

SECTION 682 VIDEO EQUIPMENT

682-1 CCTV Camera.

682-1.1 Description. Furnish and install a closed-circuit television (CCTV) camera at the location(s) shown in the Plans. Ensure that the installed equipment provides unobstructed video images of the roadway, traffic, and other current conditions around a roadside CCTV field site; that it responds to camera control signals from the operator; and that the video images can be transmitted to remote locations for observation.

682-1.2 Materials:

682-1.2.1 Camera: Furnish a CCTV camera that is compatible with the current version of the Department's SunGuide® software system, and any other camera operating software indicated in the Plans or in the contract documents. Use either a dome-type or external positioner-type CCTV camera assembly. Ensure that the appropriate type is used at the locations shown in the Plans. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

For analog cameras, ensure that the camera produces National Television System Committee (NTSC) composite video output of 1 volt peak-to-peak (Vp-p) at 75 ohms (Ω) with a minimum resolution of 470 horizontal and 350 vertical TV lines. In addition, ensure analog and internet protocol (IP) cameras provide the following features and capabilities:

1. Day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.
2. Ability to produce clear, detailed, and usable video images of the areas, objects, and other subjects visible from a roadside CCTV field site. Ensure that video produced by the camera is true, accurate, distortion free, and free from transfer smear, oversaturation, and any other image defect that negatively impacts image quality under all lighting and weather conditions in both color and monochrome modes.
3. User-selectable automatic gain control (AGC) that is peak-average adjustable to 28 decibels (dB).
4. A minimum signal-to-noise ratio of 50 dB.
5. Automatic color balance that references the white areas of the scene through the lens.
6. An automatic electronic shutter that is user selectable from 1/60 to 1/10,000 of a second.
7. A digital signal processor that provides a minimum 10x digital zoom.
8. Programmable azimuth and compass display with ability to display pan and tilt position with a 1 degree resolution.

Furnish a CCTV camera that provides titling and masking features, including, but not limited to, programmable camera title, programmable preset titles for each preset position, and programmable privacy zones. Ensure that programmable titles are a minimum of 18 characters per line.

682-1.2.2 Lens: Ensure that the standard definition CCTV camera has a minimum 22x motorized optical zoom lens with automatic iris. Ensure that the high definition CCTV camera has a minimum 18x motorized optical zoom lens with automatic iris. Ensure that the lens is capable of automatic and manual focus and iris control. Ensure that the lens depth of field

provides a clear image of roadside areas under all lighting conditions and that the lens has a maximum aperture of at least f/1.6.

682-1.2.3 Pan/Tilt Mechanism for Dome-Type Cameras: Ensure that dome-type CCTV cameras include an integrated pan/tilt mechanism capable of providing 360 degree continuous pan with a minimum 90 degree tilt range (i.e., 0 degrees to minus 90 degrees); provide variable speed control; have a preset position return accuracy of plus or minus 0.36 degree, or less than 0.10% or better; support a minimum of 64 presets; support a minimum of one tour with a minimum of 32 presets; and support a minimum of eight programmable blackout zones.

Ensure that the positioner within the dome-type CCTV camera has a minimum automatic pan speed of 240 degrees per second to a preset camera position; that the maximum manual pan speed is a minimum of 80 degrees per second; and that maximum manual tilt speed is a minimum of 40 degrees per second.

682-1.2.4 Pan/Tilt Mechanism for External Positioner-Type Cameras: Ensure that external positioner-type CCTV cameras include a pan/tilt mechanism capable of providing 360 degree continuous pan with a minimum 115 degree tilt range (i.e., minus 90 to plus 25 degrees); provide variable speed control; have a preset position return accuracy of plus or minus 0.36 degree, or less than 0.10% or better; and support a minimum of 32 presets.

682-1.2.5 Communication: Ensure that the CCTV camera supports the National Transportation Communications for ITS Protocol (NTCIP) 1205 v1.08. Ensure that the camera is capable of communication with other devices using Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)-232 or TIA-422 at a rate of 9600 bps, transmission control protocol (TCP)/IP, or user datagram protocol (UDP)/IP. Ensure that the CCTV camera supports the communication links shown in the Plans. The camera must be capable of remote firmware upgrade via the communication interface.

