastic tubing or raceway. Conductors used in cabinet wiring shall conform to the following color-code requirements:
  A: The grounded conductor of a circuit shall be identified by a continuous white or natural gray color.
  B: The equipment grounding conductor shall be identified by a continuous green color or by a continuous green color with one or more yellow stripes.
  C: The ungrounded conductors shall be identified by any color not specified in A or B above. Conductors used in cabinet wiring shall terminate with properly sized captive or spring spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. Crimp-style connectors shall be applied with a proper tool which prevents opening of the handles until the crimp is completed. Equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet and shall be connected to the metal conduit system or other approved ground with a Number 8, or larger, grounding conductor. With all the cabinet equipment in place and connected, the resistance between the grounded conductor terminal bus and the equipment grounding conductor bus shall be 50 MegaOhms, minimum, when measured with an applied voltage
of 150 volts-direct current (VDC). If direct current (DC) is to be grounded, it shall be connected to equipment ground only. Two or more terminal blocks shall be provided for field connections. Field terminals shall be installed within 22 inches (560 mm) of the face of the cabinet and shall be oriented for screwdriver operation from the door opening. All terminals shall be a minimum of 5 inches (127 mm) above the foundation. No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

Field connection shall be made for the conductors of signal cable, power cable, interconnect cable and wireless cable. Conductors shall be connected so the outgoing circuits shall be of the same polarity as the line side of the power supply. The circuit common return shall be of the same polarity as the ground side of the power supply. The grounded side of the power supply shall be grounded to the cabinet in an approved manner. All field wiring shall be neatly arranged and routed to the appropriate terminal blocks. Field wiring shall be identified in accordance with section 713.18 except that marking may be by indelible pen instead of embossed letters.

Field wiring entering the cabinet except power wiring shall be fitted with spade terminals to assure a good connection. Incoming power wiring may use space terminals; or the bare conductor wire may be connected to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completion of field wiring, the conduit entering the cabinet shall be completely sealed in an approved manner with a removable sealing compound or a molded plastic or rubber device, which is compatible with the cable jacket, the insulation and the conduit material.

1802.9 LABELS
A permanent printed, engraved or silk-screened label shall be provided for all removable items of equipment; such as, receptacles for relays, switching devices, switches, fuses, and circuit breakers. Labels shall conform to the designations on the cabinet wiring diagram. Labels for all shelf-mounted equipment shall be on the face of the shelf below the item. Labels for wall-mounted equipment shall be below the item. All equipment in the cabinet, when required, shall be permanently and clearly labeled.

1802.10 TERMINAL BLOCKS
Terminal blocks shall be rated 600 VAC, minimum, and shall be provided with nickel, silver or cadmium plated brass binder head screw terminals. Heavy duty terminal blocks shall be rated at 20 A and shall be provided with twelve poles with Number 10 x 5/16 in (250 x 7.9 mm) nickel plated brass binder head screws and nickel-plated brass inserts. Each pole position shall be provided with two terminal positions. The terminal blocks shall be the barrier type, with shorting bars in each of the twelve positions, and shall be provided with integral type marking strips. Light duty terminal blocks shall be rated at 5 A and shall be provided with twelve poles with Number 6 x 1/8 in (150 x 3.2 mm) binder head screws. Each pole position shall be provided with one terminal position. All terminal blocks shall be fitted with associated clear safety covers to protect against accident contact.

A Power Distribution Block shall be provided for the main power entering the cabinet. The power distribution block shall have the following minimum requirements:

- Current Rating – 175 Amps
- Voltage Rating – 600 Volts
- 3 Pole
- Primary Wire Range – 14 – 2 AWG Copper
- Secondary Wire Range – 14 – 4 AWG Copper
- Shall be equipped with a touch safe cover

1802.11 CIRCUIT BREAKERS
Circuit breakers shall have a minimum interrupting capacity of 5000 A, root mean square (RMS). The cabinet shall have a minimum of 3 circuit breakers installed, one 60 AMP and two 30 AMP. The power
company service shall be wired into the 60 AMP breaker. The two 30 AMP circuit breakers shall be wired through the 60 AMP circuit breaker.

**1802.12 LOAD CENTER**  
A 100 Amp, 120/240 Volt load center shall be installed in the cabinet. The load center shall be NEMA 3R rated.

**1802.13 CONDUITS ENTERING FOUNDATION**  
There shall be a total of 3 conduits entering the foundation. This includes three 2-inch Schedule 40 conduits to be connected to the 18-inch power “ELECTRIC” pull box, and one 3/4-inch galvanized steel conduit to be connected to the ground rod. The cost of these conduits shall be incidental to the cost of the ITS cabinet. It shall be the Contractor’s responsibility to place both the “ELECTRIC” and “TRAFFIC” pull boxes in locations as identified in the plans so as to get an accurate quantity of conduit to provide on a per site basis.

**1802.14 Workpads**  
Work pads shall be installed per ODOT CMS 633.11 and shall be incidental to the price of the cabinet.

**1802.15 METHOD OF MEASUREMENT**  
Measurement will be made as a Power Distribution Cabinet as defined above and as follows:

ITEM 809E65020, ITS CABINET – POWER DISTRIBUTION CABINET (PDC) furnished and installed in place, complete and accepted by the ENGINEER.

**1802.16 BASIS OF PAYMENT**  
The payment for this item will be made for the accepted number of quantities at the contract unit price.

**UNIT OF PAYMENT**

Each
1803 ITS CABINET – RAMP METER

ITEM 809E65030: ITS CABINET - RAMP METER

1803.0 GENERAL DESCRIPTION

The cabinet shall be a Model 334L Traffic Controller Cabinet meeting specifications “Traffic Signal Control Equipment Specifications” and “Transportation Electrical Equipment Specifications”, California Department of Transportation as well as the specifications detailed below. Approved Ramp Meter cabinets can be found on the Traffic Approved Products List.

The Input File Information for the Model 334L Cabinet will be taken from the diagram below, note that highlighted sections are typically used in a two-lane ramp, four lane scenario.

Furnish and install a ground mounted cabinet with 12-inch cabinet riser on standard cabinet foundation with a 19-inch (480-mm) rack frame assembly at specified sites as shown on the plans. The GROUND mounted Cabinets shall be installed as shown on the plans.

Cabinets shall be ground mounted. All cabinets shall be provided with: dedicated space for future addition of fiber optic patch panel with minimum dimension of 14 x 6 x 4 in (360 x 150 x 100 mm); grounding buss bar; 19-inch (480-mm) rack system for mounting of all devices in the cabinet; door-activated LED light bars mounted at the top (rear and front) of cabinet in a way that no cabinet rack space is used for lighting (minimum 12 inches in length, minimum 110 degree beam angle, cool white, minimum 300 lumens per unit, on/off switch, maximum 0.75 inches in width, 24 volt); pull-out shelf/drawer for laptop and maintenance use; ventilation fans; 120 volts alternating current (VAC) power supply; 120 VAC ground fault interrupted (GFI) protected duplex outlets for tools. All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to ODOT’s network switch. The gauge of the wire connected to the switches shall be 16 AWG and a length of 5 feet to connect to ODOT’s network switch. The cabinets shall be sized to ensure ease of access to equipment and provided with proper ventilation to maintain an internal operating environment that does not exceed the environmental operating ranges for devices placed within the cabinet. Furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, provisions, and requirements before the system is considered for acceptance. Each cabinet assembly shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling. The cabinet interior shall be completely insulated per this specification.

1803.1 MATERIALS
Materials and equipment furnished by the qualified provider shall meet all requirements in this provision. Equipment supplied shall be a standard production model; prototype equipment will not be acceptable. Only equipment previously marketed and sold for at least six months prior to the advertising date will be acceptable. All equipment shall be warranted against defects and any failures which may occur through normal use for a minimum of one year from the date of successful completion of the equipment’s system test.

1803.2 GENERAL

The cabinets shall be complete with a prefabricated cabinet shell, and all internal components and equipment, back and side panels, front and back doors, terminal strips, cabling and harnesses, surge protection for power and communication circuits, power distribution blocks or assemblies, shelves, connectors and all mounting hardware necessary for installation of equipment. The cabinets shall be completely weatherproof to prevent the entry of water. The cabinet top shall be crowned 1/2 inch (13 mm) or slanted to the rear to prevent standing water.

1803.3 REQUIREMENTS

1803.3.1 Construction
The cabinet shall have minimum dimensions: 67 in H x 24 in W x 30 in D. The cabinet and doors shall be fabricated of 0.125-inch (3.2-mm) minimum thickness aluminum. All exterior seams for the cabinets and doors shall be continuously welded. Exterior welds shall be ground smooth. Edges shall be filed to a radius of 0.03-inch (0.76-mm), minimum.

1803.3.2 Locks
When the door is closed and latched, the door shall be locked. The handle shall have a minimum length of 7 inches (180 mm) and shall be provided with a 5/8-inch (16-mm), minimum, steel shank. The handle shall be fabricated of cast aluminum or of zinc-plated or cadmium-plated steel. Cabinet locks shall be the solid brass and keyed to the ODOT master key Corbin Number 2, 6-pin tumbler rim type. The lock shall have rectangular, spring-loaded bolts. The locks shall be left hand, and rigidly mounted with stainless steel machine screws approximately 2 inches diagonally apart. The cabinet doors shall also be pad lockable. Keys shall be removable in the locked and unlocked positions, and two keys furnished with each cabinet. The front position of the lock shall extend 1/8 inch (3.2 mm) to 3/8 inch (9.5 mm) beyond the outside surface of the door.

1803.3.3 Doors
All cabinets shall have two full-size doors. GROUND mounted cabinets shall be designed so mounting brackets can be installed on the side so both doors are fully functional. The doors shall be provided a full-length stainless-steel piano hinge, with stainless steel pins spot-welded at the top. The hinges shall be mounted so that they cannot be removed from the door or cabinet without first opening the door. The door and hinges shall be braced to withstand a 100-pound per vertical foot (149 kg/m) of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. The door opening shall be double flanged on all four sides. Doorstops shall be included at 90 and 180-degree positions. The catches shall be 3/8-inch (9.5 mm) diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90 degrees in a 60 mph (96.5 km/h) wind at an angle perpendicular to the plane of the door. Both the door and the doorstop mechanism shall be of sufficient strength to withstand a simulated wind load of 5 pounds per square foot (24.4 kg/m²) of door area applied to both the inside and outside surfaces without failure, permanent deformation, or compromising of door position and normal operation. The cabinet door frame shall be designed so that the latching mechanism will hold tension on and form a firm seal between door gasket and door frame. The latching mechanism shall be a 3-point cabinet latch with nylon rollers. The center catch and pushrods shall be zinc-plated or cadmium-plated steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 x 3/4 in, (6.4 x 19 mm) minimum. The nylon rollers shall have a minimum diameter of 3/4 inch (19 mm) and shall be equipped with ball bearings. The doors shall be manufactured so that all internal components (locking mechanism, filter brackets, etc.) are welded to
the door. (Nothing shall be fastened to the inside of either door by the method of inserting a bolt through the door.)