Ensure that IP cameras also support the Open Network Video Interface Forum (ONVIF) Core, Streaming, and Media Service specifications.

682-1.2.6 Electrical Specifications: Camera must operate on a nominal voltage of 120 volts alternating current (V_{AC}). Supply an appropriate voltage converter for devices that require operating voltages of less than 120 V_{AC} .

682-1.2.7 Mechanical Specifications: Provide camera housings and hardware that are light in color or as noted in the Plans.

Ensure that the camera housing has a sunshield to reduce the solar heating of the camera. Ensure that the total weight of dome type CCTV cameras (including the housing, sunshield, and all internal components) is less than 17.0 pounds. Ensure that the lower dome of the camera housing is distortion free clear plastic.

Ensure that pressurized dome-type housings are capable of pressurization at 5 pounds per square inch (psi) using dry nitrogen, that they have a low-pressure alarm feature, and has a NEMA 4X/IP-67 rating.

If a non-pressurized dome-type housing enclosure is used, ensure that the unit is vented with a thermostat-controlled heater and blower. Ensure that the non-pressurized enclosure has a NEMA 4/IP-66 rating.

Ensure that the total weight of external positioner-type CCTV cameras (including housing, sunshield, all internal components, and external pan and tilt mechanism) is less than 35 pounds.

682-1.2.8 Environmental Specifications: Ensure that the CCTV camera performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.

Ensure that the CCTV camera, mounting hardware, and any other camera-related material that is exposed to the environment can withstand 150 mph wind speeds and meet the requirements of the Department’s Structures Manual, Volume 3.

682-1.2.9 Additional Requirements for IP Cameras: The following sub-articles provide additional requirements for IP-enabled cameras.

682-1.2.9.1 Video Encoding: The camera must utilize the Moving Picture Experts Group’s MPEG4 part 10 (H.264) video compression technology in accordance with the ISO and IEC requirements detailed in the ISO/IEC 14496-10:2009 Standard.

Ensure that the camera is capable of unicast and multicast operation. Ensure that the camera provides 99.999% error-free operation. Ensure the encoded video can be transmitted utilizing programmable bit rates. Ensure the camera supports, at a minimum, fixed bit rate mode.

682-1.2.9.2 Encoded Video Interoperability: Ensure the camera’s encoded video can be displayed using video display control systems on the APL.

682-1.2.9.3 Encoded Video Specifications: Ensure that the camera’s encoded video supports resolutions that include, but are not limited to, those defined in Table 1.1. Ensure that the camera is capable of delivering color and monochrome video at 30 frames per second (fps) regardless of resolution.

Table 1.1 – Minimum Resolution Requirements	
Format	Vertical Resolutions
H.264	240, 480
Note: The resolutions attained depend on the data transmission rate.	

682-1.2.9.4 Network Interface: Ensure that the camera’s local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet connections. The camera shall have a minimum of one Ethernet port, which shall be a 10/100 Base-TX connection.

Ensure that all unshielded twisted pair/shielded twisted pair network cables are compliant with the TIA-568 Standard. Ensure that the network communication conforms to TCP, UDP, Version 4 of the IP, real-time streaming protocol (RTSP), and Version 2 of the internet group multicast protocol (IGMP), at a minimum. Ensure the camera can be controlled via NTCIP using either TCP/IP or UDP/IP.

682-1.2.9.5 Configuration Management: The camera shall support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including but not limited to, network configuration, video settings, device monitoring, and security functions. Ensure that the camera supports configuration and management via serial login, telnet login, or a web-based interface.

682-1.3 Installation Requirements: Install the CCTV camera on a pole in accordance with Design Standards, Index Nos. 18100 through 18111 and as shown in the Plans.

Furnish and install the power supplies, local control equipment, and any other camera-related field electronic equipment and transient voltage surge suppressors within a pole- or base-mounted lockable cabinet. Ensure that the cabinet protects these electrical and electronic devices from rain, dust, dirt, and other harmful elements of nature.

Furnish and install all power, video, and data cables necessary to provide connection points for camera video and pan/tilt/zoom (PTZ) control signals within the cabinet. Furnish and install any and all ancillary equipment required to provide a complete and fully operational CCTV camera. Verify that all wiring meets National Electric Code (NEC) requirements where applicable.