1803.3.4 Gaskets
Ensure that cabinet doors include a gasket to provide a dust and weather-resistant seal when closed. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging and shall ensure a uniform dust and weather-resistant seal around the entire door facing. Gasket shall be provided on all door openings and shall be dust-tight. Gaskets shall be permanently bonded to the metal. The mating surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating surface. All overlapping exterior seams and doors shall meet the requirements for Type 4 enclosures in the National Electrical Manufacturers Association (NEMA) enclosure standards.

1803.3.5 Mounting
All ground mounted cabinets shall include all necessary components required for secure connection to the foundation and riser including but not limited to any mounting brackets and mounting hardware. Supply galvanized anchor bolts with nuts and washers with each cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an “L” bend on the unthreaded end.

1803.3.6 Shelves
One substantial metal shelf shall be provided to support equipment at the middle of the 19-inch rack just above the power receptacles and circuit breakers. Machine screws and bolts shall not protrude beyond the outside wall of the cabinet.

1803.3.7 Coating
All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from general appearance. All cadmium plating shall conform to the requirements in Military Specification MIL-QQ-416b. All zinc plating shall conform to the requirements in Military Specification MIL-QQ-325b. An anodic coating is not required.

1803.3.8 Ventilation
Cabinets shall be provided with vent openings in the front door to allow convection cooling of electronic components. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per min (2.8 m³/min). The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 89.6 °F (32 °C) and 149 °F (65 °C) with a differential of not more than 10.8 °F (6 °C) between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the ampacity of the fan motor installed. The manual adjustment shall be graded in 18 °F (10 °C) increments. The vent opening shall be located on the lower portion of the cabinet door and shall be covered fully on the inside with a commercially available filter. Removable air filter shall be housed behind the door vents. The filter shall be removable, washable, and re-useable and a spare filter of the same type shall be provided for each cabinet. The filter filtration area shall cover the vent opening area. A filter shell shall be provided that fits over the filter, providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent over a minimum of 0.26 inches (6 mm) to house the filter. The filter and shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed to create a waterproof sump with drain holes to the outside housing. The filter shall trap particles 2 microns and larger.

1803.3.9 Wiring
Conductors used in cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mil (254µm) and shall be nylon jacketed polyvinyl chloride or shall be irradiated cross-link polyvinyl chloride, polyhalocarbon or polychloro-alkene, except that, at the Contractor’s option, conductors No. 14 and larger may be Underwriters Laboratories Incorporated
Type Thermoplastic High Heat Resistant Nylon Coated (THHN). Conductor insulation shall be rated at 300 Volts (V) and shall be rated for use at 221 °F (105 °C). Cables shall be provided with strain relief. Wiring within cabinets shall be neatly arranged and laced or enclosed in plastic tubing or raceway. Conductors used in cabinet wiring shall conform to the following color-code requirements:

A: The grounded conductor of a circuit shall be identified by a continuous white or natural gray color.

B: The equipment grounding conductor shall be identified by a continuous green color or by a continuous green color with one or more yellow stripes.

C: The ungrounded conductors shall be identified by any color not specified in A or B above.

Conductors used in cabinet wiring shall terminate with properly sized captive or spring spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. Crimp-style connectors shall be applied with a proper tool which prevents opening of the handles until the crimp is completed. Equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet and shall be connected to the metal conduit system or other approved ground with a Number 8, or larger, grounding conductor. With all the cabinet equipment in place and connected, the resistance between the grounded conductor terminal bus and the equipment grounding conductor bus shall be 50 MegaOhms, minimum, when measured with an applied voltage of 150 volts-direct current (VDC). If direct current (DC-) is to be grounded, it shall be connected to equipment ground only. Two or more terminal blocks shall be provided for field connections. Field terminals shall be installed within 22 inches (560 mm) of the face of the cabinet and shall be oriented for screwdriver operation from the door opening. All terminals shall be a minimum of 5 inches (127 mm) above the foundation. No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

Field connection shall be made for the conductors of signal cable, power cable, interconnect cable and wireless cable. Conductors shall be connected so the outgoing circuits shall be of the same polarity as the line side of the power supply. The circuit common return shall be of the same polarity as the ground side of the power supply. The grounded side of the power supply shall be grounded to the cabinet in an approved manner. All field wiring shall be neatly arranged and routed to the appropriate terminal blocks. Field wiring shall be identified in accordance with section 713.18 except that marking may be by indelible pen instead of embossed letters.

Field wiring entering the cabinet except power wiring shall be fitted with spade terminals to assure a good connection. Incoming power wiring may use space terminals; or the bare conductor wire may be connected to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completion of field wiring, the conduit entering the cabinet shall be completely sealed in an approved manner with a removable sealing compound or a molded plastic or rubber device, which is compatible with the cable jacket, the insulation and the conduit material.

1803.10 Labels
A permanent printed, engraved or silk-screened label shall be provided for all removable items of equipment; such as, receptacles for relays, switching devices, switches, fuses, and circuit breakers. Labels shall conform to the designations on the cabinet wiring diagram. Labels for all shelf-mounted equipment shall be on the face of the shelf below the item. Labels for wall-mounted equipment shall be below the item. All equipment in the cabinet, when required, shall be permanently and clearly labeled. The marker strips shall be made of material that can be easily and legibly written upon using a pencil or ballpoint pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with all items installed.

1803.11 Convenience Receptacle
Four convenience receptacles shall be mounted in readily accessible locations inside the cabinet opposite the circuit breakers at the bottom of the cabinet. This configuration will let as much of the 19-inch rack in the cabinet to be used to mount equipment in the rack. Convenience receptacles shall
be duplex, 3-prong, NEMA Type 5-15R grounding type outlet and shall conform to the requirements in UL Standard 943. All receptacles shall be wired through the cabinet surge arrestor (per ODOT specification 733.03.C.5) and the 20 AMP circuit breakers. A supplemental surge suppressor shall be included in the price of the cabinet, wired in series with the cabinet surge arrestor and shall meet the following specifications:

- Minimum dimensions: 3.75” (depth) x 7.8” (length) x 5.75” (width)
- Minimum Surge Current: 50,000 Amps
- Normal operating current: 15 Amps
- Minimum 9 Nema 5-15R Outlets

A separate unit shall also be incidental to the price of the cabinet for the purpose of remote management of 12VDC and 24VDC power outputs. This unit shall be 19-inch rack-mountable and shall allow for remote management of a minimum of 5 separate DC power sources. There shall be a minimum of 3 alarm contact closure inputs, that when triggered will send an email to a user defined address. The unit shall also monitor the output states of all the power outputs.

1803.3.12 Terminal Blocks

Terminal blocks shall be rated 600 VAC, minimum, and shall be provided with nickel, silver or cadmium plated brass binder head screw terminals. Heavy duty terminal blocks shall be rated at 20 A and shall be provided with twelve poles with Number 10 x 5/16 in (250 x 7.9 mm) nickel plated brass binder head screws and nickel-plated brass inserts. Each pole position shall be provided with two terminal positions. The terminal blocks shall be the barrier type, with shorting bars in each of the twelve positions, and shall be provided with integral type marking strips. Light duty terminal blocks shall be rated at 5 A and shall be provided with twelve poles with Number 6 x 1/8 in (150 x 3.2 mm) binder head screws. Each pole position shall be provided with one terminal position. All terminal blocks shall be fitted with associated clear safety covers to protect against accident contact.

A Power Distribution Block shall be provided for the main power entering the cabinet. The power distribution block shall have the following minimum requirements:

- Current Rating – 175 Amps
- Voltage Rating – 600 Volts
- 3 Pole
- Primary Wire Range – 14 – 2 AWG Copper
- Secondary Wire Range – 14 – 4 AWG Copper
- Shall be equipped with a touch safe cover

Side mounted terminal blocks shall be provided to land vehicle detector field wiring. Install terminal blocks and associated wiring to the input file. Label the field wiring terminals of the side mounted terminal block by a permanent screening process to identify the input panel (I), the input file slot number (1 through 14) and the channel terminal (D, E, J, or K). An example is “I4-E”. Ensure that all terminals on these detector blocks are accessible without removing equipment from the EIA mounting rack. All terminals shall be alternating in colors, grey and white, down the block with all ground terminals colored green.

1803.3.13 Pullout Drawer Assembly

A pullout drawer shall be installed in the cabinet cage. The drawer shall be 16.92 inches (430 mm) long by 16.92 inches (430 mm) wide by 1.73 inches (44 mm) deep. It shall have a hinged top that covers the storage box area and also provides a smooth surface to write on. The top of the storage compartment shall be aluminum. The drawer shall be General Devices D4080-19W (or equal). The compartment shall have ball bearing telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartment shall open to provide storage space for cabinet documentation and other miscellaneous items. The storage compartment shall be of adequate construction to support a weight of 20 pounds (9 kg) when extended without sagging. A plastic envelope with re-sealable opening shall be in each drawer to provide protection for cabinet and site detailed drawings. The size of the envelopes shall be big enough to accommodate the above drawings.
1803.3.14 Switches
All cabinets shall have door-activated switches that provide a contact closure for alarm when the door(s) are opened to ODOT’s network switch. The gauge of the wire connected to the switches shall be 16 AWG and a length of 5 feet to connect to ODOT’s network switch.

1803.3.15 Cartridge Fuses
Cartridge fuses shall be installed in panel mounted fuse holders. Fuse type and rating shall be as recommended by the fuse manufacturer for the type of load being protected.