Ensure that data and video cables from the pole or support structure to the camera are routed inside the mounting hardware and protected from exposure to the outside environment.

Coat the exterior of the dome-type enclosure's lower half with a clear, rain repellent product prior to final acceptance.

682-1.4 Testing:

682-1.4.1 General: Subject the equipment covered by these specifications to a field acceptance test (FAT). Develop and submit a test plan to the Engineer for review and approval. Ensure that the test plan demonstrates each and every functional requirement specified for the device or system under test. The Engineer reserves the right to witness all tests.

682-1.4.2 Field Test Requirements: Perform local field operational tests at CCTV field sites according to the following:

1. Verify that physical construction has been completed as specified in the Plans.
2. Verify the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Verify all connections, including correct installation of communication and power cables.
5. Verify that the video signal from the camera is present and of consistent quality at all connection points between the camera, the cabinet, and any video devices therein.
6. Exercise PTZ and focus in all directions and execute a minimum of three other unique programming commands to ensure that the communication link between the cabinet and the camera is functioning properly.

682-2 Video Display Equipment.

682-2.1 Description. Furnish and install video display equipment as shown in the Plans.

682-2.2 Materials:

682-2.2.1 General: Use video display equipment that can display analog, digital, and other images associated with the operation of the transportation management center (TMC). These types of images include, but are not limited to:

1. CCTV video images, including feeds from other TMCs.
2. Video vehicle detection (VVD) system images.
3. System infrastructure mapping images.
4. Graphical user interfaces from computers running typical TMC applications.
5. Weather mapping images.
6. Television broadcasts.

7. Digital video discs (DVDs), videocassette recordings, or other video storage media.

Provide equipment, mounting hardware, cabling, and other video display components that are compatible with each other. Ensure that all equipment and materials furnished and installed are reviewed and approved by the Engineer.

Use display devices of the types shown in the Plans.

682-2.2.2 Video Display Control System: Furnish a video display control system listed on the APL. Ensure that the video display control system enables the operator to control and manage the display of video and computer-generated graphics on the display equipment connected to the system as well as provide selection and switching of multiple sources for display, including video streams available on the TMC Ethernet network. Ensure that the display control system allows an operator to control all displays from the same workstation that is used for the SunGuide® operator interface. Ensure that the video display control system is capable of decoding and displaying all video streams produced by encoders listed on the APL.

Use a video display control system capable of simultaneously displaying a minimum of 32 video windows, each containing streaming video at a minimum resolution of 720 pixels x 480 pixels and frame rate of 30 (fps). Ensure that the system allows any display window to be sized from 1/32 of the total display area up to the total display area, and any size in between.

Ensure that the video display control system hardware is designed to be rack mounted and secured in an EIA 19 inch equipment rack. Ensure that any system incorporating personal computer (PC) hardware utilizes current microprocessor technology and commercial, off-the-shelf components, including random access memory (RAM), hard disk drives, and network interface cards sufficient to provide the functional requirements of the system.

682-2.2.2.1 Display Control Software: Provide display control software that enables multiple operators to control all features and functions of the video display control system. These features and functions include, but are not limited to, selection of video sources for display; adjusting the size, location, and layout of video and other graphic information the system displays; and system configuration and setup. Ensure that the control software is able to operate a video wall composed of multiple display components as though it were a single, high-resolution display.

Use display control software that is compatible with the Department's SunGuide® software system.

Ensure that the display control software includes a non-proprietary software development kit (SDK) including, but not limited to, an application programming interface (API) that describes interfaces and protocols which can be used to integrate system features and functions with third-party applications.

682-2.2.2.2 Inputs and Outputs: Use a video display control system that supports and displays a variety of video and data inputs simultaneously, including composite and component National Television System Committee (NTSC) video, digital visual interface (DVI), video graphics array (VGA), super video graphics array (SVGA), and super extended graphics array (SXGA) computer graphics. Ensure that all inputs and outputs can be controlled by an operator in order to display any or all of this information on any number of display devices within the system. Ensure all inputs and outputs can be sized with and without constrained

proportions across multiple screens and moved at will around any display area and combination of displays.

Ensure that the video display control system is expandable and scalable to support any combination of inputs and outputs. Provide the video display control system with a minimum configuration of 4 composite video inputs, 4 component (red, green, and blue [RGB]) video inputs, and 4 DVI inputs as well as network connections, decoders, and associated hardware and software required to display 32 inputs simultaneously at a minimum resolution of 720 pixels x 480 pixels and a frame rate of 30 fps, or as shown in the Plans. Provide the video display control system with a minimum configuration of 4 composite video outputs, 2 component (RGB video outputs), and 4 DVI outputs, or as shown in the Plans. Ensure the video display control system can be expanded to accommodate at least 128 discreet inputs and outputs.

Ensure that a single input can be routed to multiple displays simultaneously and that multiple inputs can be routed to a single display simultaneously for viewing in separate windows. Ensure that all inputs and outputs are synchronized by the video display control system and that switching between inputs or outputs does not cause displayed images to unlock, roll, or otherwise exhibit visible distortion.

682-2.2.2.2.1 Analog Video: Ensure that the video display control system is able to accept S-video, composite, and component video sources, and can digitize these signals for manipulation and display on any display device attached to the system. Ensure that all analog video inputs utilize BNC connectors.

Ensure that analog video sources can be displayed within their own windows, and can be resized up to or beyond their native resolution to conform to the wall display size.

682-2.2.2.2.2 Digital Video: Ensure that the video display control system is able to accept digital video sources, and can manipulate and display these signals on any display attached to the system. Ensure that all digital video outputs utilize DVI connectors.

Ensure that each MPEG video stream can be displayed within its own window, which shall be freely movable and sizable up to or beyond its native resolution to conform to the wall display size.

682-2.2.2.2.3 RGB Video: Include an analog input that enables the TMC operator to project an exact copy of his or her workstation desktop display on the video wall display. Ensure that analog RGB inputs allow native images up to 1,280 pixels by 1,024 pixels at 60 Hz to be displayed on the video wall.

Ensure that RGB inputs are sizable up to or beyond their native resolution to conform to the wall display size.

682-2.2.2.2.4 Streaming Media: Ensure that the video display control system can display a minimum of 32 compressed video streams simultaneously in MPEG-2 over TCP/UDP/RTP over IP and supports multicasting as defined in Version 2 of the Internet Gateway Message Protocol (IGMP). Ensure that the video display control system can display MPEG-4 and H.264. Ensure that the MPEG video input interface is, at minimum, a 10/100 megabit per second network port per every 15 streams.

682-2.2.2.2.5 Primary Display Output: Use a video display control system that can process the various signal input types to be viewed, such as the RGB feeds from monitor outputs and streaming video feeds. Ensure that the unit provides direct digital streaming video through cable feeds using a digital video decoder. Ensure that the video display

control system provides the layout definitions for each signal to be displayed and saves the predefined layouts. Ensure that the video display control system also permits switching of the predefined layouts and accepts external alarm triggers to change the layouts.

Include output capacity with sufficient memory and processing speed to provide fast rendering of video and image displays. Ensure that the output has, at a minimum, a dual DVI connector that allows a digital connection of 1,280 horizontal pixels by 1,024 vertical pixels or greater resolution. Ensure that the color depth is a minimum of 24 bits per pixel. If the projection device requires an analog signal, then breakout cables may be used to convert the DVI output connector to a HD15 analog RGB connector.

682-2.2.3 Video Wall Display: Furnish and install a video wall display consisting of tiled, rear projection video display cubes arranged in a wall, as shown in the Plans, together with a video display control system.

Ensure that the video wall display is capable of producing, at a minimum, a large-scale, high-resolution video image having accurate color rendition, sufficient image brightness, and a high contrast ratio, as described in 682-2.3. Ensure that the display system provides access to serviceable components for repair and replacement of electronics, lamps, and optical components without removing the device from service for a period longer than 30 minutes.

Integrate the individual projection units in a single, seamless display capable of projecting a continuous image across the entire active display area provided, under the complete control of the TMC operators from their individual shared workstations.