1803.3.16 Circuit Breakers
Circuit breakers shall have a minimum interrupting capacity of 5000 A, root mean square (RMS). The cabinet shall have a minimum of 3 circuit breakers installed, one 60 AMP and two 20 AMP. The power company service shall be wired into the 60 AMP breaker. The two 20 AMP circuit breakers shall be wired through the 60 AMP circuit breaker. The required convenience receptacles shall be wire through the 20 AMP circuit breakers.

1803.3.17 Connectors
Connectors used for interconnecting various portions of circuits together shall be designed and constructed for the application involved. Connectors shall be designed to provide positive connection of all circuits, and easy insertion and removal of mating contacts. Connectors shall be permanently keyed to prevent improper connection of circuits. Connectors, or devices plugging into connectors, shall be provided with positive means to prevent any individual circuit from being broken due to vibration, pull on connecting cable or similar disruptive force.

1803.3.18 Conduits Entering Foundation
There shall be a total of 4 conduits entering the foundation. This includes two 4-inch Schedule 40 multicell conduits to be connected to 36-inch communications “TRAFFIC” pull box, one 2-inch Schedule 40 conduit to be connected to the 18-inch power “ELECTRIC” pull box, and one 3/4-inch galvanized steel conduit to be connected to the ground rod. The cost of these conduits shall be incidental to the cost of the ITS cabinet. It shall be the Contractor’s responsibility to place both the “ELECTRIC” and “TRAFFIC” pull boxes in locations as identified in the plans so as to get an accurate quantity of conduit to provide on a per site basis.

1803.3.19 Workpads
Work pads shall be installed per ODOT CMS 633.11 and shall be incidental to the price of the cabinet.

1803.3.20 Accessories
Fully equip the cabinets with two channel loop detector sensors, transfer relay, power supply, 208 conflict monitor and switchpacks. When ramp meter warning signs with flashers are used, include a NEMA or Caltrans type flasher wired for control from the controller. Lightning/surge suppression shall comply with the requirements from CMS 733.03.C.5. Fully equip the cabinets with two channel loop detector sensors, transfer relay, power supply, conflict monitor and switchpacks. When ramp meter warning signs with flashers are used, include a NEMA or Caltrans type flasher wired for control from the controller. Furnish an aluminum shelf with integral storage compartment in the rack below the controller. Ensure that the storage compartment has telescoping drawer guides for full extension. Ensure that the compartment top has a non-slip plastic laminate attached. Ensure that each cabinet has two fluorescent lights installed at the top of the cabinet, one near each door. Wire the lights to the door switches such that opening either door will turn on both lights. Furnish a Model 208 conflict monitor unit

1803.4 ENVIRONMENTAL
The components such as surge suppressors and power distribution shall operate properly within the ambient temperature limits of 0 °F (-17.8 °C) to 120 °F (48.9 °C) and meet the ambient temperature range, relative humidity, applied power, shock and vibration range of NEMA TS-2.
1803.5 TESTING
General: Subject the equipment covered by these provisions to design approval test (DAT) and factory approval tests (FAT’s). The Department reserves the right to witness all FAT’s. Complete the tests within five calendar days. Ensure that the test plans demonstrate each and every feature available in the device or system under test and includes the tests discussed below. The Department will evaluate material and devices purchased under this contract to verify compliance with provisions and determine suitability for use. Sample material and devices must be submitted at no additional cost to the Department for evaluation and will be retained for operational testing as long as the material or device is approved for use.

DAT and FAT: Develop and submit a test plan for DAT’s and FAT’s to the Department for consideration and approval. The Department may accept certification by an independent testing laboratory in lieu of the DAT’s to satisfy the requirement that certain features and functions have been witnessed and documented as performing satisfactorily. Arrange for and conduct the tests and is responsible for satisfying all inspection requirements prior to submission for the Department’s inspection and acceptance. The Department reserves the right to witness all DAT’s and FAT’s. Complete the tests within five calendar days.

Transient, Temperature, Voltage, and Humidity Testing: The selected manufacturer will provide one cabinet of each type for testing and evaluation purposes at no cost to the Department. The units shall be tested and evaluated as indicated below. The Traffic operations Research Laboratory (TERL) will review the proposed products for compliance of the test procedures as noted within Section 2.2.7 of the NEMA TS 2-1998 standard and shall include the following tests:

- Test A: (DAT) Placement in Environmental Chamber and Check-Out of Hook-Up.
- Test B: (DAT) Temperature Cycling and Applied Transient Tests (Power Service).
- Test C: (DAT and Production Testing) Low-Temperature Low-Voltage Tests.
- Test D: (DAT and Production Testing) Low-Temperature High-Voltage Tests.
- Test E: (DAT and Production Testing) High-Temperature High-Voltage Tests.
- Test F: (DAT and Production Testing) High-Temperature Low-Voltage Tests.
- Test G: Test Termination (All Tests).
- Test H: Appraisal of Equipment under Test.

1803.6 METHOD OF MEASUREMENT
Measurement will be made as an ITS cabinet as defined above and as follows:

- ITEM 809E65030: ITS CABINET - RAMP METER furnished and installed in place, complete and accepted by the ENGINEER, including conduit and work pads as specified.

1803.7 BASIS OF PAYMENT
The payment for this item will be made for the accepted number of quantities at the contract unit price. This item shall be incidental to ITEM 809E67000 RAMP METER SYSTEM, when new installations are specified in the plans.

UNIT OF PAYMENT

Each
1804 ITS CABINET - DMS

ITEM 809E65040: ITS CABINET - DMS

1804.0 GENERAL DESCRIPTION
This cabinet item shall include all requirements from Section 1800 ITS GROUND MOUNTED CABINET, an shall additionally include a load center / power panel to feed additional devices such as DMS, VSL, etc., and any other differences are described below.

1804.1 CIRCUIT BREAKERS
Circuit breakers shall have a minimum interrupting capacity of 5000 A, root mean square (RMS). All cabinet circuit breakers shall be housed in the load center and no other breakers shall be installed in the cabinet.

1804.2 POWER UNIT
The rack mounted power unit shall not be required and will be replaced by a power panel with load center.

1804.2.1 POWER PANEL WITH LOAD CENTER
A rack mounted power panel with load center shall be mounted in the bottom front of the cabinet.

A 120/240 Volt load center with main lug rated for up to 100 Amps and room for a minimum of 10 breaker spaces, shall be installed in the cabinet. The load center shall include at a minimum a 40 Amp two pole breaker for a Dynamic Message Sign, a 20 Amp equipment breaker, and a 20 Amp auxiliary breaker for fans/lights/GFCI outlet. The load center may also be equipped with other breakers if required per the project plans. Since the load center will be installed in the cabinet, the load center shall be a minimum of NEMA 1 rated. The load center shall be installed near the bottom rear and side of the cabinet, behind the power unit. When looking from the rear door, the load center should mount to the left side of the cabinet and be clear of interfering with any wiring or equipment access to the power panel.

The power panel shall contain the following requirements:

- Maximum Dimensions: 19 inches (W) x 17 inches (H) x 8 inches (D)
- Equipment Receptacle:
  - Equipment receptacles shall be duplex, 3-prong, NEMA Type 5-20R grounding type outlet and shall conform to the requirements in UL Standard 943.
- Field Personnel Testing Outlet
  - One GFCI receptacle outlet on right front
- Surge Suppression:
  - Shall be installed so that any LED indicators can be easily seen, and the unit can be easily replaced.
  - 100 kA per phase rating
  - 120 Single Phase
  - UL 1449 Listed
  - < 1 nanosecond response time
  - Normal Operating Temperature: -40 to +55 Celsius
  - Peak Operating Temperature: 80 Celsius
  - Maximum Dimensions: 8 inches (W) x 4 inches (H) x 4 inches (D)

A separate low voltage distribution unit shall also be incidental to the price of the cabinet for the purpose of remote management of 12VDC, 24VDC, 48 VDC, and 24 VAC power outputs. This unit shall be 19-inch rack-mountable and shall allow for remote management of a minimum of 5 separate DC power sources and one 24 VAC power source. There shall be a minimum of 3 alarm contact closure inputs, that when triggered will send an email to a user defined address. The unit shall also monitor the output states of all the power outputs.
SECTION 1900 – TRAFFIC SIGNALS
1901 Closed Loop Arterial Traffic Signal System

ITEM 809E66000 CLOSED LOOP ARTERIAL TRAFFIC SIGNAL SYSTEM

Category A – Closed Loop Arterial Traffic Signal System

General Description:
A closed loop arterial traffic signal system establishes timed traffic flow between traffic signals to minimize delays and stops on a progressively timed arterial. The signals may be interconnected via wired or wireless communications, or progressive timing may be established using time-based coordination. System supervision and oversight will be by standard closed loop signal packages from established suppliers. Interconnected control systems provide the capability for wired or wireless communication with the operations personnel. They enable the operations personnel to monitor the condition of intersection equipment and to download timing plan changes. In addition to time-of-day timing plan selection, the operator may select a timing plan at any time. System detectors, if provided at all, are used for general traffic monitoring by the operator and for planning purposes. Traffic adjusted control provides a relatively slow capability to automatically select timing plans using data from traffic detectors. Control is usually provided by the Urban Traffic Control System (UTCS) First Generation Control Algorithm or by algorithms provided by closed loop systems. The UTCS algorithm selects an entire timing plan based on sensed conditions. Closed loop systems change cycle, split and offset separately according to sensed traffic conditions.

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Notes:
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Approved Product List.
Category B – Centrally Controlled Arterial Traffic Signal System

General Description:
A centrally control traffic signal system consists of intersection traffic signals, a communications network to tie them together, and a central computer or network of computers to manage the system. Interconnected control systems provide the capability for wired or wireless communication with the operations personnel. They enable the operations personnel to monitor the condition of intersection equipment and to download timing plan changes. In addition to time-of-day timing plan selection, the operator may select a timing plan at any time. System detectors, if provided, are used for general traffic monitoring by the operator and for planning purposes. Traffic adjusted control provides a relatively slow capability to automatically select timing plans using data from traffic detectors. Control is usually provided by the UTCS First Generation Control Algorithm or by algorithms provided by the control systems. The UTCS algorithm selects an entire timing plan based on sensed conditions.

Functional Requirements

<table>
<thead>
<tr>
<th>Requirement Number</th>
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</thead>
<tbody>
<tr>
<td>B001</td>
<td>The system shall provide capability to monitor proper operation of traffic signals in real time.</td>
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<tr>
<td>B002</td>
<td>The system shall provide cycle length, phase split and offset monitoring for traffic signals.</td>
</tr>
<tr>
<td>B003</td>
<td>The system shall provide for parameters to constrain the implementation of system signal timing, which include minimum green time, yellow change interval time, red clearance interval time, max pedestrian phase, passage time (gap out) and max out times, and max green times.</td>
</tr>
<tr>
<td>B004</td>
<td>The system shall be responsive to traffic actuations.</td>
</tr>
<tr>
<td>B005</td>
<td>The system shall provide the capability to check signal timings remotely.</td>
</tr>
<tr>
<td>B006</td>
<td>The system shall provide the capability to record of failures for maintenance or legal purposes.</td>
</tr>
<tr>
<td>B007</td>
<td>The system shall provide detector surveillance/tabulation for database development for timing plan changes.</td>
</tr>
<tr>
<td>B008</td>
<td>The system shall provide the capability for traffic adjusted operation because of variability in timing plan selection periods responsive to day-to-day or seasonal volume variations.</td>
</tr>
<tr>
<td>B009</td>
<td>The system shall provide capability for surveillance of operational efficiency/effectiveness to determine the need for new timing plans.</td>
</tr>
<tr>
<td>B010</td>
<td>The system shall provide for failure detection of system elements</td>
</tr>
</tbody>
</table>

Notes:
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Approved Product List.
Category C – Highway Rail/Traffic Signal Pre-emption

**General Description:**
Highway/Rail signal preemption systems are used to clear highway-rail grade crossings and maintain the clearance while the train passes to avoid a collision between trains and vehicles or people. The application is used for railroad grade crossings located in close proximity to a traffic signal.

<table>
<thead>
<tr>
<th>Requirement Number</th>
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</thead>
<tbody>
<tr>
<td>C001</td>
<td>The system shall provide circuitry to interface with the railroad crossing equipment to initiate the railroad preemption special control mode of the traffic signal controller.</td>
</tr>
<tr>
<td>C002</td>
<td>The system shall provide through the traffic signal controller the termination of any conflicting phases and initiation of the designated track clearance phases.</td>
</tr>
<tr>
<td>C003</td>
<td>The system shall provide for the traffic signal to hold track clearance phases in green at least until the railroad gate arm(s) for traffic approaching the intersection have reached the horizontal position.</td>
</tr>
<tr>
<td>C004</td>
<td>The system shall provide for traffic signal transitions from track clearance phases to limited service phases.</td>
</tr>
<tr>
<td>C005</td>
<td>The system shall respond to inputs from the railroad indicating the crossing has been cleared by releasing of the traffic signal controller from preemption special control mode.</td>
</tr>
<tr>
<td>C006</td>
<td>The system shall provide for traffic signal transitions from designated limited service phases to designated exit phases and normal operations of the traffic signal system.</td>
</tr>
<tr>
<td>C007</td>
<td>The system shall provide for failure detection of system elements.</td>
</tr>
</tbody>
</table>

**Notes:**
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Traffic Authorized Product List. Refer to ODOT Supplemental Specification 819/919 for additional requirements.
### Category D – Traffic Signal System with Emergency Vehicle Pre-emption

**General Description:**
Emergency vehicle preemption (EVP) systems are used to support safe and expeditious movement of police, fire, ambulance, or other critical emergency service vehicles through a signalized intersection. The basic concept is that an emergency vehicle that needs to travel as quickly as possible to or from an incident scene requests priority control movement through all or many of the signals on its travel route by either a call to a central control system, or by emitting an advance request for preemption service to each properly instrumented signal on its route. EVP is not absolute in the sense that preemption is not necessarily granted in all cases, for example, when EVP has already been granted for an emergency vehicle on a conflicting approach.

<table>
<thead>
<tr>
<th>Requirement Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>D001</td>
<td>The system shall provide signal capability to detect emergency vehicles requesting preemption and to initiate the emergency vehicle preemption special control mode of the traffic signal controller.</td>
</tr>
<tr>
<td>D002</td>
<td>When the preemption input is first sensed, or after some fixed delay, current vehicular phase is terminated if it conflicts with the emergency vehicle movement, unless the pedestrian phase is active. If the pedestrian White Walking Person display (symbolizing WALK) is active, such display may be terminated, but the Pedestrian Change interval, displayed as the flashing Orange upraised hand (symbolizing flashing DON’T WALK) shall be displayed in its entirety. Once the Pedestrian Change interval (displayed as the flashing Orange Upraised Hand (symbolizing flashing DON’T WALK) is displayed, it shall not be shortened and shall be displayed in its entirety.</td>
</tr>
<tr>
<td>D003</td>
<td>The system shall provide for the traffic signal to hold the phases that serve the emergency vehicle movement (typically the phase serving a through movement plus any protected left-turn phase in the same direction) and remains in these phases until the preemption input goes away or a maximum timer expires.</td>
</tr>
<tr>
<td>D004</td>
<td>The system shall provide for detection of the emergency vehicle when it clears the crossing and releasing of the traffic signal controller from preemption special control mode.</td>
</tr>
<tr>
<td>D005</td>
<td>The system shall provide for traffic signal transitions from designated limited service phases to designated exit phases and normal operations of the traffic signal system.</td>
</tr>
<tr>
<td>D006</td>
<td>The system shall provide for failure detection of system elements.</td>
</tr>
</tbody>
</table>

**Notes:**
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Traffic Authorized Product List. Refer to ODOT Traffic Engineering Manual for additional requirements.
### Category E – Traffic Signal System with Transit Priority

**General Description:**
Transit Signal Priority is similar to Emergency Vehicle Preemption but with a lower priority to force a green extension or early truncation of a red phase. Typical implementations are based on active tracking of bus passage times relative to scheduled passage times at route checkpoints.

<table>
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<tr>
<th>Requirement Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>E001</td>
<td>The system shall provide capability to detect transit vehicles requesting priority and to initiate the transit signal priority control mode of the traffic signal controller.</td>
</tr>
<tr>
<td>E002</td>
<td>The system shall provide conditional signal priority at intersections if they can effectively use the additional green time.</td>
</tr>
<tr>
<td>E003</td>
<td>The system shall provide several control techniques under conditional signal priority including:</td>
</tr>
<tr>
<td>E003.1</td>
<td>Phase / green extension: desired phase green is lengthened by a programmable maximum time. This proves helpful when the transit vehicle is detected near the end of the green and no near side bus stop is present. By extending the green a few seconds, the transit vehicle avoids stopping at the signal.</td>
</tr>
<tr>
<td>E003.2</td>
<td>Phase early start or red truncation: desired phase green is started earlier. This is helpful if the transit vehicle is detected during the desired phase red. Starting the desired phase green a few seconds earlier will save a few seconds of delay.</td>
</tr>
<tr>
<td>E003.3</td>
<td>Red interrupt or special phase: a short special green phase is injected into the cycle. This is especially helpful with near side stops serviced from a shoulder. The special phase will permit a queue jump and Buses will get a special advance.</td>
</tr>
<tr>
<td>E003.3</td>
<td>Phase display which allows them to get through the intersection smoothly and get back into a regular lane of travel easily.</td>
</tr>
<tr>
<td>E003.4</td>
<td>Phase suppression / skipping: logic is provided so that fewer critical phases are skipped. This can be used with logic that assesses congestion on the approaches to the skipped phase.</td>
</tr>
<tr>
<td>E003.5</td>
<td>Compensation: non-priority phases are given some additional time to make up for the time lost during priority. Other compensation techniques include limiting the number of consecutive cycles in which priority is granted.</td>
</tr>
<tr>
<td>E003.6</td>
<td>Window stretching: non-priority phases are given a core time, which must be serviced every cycle, and a variable timer, which could be taken away for priority purposes. Flexible window stretching differs in that the core time is not fixed in position relative to the cycle.</td>
</tr>
<tr>
<td>E004</td>
<td>The system shall provide for the traffic signal to hold the phases that serve the transit vehicle movement (typically the phase serving a through movement plus any protected left-turn phase in the same direction) and remains in these phases until the preemption input goes away or a maximum timer expires. If a bus stop is located in the priority provision zone and the bus doors are open, the priority request is terminated and reinitiated when the doors close.</td>
</tr>
<tr>
<td>E005</td>
<td>The system shall provide for detection of the transit vehicle when it clears the crossing and releasing of the traffic signal controller from priority special control mode.</td>
</tr>
<tr>
<td>E006</td>
<td>The system shall provide for traffic signal transitions from designated limited service phases to designated exit phases and normal operations of the traffic signal system.</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>E007</td>
<td>The system shall provide for failure detection of system elements.</td>
</tr>
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</table>

**Notes:**
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Approved Product List.
Adaptive Traffic Signal Control System

General Description:
Adaptive Traffic Signal Control coordinates control of traffic signals across a signal network, adjusting signal control parameters based on prevailing traffic conditions. Adaptive traffic signal control includes two control schemes commonly referred to as traffic responsive control and traffic adaptive control. Traffic responsive control systems may change the split at each phase of the traffic signal cycle based on traffic measurements upstream of the intersection. Small changes in cycle time and offset may be made during time periods ranging from each cycle to a few minutes. The greatest benefit for traffic responsive systems is the ability to react to non-schedulable events or unpredictable events such as incidents. Other benefits include the ability to adjust timing plans without the requirement to manually generate new plans. Examples of traffic responsive control systems are ACS lite and InSync. Traffic adaptive control strategies such as RHODES and OPAC do not employ defined traffic cycles or signal timing plans. They utilize traffic flow models that predict vehicle arrivals at the intersection and adjust the timing of each phase to optimize an objective function such as delay. Because they emphasize traffic prediction, these systems can respond to the natural statistical variations in traffic flow as well as to flow variations caused by traffic incidents or other unpredictable events.