Source all major wall display components from a single provider or manufacturer to ensure that the various devices are compatible with each other and able to function together as an integrated display.

Ensure that the individual video images exhibit a uniformity of color quality across the multiple displays. Ensure that colors are displayed evenly across the video wall, and that the video wall maintains uniform brightness characteristics from one video display unit to the next in the tiled display, with no degradation in color or brightness uniformity over time. Ensure that the video wall display provides features that allow physical and electronic alignment of the separate high-resolution display units that comprise the wall.

682-2.2.4 Video Wall Support Structure: Furnish and install an aluminum or steel-frame structure capable of supporting the rear projection video display units as mounted and stacked to form the matrix for the video wall display. Ensure that the support structure consists of stackable projection modules delivering a one-to-one relationship between the number of projectors and the number of screens. Ensure that this structure maintains a consistent maximum horizontal and vertical spacing of 0.04 inches between adjacent display units in the video wall matrix.

Fabricate the support structure specifically to ensure that a continuous, accurate image is projected on the screens without any distortion or unused screen space. Ensure that no observable distortions are present in the installed video wall display due to normal building vibration. Ensure that each completed structure is enclosed such that there is no ambient light effect on the screen from behind the display.

Ensure that the components of the individual video modules can be serviced without disturbing the integrity of the entire video wall display.

682-2.2.5 Rear Projection Video Display: Use rear projection video displays that are suitable for digital video wall applications in mission-critical TMCs where video wall

image quality, operational reliability, and serviceability objectives as stated in this specification can be achieved.

Use rear projection video displays capable of displaying a minimum of a single or quad-split, four-paned CCTV camera video image. Ensure that each video display can be independently controlled from any of the central operator or shift supervisor workstations, and that each video display can be integrated with additional video units to form a single video display, or a virtual desktop where video windows can be positioned and resized by the operator.

Ensure that the rear projection video display facilitates lamp replacement without the need to readjust the image being projected on the screen.

Ensure that the rear projection video display's intensity is sufficient to ensure effective and comfortable viewing by TMC operations personnel under normal lighting conditions, subject to approval by the Department. Ensure that the unit's display engine produces a minimum light output of 550 ANSI lumens.

Ensure that the rear projection video units have the following minimum features and characteristics:

1. Screen brightness achieved by a combination of projection techniques and screen materials, so that the video display has a minimum brightness measurement of 130 candelas per square meter (cd/m²) across the outside viewing surface of the projection screen.

2. Brightness uniformity that meets or exceeds 80 percent across the display unit, as measured using a photometer.

3. A multi-lamp optical engine must be provided for rear projection video units that do not use light-emitting diodes (LEDs) for illumination. Multi-lamp optical engines must provide a failover feature whereby a second lamp can be automatically activated when the first lamp fails. Ensure displays with multi-lamp optical engines provide indication of lamp status.

4. Multi-lamp optical engines must include (1) a "hot standby" mode in which failover to the second lamp takes no more than two seconds and (2) a "cold standby" mode in which failover and the time for the display to return to full light output does not exceed 30 seconds.

5. A display module that utilizes modular component architecture to permit service or replacement of serviceable parts without removing the projection engine.

6. Each unit shall be completely enclosed and light tight, with fixed panels for access to the lamp, power supply, and projection engine.

682-2.2.6 Flat Panel Display: Furnish and install a flat panel display unit to reproduce video and computer graphics information. Ensure that the device displays, at a minimum, a high-resolution, distortion-free image and maintains a consistent level of illumination across the entire screen area. Ensure that it has the following minimum features and characteristics:

1. Dimensions of 24 inches high by 41 inches wide by 4 inches deep, or as shown in Plans.

2. Ability to be installed on the face of a standard wall or flush mounted within the wall system.

682-2.2.7 Cabling: Furnish each video display component with all required appurtenances, including all the necessary cables, with proper length and connectors for power and communication, as defined by the manufacturer. Ensure that cabling conforms to applicable

EIA/TIA standards. Size the power cables to meet NEC requirements. Provide communication cables from each video display component to the network communication devices that are appropriate for and compatible with the technology employed (e.g., fiber optic, twisted pair, or coaxial), and meet the minimum size and bandwidth specifications the manufacturer requires.