Functional Requirements

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<td>The system shall provide cycle length, phase split and offset monitoring for traffic signals.</td>
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<td>G003</td>
<td>The system shall provide for parameters to constrain the implementation of system signal timing, which include minimum green time, yellow change interval time, red clearance interval time, max pedestrian phase, passage time (gap out) and max out times, and max green times.</td>
</tr>
<tr>
<td>G004</td>
<td>The system shall be responsive to traffic actuations.</td>
</tr>
<tr>
<td>G005</td>
<td>The system shall provide the capability to check signal timings remotely.</td>
</tr>
<tr>
<td>G006</td>
<td>The system shall provide the capability to download new timing plans without field visits.</td>
</tr>
<tr>
<td>G007</td>
<td>The system shall provide the capability to record of failures for maintenance or legal purposes.</td>
</tr>
<tr>
<td>G008</td>
<td>The system shall provide detector surveillance/tabulation for database development for timing plan changes.</td>
</tr>
<tr>
<td>G009</td>
<td>The system shall provide capability for traffic adjusted operation because of variability in timing plan selection periods responsive to day-to-day or seasonal volume variations.</td>
</tr>
<tr>
<td>G010</td>
<td>The system shall be capable of analyzing detector data to determine the need for new timing plans.</td>
</tr>
<tr>
<td>G011</td>
<td>The system shall be capable of analyzing detector data to determine an alternate route for diversion.</td>
</tr>
<tr>
<td>G012</td>
<td>The system shall provide the capability for detector data for planning data.</td>
</tr>
<tr>
<td>G013</td>
<td>The system shall provide the capability to respond to short term traffic flow irregularities.</td>
</tr>
<tr>
<td>G014</td>
<td>The system shall require minimal timing plan development support after initial setup.</td>
</tr>
<tr>
<td>G015</td>
<td>The system shall provide the capability to respond to traffic condition changes, including, at a minimum, special events, street construction, incidents, double parking, and diversion of traffic from a freeway or other arterial.</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>G016</td>
<td>The system shall provide the prevention of a “Yellow Trap” situation.</td>
</tr>
<tr>
<td>G017</td>
<td>The system shall provide for failure detection of system elements.</td>
</tr>
</tbody>
</table>

**Notes:**
Any system providing additional functionality will require a project-specific Systems Engineering Analysis. Any system to be implemented must be from ODOT’s Approved Product List.
ITEM 633E68510  COMMUNICATIONS

1907.1 GENERAL
The CONTRACTOR shall follow section 633.15 of the ODOT Construction and Materials Specifications and shall provide a device as listed on the ODOT Traffic Authorized Products list.

1907.2 BASIS OF PAYMENT
The pay item will pay for each device that is provided and approved by the ENGINEER.
1908 ATC V6.24 Controller

ITEM 809E69122: ATC V6.24 Controller

1908.0 GENERAL DESCRIPTION
This item of work shall consist of furnishing, installing, and programming a controller unit, consisting of the timing unit, software, and signal timing, into the specified type of prewired cabinet at the locations shown on the plans and ready for service. The controller shall be installed and programmed in accordance with ODOT’s Construction and Material Specification 633.07 and Supplement 1111.

1908.1 SOFTWARE DOCUMENTATION
The following up-to-date documentation shall be furnished with each controller unit:
- Full operating instructions
- Full software documentation

1908.2 MATERIAL
Controller units shall have a manufacturing date (determined by serial number) within one (1) year of the date of shipment to the project as determined by the required warranty decal.

1908.3 WARRANTY
Furnish 60-month warranties or for the manufacturers’ standard warranty, whichever is greater. Transfer manufacturers’ guarantees or warranties on all installed traffic signal control equipment to the maintaining agency upon completion and acceptance of the project.

1908.4 TESTING
Performance testing shall be in conformance with ODOT CMS 633.06.

1908.5 METHOD OF MEASUREMENT
Measurement will be made as follows: ITEM 809E69122: ATC V6.24 Controller furnished and installed in place, complete and accepted by the ENGINEER.

1908.6 BASIS OF PAYMENT
The payment for this item shall be made at the contract unit price for each unit, complete and in place.

UNIT OF PAYMENT
Each
SECTION 2000 - RAMP METERING
2000 RAMP METER SYSTEM

ITEM 809E67000: RAMP METER SYSTEM

2000.0 GENERAL DESCRIPTION
This item of work shall consist of furnishing, installing, and testing of existing ramp metering stations to conform to the new specifications as described within. This specification describes the minimum requirement for the ramp metering signal, hardware, and software as furnished and installed by the Contractor. The ramp meter signal shall be capable of being operated by the Ohio Department of Transportation's Intelligent Transportation System (ITS). The ramp meter shall also be capable of operating locally in a traffic responsive operation. This shall be performed by means of loop detectors, side-fired radar detectors, and traffic responsive ramp metering software installed locally in the ramp metering signal controller.

2000.1 PLAN AND SPECIFICATION COMPLIANCE
The Contractor shall provide all services and equipment necessary to install ramp metering stations in compliance with the construction plans and material specifications, including all supplemental specifications and in accordance with the specifications listed below.

1. ODOT, Roadway Engineering, Standard Construction Drawings TC-82.10, TC-83.10, TC-83.20, TC-85.10, HL-30.11.


5. National Electrical Manufacturers Association Standards Publication TS-1, Parts 1, 2, 5, 6, 8, 13, and 14.


7. International Municipal Signal Association, Inc.
In case of any conflicting specification statements, the specification document hierarchy shall be in the order of “Supplemental Specifications and then follow the order listed above from 1 (highest) to 7 (lowest).

2000.2 USER CHARACTERISTICS
All field programming shall be accomplished through the use of a plug-in laptop computer and downloaded to the field processor. All data shall be in a user-friendly form, not requiring the use of hexadecimal input nor frequent references to either printed material or other screens on the loading program.

2000.3 HARDWARE REQUIREMENTS

2000.3.1 RAMP METER STATION
a. Ramp meter control equipment shall be located as per plan, and per the typical drawing.

b. Mean time between failures for the controller and cabinet hardware shall be 30,000 hours. This shall be documented and certified by the manufacturer(s) of the various hardware items.

c. The CONTRACTOR shall install 2 – 4” Multi-cell, Schedule 40 conduit and one 2” conduit between the closest 32”/36” pull box and the Ramp Meter Station cabinet as shown in the plans.
d. The CONTRACTOR shall install communication path and hardware as reflected and specified in the plans.

e. The PRIME CONTRACTOR shall hire a manufacturer representative for the side fire radar detection used to perform a site visit to direct on the exact placement of the Microwave Radar poles and detector mounting height. The Microwave Radar units shall be placed in a position that is downstream from the merge-point of the ramp with the mainline.

f. The Ramp Metering Station controller and related hardware shall be housed in a cabinet, ITS Cabinet – Ramp Meter, as per Ohio Department of Transportation Office of Traffic Operations Handbook, Section 1803 and the CALTRANS TEES 2009. Cabinet shall be included with Work Pads per ODOT Specification 633.11. Cabinet shall be incidental to the Ramp Meter System pay item.

g. Each ramp meter station shall consist of all hardware needed to be fully functional. At a minimum, the following hardware shall be furnished, installed, and included in the bid price for ITEM 809E67000 “Ramp Meter System” each:

- Model 2070 ATC Controller w/ 7A Serial Module, 1C CPU, and 2E Field I/O Module
- Model 206 Power Supply Module.
- Model SSS-8610 Flasher Module, Model 204, or equivalent.
- Model 200 Load Switch, or Model SSS-88, or equivalent shall be used to power signal heads (Qty. 3 per Ramp Meter Station)
- Two (2) Channel Loop Detectors units to cover all mainline lanes in dual mode and ramp detectors shown in the plans as wired per wiring diagram and input file software requirements.
- Vehicular Signal Heads, Miscellaneous: 12", 2-section LED per ODOT standard Specification, five (5) units, polycarbonate housing with aluminum visors (Yellow).
- Pedestals, 8’, Transformer Base per ODOT Standard Specification, two (2) units.
- Pedestals, Foundations per TC-83.20 per ODOT Standard Specification, two (2) units.
- “Stop Here on Red” right arrow 24” x 30” sign including support.
- “Stop Here on Red” left arrow 24” x 30” sign including support.
- “One Vehicle per Green” 24” x 24” sign, two (2) units.
- Ramp Meter Sign, per ODOT Standard Specification, including:
  - Pole, breakaway, foundation, and anchor bolts.
  - Sign, signal beacons, and all mounting hardware.
- Microwave Detector support, located a minimum of 500 feet downstream from the ramp merge point with the mainline, as detailed within including:
  - Pole, foundation, and anchor bolts
  - Microwave Detector
    - Side-Fire Radar Detector with loop emulation option and one of the following communication protocol combinations
      - Two (2) RS485/RS422 or RS232 communication ports with a minimum of 16 contact closures
      - One (1) RS485/RS422 or RS232 communication port, one (1) Ethernet TCP/IP port, and a minimum of 16 contact closures
    - A Bluetooth Module shall be possible to be integrated into the unit as a replacement to one of the communication ports
    - Cabling shall be run from the radar detector down to a pole-mounted Nema 4X breakout box cabinet, where it will then have the contact closure wires continue through and the communication port wires connected to separate cabling to send the communication back to the Ramp Meter Cabinet
      - The wires to be used for the contact closures will bypass the termination block and head directly to the ramp meter cabinet.
• The wires to be used for the communication port will be terminated to separate cabling the ran to the ramp meter cabinet.
• 2 EDCO PC642C020 surge suppressor w/ compatible PCB1B base, Qty. 2 per Ramp Meter Station, or equivalent
• Detector Loop Terminal Strip shall be located on the inside of the cabinet so as to provide easy access to the Loop Detector Connections.
• 19” Rack-mount pull-out drawer to house spare parts and any technical drawings/information per ODOT Construction and Material Specification 733.03.D.4
• There shall be enough power outlets installed in each cabinet to power all devices and provide ITS engineers with two additional GFCI outlets for testing equipment.
• Qty. 1 – 32 Mbit Datakey per controller installed.

Additional Cabinet Power Surge Suppression

In addition to the surge suppression provided on the incoming power to the cabinet, Surge Suppression shall be installed, in order to provide protected power outlets to all devices placed in the cabinet. This surge suppression shall be capable of being plugged into a standard 5-15 outlet. This device shall meet the following minimum specifications:
• 9 NEMA 5-15 outlets
• Shall mount in a standard 19” rack
• Energy Handling – 1280 Joules
• UL 1499 let through rating – 400 Volts
• Surge Current Rating – 50,000 Amps
• Output Current – 15 A

This secondary Surge Protection shall be included in the bid price for the Ramp Metering System.

a. In addition to the hardware documentation required by the CalTrans Specifications, five (5) copies of the ramp metering software operation manuals and documentation shall be delivered to the Intelligent Transportation Systems (ITS) Engineer six (6) weeks prior to delivery of the controller.
b. Upon receipt of these copies, the ITS Engineer will furnish the CONTRACTOR with the data needed to start up the system. An ITS Engineer (614-387-4013) shall be contacted three (3) days prior to the activation of the ramp meter, in order for the Engineer to perform on-site testing when the activation starts.

2000.3.2 RAMP METER SIGNAL DISPLAY

a. Ramp meter signal displays shall be located as shown on the plans and on the typical in the plans.
b. The foundation, transformer base, and pedestal shaft shall conform to Standard Construction Drawing TC-83.20.
c. Signal heads shall be 12”, two section, red over green, LED and shall conform to 732.01. The signal housings shall be polycarbonate with aluminum visors. The low mounted signal head shall be mounted as shown on Standard Construction Drawing TC-85.10.
d. The signal display shall be bid as part of the Ramp Meter System item. It includes the foundation excavation, foundation concrete, anchor bolts, transformer base, pedestal shaft, signal heads complete with bulbs, reflectors and lenses, attaching hardware and all other items necessary for complete installation. Electrical cable will be paid as a separate item.

2000.3.3 RAMP METER SIGN

a. Ramp meter sign and warning flashers shall be installed as per the Ramp Meter Sign drawing. All signs shall be of the high-visibility retro-reflective type.
b. This item shall include the foundation excavation, foundation concrete, anchor bolts, breakaway base, pole, sign, sign brackets, sign luminaire, flashers, cabinet installed flasher module, mounting hardware, and all other items necessary for a complete installation.

c. Electrical cable will be paid as a separate item. A quantity of signal cable, five (5) conductors, #14 AWG will be provided - two (2) conductors of which is for the flashers and two (2) conductors for the luminaire.

Electrical cable shall be paid under ITEM 632E40500 SIGNAL CABLE, 5 CONDUCTOR, NO.14 AWG

2000.4 SOFTWARE REQUIREMENTS

2000.4.1 RAMP METERING CONTROLLER PROCESSOR

a. Shall be compatible with the Ohio Department of Transportation’s specified data protocol for communications with the Traffic Management Center (1980 W. Broad St, Columbus, Ohio)/ITS Lab (1606 W. Broad St, Columbus, Ohio) for both (accepts and transmits)

b. Processes all local detector data.

c. Turn advanced warning sign Beacons on 20 seconds prior to metering operation displaying first RED signal

d. Ramp loop monitoring and error flagging.

e. Dwell in steady green during all non-metering periods.

2000.4.2 LOCAL METERING CAPABILITY

a. Local parameters can be entered, modified, and viewed using a laptop computer and on-screen display:
   - Table appears on the screen.
   - Type over to enter or modify local database.
   - Direct numerical input to PC.
   - No direct Hexadecimal or machine input required by the person entering the data.
   - Ramp Meter Controller Status Display showing minimum of the following real-time data:
     1. Ramp Meter Operation
        a. Implemented Action
        b. Metered Lane Interval
        c. Command Source
        d. Metering Level
        e. Metering Rate
        f. Minimum Metering Time
        g. Minimum Non-Metering Time
        h. Interval Timer
     2. Mainline Data
        a. Station Average Speed, Occupancy, and Flow Rate
        b. Average Mainline Station Speed, Occupancy, and Flow Rate per Lane
        c. Historical Station Average Speed, Occupancy, and Flow Rate

b. The ramp metering software shall utilize a NTCIP 2070 controller and shall be capable of setting the following parameters with minimal effort:
   - Operational Minimum Metering Rate
   - Operational Maximum Metering Rate
   - Startup Warning Time
c. The ramp metering software shall be capable of performing the following user-defined ramp metering modes:
   • Fixed Time-of-Day Metering
   • Local Traffic Responsive Metering based on downstream mainline conditions communicated from the Side-fired radar vehicle detector.
     ○ Capable of utilizing both Speed and/or Occupancy Mainline Data as defined by the End-User on a lane-by-lane basis
   • Dwell in Green during all non-metering periods.
   • Emergency Green and/or Pre-emption green
   • Rest in Dark

d. The ramp meter shall have the capability of being controlled/programmed by the following sources (Prioritized from Highest Priority to Lowest Priority):
   • Central Command
   • Manual Control (Locally)
   • Time-Based (Local Controller Settings)

e. The ramp meter shall have the following loop detector inputs:
   • Demand
   • Passage
   • Intermediate Queue
   • Excessive Queue

f. Metering Modes:
   • Fixed rate metering.
   • Local traffic responsive metering based upon:
     1. Volume and Occupancy thresholds.
     2. Volume only threshold.
     3. Occupancy only threshold.

2000.4.3 SOFTWARE DOCUMENTATION
a. The following up-to-date documentation shall be furnished with each ramp meter cabinet:
   • Full operating instructions.
   • Full software documentation

2000.5 TESTING AND CERTIFICATION
1. All loops installed by the CONTRACTOR shall be tested for continuity (paragraph 3) and insulation (paragraph 4) as per 632.27. The insulation resistance measured to ground shall not be less than one hundred (100) megohms. A copy of the test records shall be furnished to the ODOT ENGINEER. Any loops which test open or less than one hundred (100) megohms to ground shall be re-cut at the CONTRACTOR’s expense.
Each ramp meter installed under this project, including all hardware and software components, warning sign, and loop detectors, shall be tested for operational completeness. Testing shall be performed in the presence of an ITS ENGINEER and/or his/her designated representative and shall consist of Pre-Test check-out Test and a Ramp Meter Sixty-day Performance Test.

The CONTRACTOR shall state, to the ENGINEER, in writing, that the ramp meter is complete and ready for local testing. Within five (5) days upon receiving this notification the ENGINEER shall begin the Pre-test Check-out.

a. Pre-test Check-out

   The ENGINEER and/or his/her representative shall thoroughly exercise the system, using and test or procedure that would demonstrate the capabilities of each component. All hardware, software, and performance functions, including the maintenance and troubleshooting software, shall be individually checked for compliance with the specifications. Training is considered a system component and shall have been furnished before the tests can begin. Any portion of the project which does not meet these specifications shall be corrected by the CONTRACTOR and rechecked by the ITS ENGINEER. The CONTRACTOR shall demonstrate that the field equipment can meet the requirements as specified in this document.

b. Ramp Meter Sixty-day (60) Performance Test – Local Control.

   Following successful completion of the Pre-test Check-out, and the correction, repair and/or replacement of identified deficiencies, the CONTRACTOR shall demonstrate that the system satisfies the specified operational requirements as an integrated unit by operating the system continuously for ten (10) consecutive days without major malfunction or failure.

   The CONTRACTOR shall notify the ENGINEER, in writing, that the Ramp Meter Sixty-day (60) Performance Test will begin on a date and time mutually acceptable to all parties, including the City.

   During the Ramp Meter Sixty-day (60) Performance Test the ITS ENGINEER shall exercise the system and document the performance of all specified features and any other events, which could be expected to occur in an operational Traffic Management System, including the simulation of failures. During the system exercise, the Ramp Meter Sixty-day Performance Test may be suspended or terminated by the ENGINEER or the CONTRACTOR. Suspension is defined as halting the test progress, the CONTRACTOR or City taking necessary corrective action, and the test being resumed from the point of suspension. Termination is defined as halting the test. In the event of termination, the CONTRACTOR shall take necessary corrective action, and the test shall be restarted from the beginning. Any corrective action shall be by mutual agreement between the CONTRACTOR and the ENGINEER.

   The Ramp Meter Sixty-day (60) Performance Test may be suspended for the following reasons, including but not limited to:

   - Failure of interference due to conditions beyond the control of the CONTRACTOR, such as vandalism, traffic accidents, power failures, and similar occurrences.
   - Communications noise from an outside source.
   - Failure of any support or diagnostic equipment necessary to successfully test the system.
   - Failure of any communications hub.
• A hardware failure of the computer or associated critical peripheral equipment, or a computer software error, which causes the system to crash or behave erratically.

The Ramp Meter Sixty-day (60) Performance Test may be terminated for the following reasons, including but not limited to:

• Failure of any hardware or performance item to meet these specifications.
• Communications noise from an outside source.
• Failure of software to change timing patterns or go from metering to non-metering in the local mode of operation.
• Failure of the warning sign to operate properly, except for lamp outages.
• Intermittent or catastrophic failure of any ramp meter loop detectors.
• Failure of any electronic component in the ramp meter cabinet.
• The appearance of any problem, which, in the opinion of ODOT or its representative, has a significant effect upon the reliability, safety, or operation of the system.

Each ramp meter will be tested for proper operation from the ODOT ITS Lab, 1606 West Broad St., Columbus, Ohio.

2000.6 BASIS OF PAYMENT

The testing report shall be turned into the ENGINEER and all deficiencies corrected before payment of any “Item 809”, “Ramp Metering System” item. The pay item will pay for each system that furnish and install and approved by the ENGINEER.
2001 RAMP METER TRAINING

ITEM 809E67050: RAMP METERING TRAINING

2001.1 TRAINING

General
The CONTRACTOR shall supply an 8-hour classroom and hands-on training session for maintenance personnel in the operation and maintenance of all field equipment. The personnel shall be designated from ODOT.

Training in proper maintenance and operating procedure is a key element in the success of any traffic control system. The CONTRACTOR shall provide all maintenance and local operations training prior to any equipment being made operational in the field.

Training shall be provided by personnel thoroughly familiar with the equipment operation. This may be the CONTRACTOR’s personnel, equipment manufacturer representatives, or a combination of the two. A complete course outline and summary of the experience and qualifications of the instructional personnel shall be submitted and approved by the ITS ENGINEER prior to the start of training. Training sessions may be combined and/or shortened with the agreement of the ITS ENGINEER and the CONTRACTOR.

Recommended test equipment, literature, and drawings for the classes shall be furnished by the CONTRACTOR. At the conclusion of classes all items furnished, which are not currently owned by ODOT, shall be turned over to the ITS ENGINEER.

Maintenance Personnel Training
Training for maintenance personnel shall consist of two separate and identical courses of 8 classroom and system demonstration hours each. Training shall be as follows:

Part 1: 4 hours: The objective of Part 1 is to provide operational description, troubleshooting procedures, recommendations for test equipment, test equipment use, repair procedures, design data, and drawings for Ramp Meter Cabinets and equipment furnished as part of this project. This training shall be provided before the first ramp meter is installed.

Part 2: 4 hours: The objective of Part 2 is to provide “hands on” experience with trouble shooting software, manuals, drawings, and test equipment for all Ramp Metering and communications equipment furnished as part of this project.

Training shall be conducted at ODOT Central Office. The training shall, when possible, make use of and be centered around test equipment presently owned by the owner agencies. The CONTRACTOR is responsible for determining the test equipment available at each of the various maintenance agencies. Class size for each of the two courses shall be limited to fifteen (15) persons to afford maximum individual experience.

All training class time (indoors or outdoors) shall be videotaped by the CONTRACTOR on standard format. The media shall be turned over to the ITS ENGINEER following the training.

2001.2 BASIS OF PAYMENT
The pay item will pay for each complete 8-hour training session that is provided and approved by the ENGINEER.
SECTION 2100 - DETECTION
2100 SIDE FIRED VEHICLE DETECTOR

ITEM 809E68900: SIDE-FIRED RADAR DETECTOR

2100.0 GENERAL DESCRIPTION
Furnish and install units as listed on the TAP. The Microwave Detector assembly shall consist of everything as detailed below.

- Microwave Detector
  - Side-Fire Radar Detector with loop emulation option and one of the following communication protocol combinations, depending on the type of installation.
    - Two (2) RS485/RS422 or RS232 communication ports with a minimum of 16 contact closures (To be used for Ramp Metering Sites only)
    - One (1) RS485/RS422 or RS232 communication port, one (1) Ethernet TCP/IP port, and a minimum of 16 contact closures
    - One (1) RS485/RS422 or RS232 communication port, one (1) Ethernet TCP/IP port
    - One (1) Ethernet TCP/IP port only (To be used with Central Office ITS approval only)
    - Two (2) Ethernet TCP/IP ports (To be used with Central Office ITS approval only)
    - One (1) RS485/RS422 communication port and One (1) RS232 communication port
  - If unit has an Ethernet TCP/IP port, it may additionally have access to an internal camera, but it is not required.
  - Cabling shall be run from the radar detector down to a pole-mounted Nema 4X breakout box cabinet (if not on the same pole as any other ITS device), where it will then have the contact closure wires continue through (if used with Ramp Metering) and the communication port wires connected to separate cabling to send the communication back to the Ramp Meter Cabinet or ITS Cabinet
  - A Bluetooth Module shall be possible to be integrated into the unit as a replacement to one of the communication ports

- All connectors, plugs, and wiring needed to make the detection system fully operational shall be considered part of this work. This shall include wiring to pole or ground mounted ITS cabinet.

Installations will be new installations. Installation will include all mounting hardware necessary for attachment to poles.

2100.1 REQUIREMENTS

2100.1.1 GENERAL REQUIREMENTS
1) The detectors will operate in loop emulation mode.
2) Provide NEMA 4X breakout box cabinet enclosure mounted on the radar pole with surge suppression as necessary for each unit.
3) 120VAC power will be provided to each site. Side-fire radar units shall operate at 24 VDC or Power Over Ethernet (POE). The contractor shall provide a power transformer/converter from 120VAC to 24VDC or appropriate POE injector, or equipment as otherwise required by the OEM for the side-fire radar unit to operate.
4) Primary communications with the VDU shall be Ethernet.

2100.1.2 COMPLIANCE
1) All materials installed shall be fully compliant with NTCIP and NEMA TS-4 standards where the standards are applicable.

2100.1.3 INSTALLATION
1) The detector will be mounted in a side-fired configuration. It will be mounted on poles or structures at the specified locations, using mounting brackets recommended by the manufacturer for attachment to steel or aluminum poles.

2) The contractor shall install the detector unit on a pole at the height, as determined by the manufacturer’s installation instructions, above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified elevation angle as suggested by the manufacturer. The detection zones shall be set up using the provided software and a laptop PC.

2100.1.4 TESTING
1) Upon completion of the SFRVD equipment installation at a roadside site, an acceptance test shall be conducted by the CONTRACTOR at the site according to the approved testing plan for SFRVD equipment. The CONTRACTOR shall provide seven-calendar days’ notice to ENGINEER, requesting permission to conduct a site acceptance test on a specific workday. No more than two acceptance tests shall be scheduled in any given four-hour period per day. At the discretion of the ENGINEER, the ENGINEER or a designated representative may witness the Stand-Alone Site Acceptance test. The CONTRACTOR shall arrange, at no additional expense to the Department, the attendance of a qualified technical representative of the equipment manufacturer to attend each test until ten percent (10%) or a minimum of two (2) sites of that particular type are approved, whichever is greater. The contractor is required to submit a Stand-Alone Site acceptance test plan for review and approval. At a minimum this test plan shall include basic tests for volume and speed. The test methodology should compare traffic count and speed data collected by the SFRVD against data collected using both manual and automated data collection methods. All raw data must be placed in a form suitable for analysis. The test plan is required to be developed to ensure a 95% confidence level that the average speed measured is within ± 5 mph.

2100.2 METHOD OF MEASUREMENT
Measurement will be made as follows: ITEM 809E68900: SIDE-FIRED RADAR DETECTOR, furnished and installed in place, complete and accepted by the ENGINEER.

2100.3 BASIS OF PAYMENT
The payment for this item will be made for the accepted quantities at the contract unit price.
UNIT OF PAYMENT
Each
2101 STOP LINE RADAR DETECTION

ITEM 809E69100: STOP LINE RADAR DETECTION

2101.0 GENERAL DESCRIPTION
The contractor shall furnish and install a Stop Line Radar Detection unit capable of intersection detection control utilizing above ground Advanced Radar Tracking Techniques. One unit shall be provided per approach, where specified in the plans, covering multiple lanes where stop line detection is required.
The following shall be incidental to this item of work:
  • A serial to Ethernet communications module and Ethernet cable (min. 7 feet) shall be provided.
  • The power supply and communications modules shall be secured to a single panel that can be mounted to the interior of a traffic cabinet. The panel shall include modular-plug style connections for up to four (4) sensor cables. Additional sensors may be hard-wired to the communication modules, as necessary.

2101.1 REQUIREMENTS

2101.1.1 GENERAL REQUIREMENTS
  • The unit shall be non-intrusive and shall detect vehicles from 6 feet up to 140 feet for a 90-degree field of view from the unit.
  • The unit shall provide real-time presence data for a minimum of 10 lanes.
  • The unit shall provide at least 16 detection zones simultaneously for intersection control.
  • The unit shall provide presence-detection of stopped vehicles with a minimum of 98% accuracy for all motor vehicles.
  • The unit shall include a simple setup routine that shall automatically configure and calibrate the unit for proper operation during installation. The unit shall also be capable of being programmed and updated from a laptop computer or other portable programming device, such as a Pocket PC, via a local or remote ethernet connection using vendor supplied software. The software shall support TCP/IP connectivity, unit configuration back-up and restore, and Real-time traffic visualization for performance verification and traffic display. The graphical user interface shall operate on a Windows platform.
  • The unit shall have two half-duplex RS-485 communication ports and shall have the ability to upgrade firmware over any communication port.
  • Surge protection devices, as recommended by the manufacturer, shall be included both at the pole where the unit is located to protect the unit and in the traffic cabinet to protect the cabinet electronics.
  • The unit shall consume less than 10 Watts and operate from a DC input between 9 VDC and 28 VDC. Complete and automatic recovery from a power failure shall be within 15 seconds after resumption of normal power.
  • All required inputs cards shall be included in the traffic cabinet and shall be compatible with CalTrans, NEMA TS1 and NEMA TS2 detector racks. The cards shall provide true presence detector calls or contact closure to the traffic controller.
  • The manufacturer’s representative shall be on site during installation and testing and shall provide onsite training on the setup, operation, and maintenance of the unit.

2101.2 COMPLIANCE
  • The unit shall be tested to meet NEMA TS2 environmental standards and maintain accurate performance in the following operating conditions:
    o Rain up to 1 inch per hour
    o Freezing rain
    o Snow
    o Wind
    o Dust
• The radar design for each unit shall conform to the following:
  o Operating frequency: 24.0–24.25 GHz (K-band)
  o No manual tuning to circuitry
  o Transmits modulated signals generated digitally
  o No temperature-based compensation necessary
  o Bandwidth stable within 1%
  o Printed circuit board antennas
  o Antenna vertical 6 dB beam width (two-way pattern): 65 Degrees
  o Horizontal field of view: 90 Degrees minimum
  o Antenna two-way sidelobes: -40 dB
  o Transmit bandwidth: 245 MHz
  o Un-windowed resolution: 2 feet
  o RF channels: 8 minimum
  o Self-test for verifying hardware functionality
  o Diagnostics mode for verifying system functionality

2101.3 METHOD OF MEASUREMENT
Measurement will be made as follows: ITEM 809E69100: STOP LINE RADAR DETECTION, furnished and installed in place, complete and accepted by the ENGINEER.

2101.4 INSTALLATION
The unit shall be mounted in a forward-fire or side-fire position, looking at either approaching or departing traffic and shall only detect vehicles in one direction of travel. The unit shall be mounted directly to a pole or mast arm, as recommended by the manufacturer. Cable(s) shall be provided as required and recommended by the manufacturer. Power shall be provided from the traffic cabinet.

2101.5 BASIS OF PAYMENT
The payment for this item shall be made at the contract unit price for each unit, complete and in place including all required cabinet hardware, mounting brackets, cables, conduit and connections tested and accepted.

UNIT OF PAYMENT
Each
2102 ADVANCE RADAR DETECTION

ITEM 809E69000: ADVANCE RADAR DETECTION

2102.0 GENERAL DESCRIPTION
This item of work shall consist of furnishing and installing an Advance Radar Detection unit capable of intersection advance detection control utilizing above ground Digital Wave Radar Techniques. One unit shall be provided per approach, where specified in the plans, covering multiple lanes where advance detection is required. The following shall be incidental to this item of work:

- A serial to Ethernet communications module and Ethernet cable (min. 7 feet) shall be provided.
- The power supply and communications modules shall be secured to a single panel that can be mounted to the interior of a traffic cabinet. The panel shall include modular-plug style connections for up to four (4) sensor cables. Additional sensors may be hard-wired to the communication modules, as necessary.

2102.1 REQUIREMENTS

2102.1.1 GENERAL REQUIREMENTS

- The unit shall track the speed, range, and perform real time calculations of how long it will take a vehicle to arrive at the stop line for each vehicle it detects.
- The unit shall determine the time, location and size of gaps in flowing traffic.
- The unit shall be non-intrusive and shall detect vehicles from 50 feet up to 900 feet from the unit.
- The unit shall provide up to 8 detection zones simultaneously for intersection control.
- The unit shall provide presence-detection of moving vehicles with the following accuracy:
  - Detection accuracy shall be 98% for large vehicles and 95% for all motor vehicles.
  - Range accuracy shall be ± 10 feet for 90% of measurements
  - Speed accuracy shall be ± 5 miles per hour 90% of measurements
- The unit shall include a simple setup routine that shall automatically configure and calibrate the unit for proper operation during installation. The unit shall also be capable of being programmed and updated from a laptop computer or other portable programming device, such as a Pocket PC, via a local or remote ethernet connection using vendor supplied software. The software shall support TCP/IP connectivity, unit configuration back-up and restore, and virtual sensor connections. The graphical user interface shall operate on a Windows platform.
- The unit shall have one full-duplex RS2-232 and one half-duplex RS-485 communication ports and shall have the ability to upgrade firmware over any communication port.
- Surge protection devices, as recommended by the manufacturer, shall be included both at the pole where the unit is located to protect the unit and in the traffic cabinet to protect the cabinet electronics.
- The unit shall consume less than 10 watts and operate from a DC input between 9 VDC and 28 VDC. Complete and automatic recovery from a power failure shall be within 15 seconds after resumption of normal power.
- All required inputs cards shall be included in the traffic cabinet and shall be compatible with CalTrans, NEMA TS1 and NEMA TS2 detector racks. The cards shall provide true presence detector calls or contact closure to the traffic controller.
- The manufacturer’s representative shall be on site during installation and testing and shall provide onsite training on the setup, operation and maintenance of the unit.

2102.2 COMPLIANCE

- The unit shall be tested to meet NEMA TS2 environmental standards and maintain accurate performance in the following operating conditions:
  - Rain up to 4 inches per hour
• Freezing rain
• Snow
• Wind
• Dust
• Fog
• Changing temperature
• Changing lighting

The radar design for each unit shall conform to the following:

- Operating frequency: 10.5–10.55 GHz (X-band)
- No manual tuning to circuitry
- Transmits modulated signals generated digitally
- No temperature-based compensation necessary
- Bandwidth stable within 1%
- Printed circuit board antennas
- Antenna vertical 6 dB beam width (two-way pattern): 80 Degrees
- Antenna horizontal 6 dB beam width (two-way pattern): 10.5 Degrees
- Antenna two-way sidelobes: -40 dB
- Transmit bandwidth: 45 MHz
- Un-windowed resolution: 11 feet
- RF channels: 4

2102.3 METHOD OF MEASUREMENT
Measurement will be made as follows: ITEM 809E69000: ADVANCE RADAR DETECTION furnished and installed in place, complete and accepted by the ENGINEER.

2102.4 INSTALLATION
The unit shall be mounted in a forward-fire or side-fire position, looking at either approaching or departing traffic and shall only detect vehicles in one direction of travel. The unit shall be mounted directly to a pole or mast arm, as recommended by the manufacturer. Cable(s) shall be provided as required and recommended by the manufacturer. Power shall be provided from the traffic cabinet.

2102.5 BASIS OF PAYMENT
The payment for this item shall be made at the contract unit price for each unit, complete and in place including all required cabinet hardware, mounting brackets, cables, conduit and connections tested and accepted.

UNIT OF PAYMENT
Each
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SECTION 2200 – MISCELLANEOUS NOTES
2200 DOWNTIME FOR ITS DEVICES

2200.0 GENERAL DESCRIPTION

The following specifies the duration allowed for outages communication and power for ITS devices located throughout the State of Ohio. The contractor shall be required to abide by these maximum downtimes and shall have adequate means to ensure that any necessary temporary lines/devices are installed prior to the removal/de-energizing of any cable to the specified device. The ODOT Office of Traffic operations requires notification of any outage a minimum of 7 workings days in advance so that any additional work on ODOT’s part may be coordinated. Notification shall be emailed to CEN.ITS.Lab@dot.state.oh.us. ODOT Traffic operations shall be the sole determining party in deeming if a circumstance is unusual and shall be granted additional downtime. All work shall be performed on the weekend, unless it has been determined otherwise by ODOT Traffic operations.

2200.1 Dynamic Message Signs (DMS):
DMS shall be limited to a maximum downtime of 8 hours. The contractor shall make arrangements to maintain power to this device at a minimum. When relocating DMS, the downtime shall be limited to a maximum downtime of 48 hours.

Disincentive: $400/day or $17/hour – beginning after the allowable downtime

2200.2 CCTV Cameras:
CCTV Cameras shall be limited to a downtime of 72 hours. The contractor shall make arrangements when having to relocate these devices so that the new infrastructure is in place before taking the existing site equipment offline.

Disincentive: $400/day or $17/hour – beginning after the allowable downtime

2200.3 Highway Advisory Radios (HAR):
HAR shall be limited to a maximum downtime of 8 hours. These devices shall be maintained in the approximate area of the existing location prior to the start of construction. If necessary the HAR may be moved temporarily to the construction project office, if located nearby. When located at the construction project office it shall be reinstalled and reconnected to the ODOT network at the project office within the maximum downtime period.

Disincentive: $400/day or $17/hour – beginning after the allowable downtime

2200.4 Vehicle Detector Stations (VDS) / Radar Vehicle Detectors (RVD):
VDS and RVD shall not be limited to a maximum downtime. However, the contractor shall not perform any action that results in the loss of communication/power to two or more VDS/RVD in succession. Those RVD's that are part of a queue warning station do not apply to this item and the contractor is directed to the queue warning station section of this note.

2200.5 Highway Advisory Radio Flashing Beacon Systems (HAR-FBS):
HAR-FBS shall not be limited to a maximum downtime. The purpose of these sites is to notify the motoring traffic of the radio station that broadcasts traffic data and alert motorists of traffic alerts through the use of flashing beacons. If these devices are disturbed during construction, they shall be returned to the approximate original location and in the same condition in which they were removed.

2200.6 Queue Warning Stations
Due to the function of these devices, the maximum downtime shall be limited to 8 hours. These devices are comprised of multiple radar vehicle detectors and changeable message signs. Due to the interoperability of all devices related to the system, any one of these items being down equals the entire system being down.
Disincentive: $400/day or $17/hour – beginning after the allowable downtime

2200.7 Fiber Optic Cable
All fiber optic cable shall be limited to a 24-hour maximum downtime, except the 24-strand single-mode fiber optic cable located in the District 6 Region along I-71 (downtown to the North Outerbelt), which shall be limited to a maximum downtime of 12 hours. All temporary fiber optic cable shall be installed and ready for splicing prior to any existing fiber optic cables on the project being severed. The contractor shall be required to provide a temporary fiber optic cable having the exact same fiber count and buffer tube orientation as the existing, so as not to confuse any maintenance activities that may occur during the construction project. All fibers of the temporary cable shall be core-aligned fusion spliced to the like fiber (buffer-tube to buffer-tube, color to color) regardless if they are active.

Disincentive: $400/hour – beginning after the allowable downtime
2201 MAINTAINING ITS DURING CONSTRUCTION

ITEM 809E700000: MAINTAINING ITS DURING CONSTRUCTION

2201.0 GENERAL DESCRIPTION

It is the contractor’s responsibility to maintain and restore as necessary the functionality of all permanent ITS fiber and equipment in accordance with the ‘ITS Device Downtime Section’ of the 809 supplemental specification and this handbook, as well as maintaining the initial ITS field locate that ODOT performs, within the project area.

2201.1 REQUIREMENTS

Equipment not damaged or disturbed due to construction activities shall remain operational by providing some type of temporary connection between the pieces of equipment and an adjacent operational cabinet. This may be accomplished via aerial connection or through an existing/new conduit and fiber cable. The contractor shall be responsible for all connections, and work shall not be acceptable until reviewed and inspected by the project engineer and ITS personnel. Service to all ITS device shall be maintained throughout construction.

The ITS Infrastructure is not listed as a member of OUPS at this time. All requests for locates shall be coordinated through the Office of Traffic Operations, ITS Field Operations Section. The contractor shall submit requests to CEN.ITS.LAB@dot.ohio.gov. The ITS shall be marked once by ODOT personnel or an ODOT representative and the contractor shall take care to note where the infrastructure is located. After this initial marking has occurred, it shall be the responsibility of the contractor to perform any remarking of the ITS infrastructure when needed. Locating by the contractor will be done every 10 days.
SECTION 2300 – HIGHWAY LIGHTING

RESERVED FOR FUTURE USE
SECTION 2400 – Communications
2400 ETHERNET CABLE, OUTDOOR-RATED

ITEM 809E64550: ETHERNET CABLE, OUTDOOR RATED

2400.1 GENERAL DESCRIPTION

The Contractor shall furnish and install a Category 5e or greater outside plant Ethernet cable that meets the following minimum specifications:

- Footage Markings: Every 3 feet
- Armor: Aluminum with inner jacket
- Conductor Insulation: Polyolefin
- Jacket: UV and Abrasion Resistant Polyethylene
- Conductors: 24 AWG solid bare annealed copper
- Cable Diameter: Maximum 0.35 inches
- Flooding Compound: Waterproof Gel
- Minimum Bend Radius: 1.0 Inch
- Maximum Pulling Force: 25 pounds
- Shielded or Unshielded
- Temperature Rating
  - Installation: -30 to +60 C
  - Operation: -45 to +80 C
- Color Code
  - Pair 1: Blue-White/Blue
  - Pair 2: Orange-White/Orange
  - Pair 3: Green-White/Green
  - Pair 4: Brown-White/Brown

The Contractor shall install cable as shown in plans, or as directed by engineer, leaving 10 feet of slack in each pull box. The cable shall be terminated with RJ-45 connectors and wired per TIA/EIA 568-B.

2400.2 METHOD OF MEASUREMENT

Measurement will be made as follows: ITEM 632E62810: INTERCONNECT CABLE, MISC.: CATEGORY 5E CABLE, OUTDOOR RATED, furnished and installed in place, complete and accepted by the ENGINEER.

2400.3 BASIS OF PAYMENT

The payment for this item will be made for the accepted quantities at the contract unit price.

UNIT OF PAYMENT
Feet