Provide all cabling of adequate length, along with the compatible connectors and any ancillary equipment necessary to fully interconnect the video components and display control systems needed to achieve the functions required. Label all cables at both ends, as approved by the Engineer.

682-2.2.8 Electrical Specifications: Provide equipment that operates on 120 VAC at a frequency of 60 Hz. Furnish a transformer or other necessary means of power conversion for any device that requires another voltage or frequency.

Conduct TMC field reviews to examine the electrical distribution panels allocated for various equipment items and the electrical schedules for each. Make any changes, additions, or corrections to the electrical panels, wiring, outlets, and connectors that may be deemed necessary to adequately power all of the equipment proposed for a video display project at the intended location, subject to the approval of the Engineer. Make any changes to the building's electrical wiring in accordance with applicable codes and permits, and with the NEC. Submit any modifications to an existing building's wiring or the video wall electrical wiring plans, signed and sealed by a Specialty Engineer, as defined in 1-3.

682-2.3 Performance Specifications: Use only display devices meeting the following minimum requirements.

	Flat Panel Display			Rear Projection Video Display
Type	Direct View LCD			DLP or LCD
Size	(dependent on TMC design, as shown in Plans)			
Aspect Ratio	(dependent on TMC design, as shown in Plans)			
Resolution	1600 x 1200 / 1280 x 768 pixels; 16.7 million colors			1024 x 768 pixels
Viewing Angle	170 degrees horizontally and vertically	160 degrees horizontally and vertically		160 degrees horizontally and vertically
Half Gain Angle	—	—		±40 degrees horizontally and vertically
Contrast Ratio	500:1	600:1		600:1
Screen Brightness *	250 cd/m2	450 cd/m2		130 cd/m2
Lamp Life	—	—		8,000 hrs. (avg.)
Video Inputs	Analog/digital via 15-pin D-sub (HD-15) connector; DVI-D connector.	Composite video (NTSC) on RCA connector; analog/digital via 15-pin D-		Composite video (NTSC) on BNC; RGB via 15-pin D-sub (HD-15) connector;

		sub (HD-15) connector; DVI-I connector; HDMI.		DVI-D connector.
Operating Temperature and Humidity	32° to 95°F. 20 to 80%.	32° to 95°F. 20 to 80%.		32° to 95°F. 20 to 80%.
Power Requirements	120 VAC at 60 Hz	120 VAC at 60 Hz		120 VAC at 60 Hz
* Measured using a photometer.				

682-2.4 Installation Requirements: Do not proceed with any part of the procurement, construction, or installation of the video display equipment until the Construction Plans and materials are approved by the Engineer. Submit to the Engineer documentation, including the manufacturers' product specification sheets and a detailed description of each item's function as well as a compliance matrix that confirms all equipment meets or exceeds the requirements of these specifications.

Configure each video display unit to provide individual, independent control from each operator workstation.

Create the video wall display by arranging individual video display units in a framework or apparatus that creates the video wall configuration as shown in the Plans. Ensure that the finished video wall provides a single, apparently seamless display area. Ensure that adjacent individual display units are aligned physically and electronically so that image content stretched across multiple monitors align within plus or minus 2 lines of horizontal and vertical resolution.

Ensure that all rear projection video unit controls are accessible at all times when the devices are permanently installed. Ensure that installation and positioning does not conceal or limit access to any display unit controls at any time during active use.

Follow proper ventilation and cooling procedures for the equipment installed, as determined by the equipment manufacturers. Provide electrical requirements and power distribution units and power supplies for the video display components on an as-needed basis.

682-2.5 Testing:

682-2.5.1 General: Submit a detailed system acceptance test plan to the Engineer for review and approval. Prepare a test plan that covers all areas of system function described in this section, and that is developed according to the various equipment manufacturers' recommendations.

Check and test the satisfactory operation of all video display components upon completion of the equipment's installation. At minimum, include in the video display system test the testing of each color video monitor type, each secondary display output at workstations, each rear projection video display unit, and the video wall display's image alignment and control functions.

682-2.5.2 Observation Period: Subject the video wall display to a 90 day operational observation period, during which time the Contractor shall perform any and all maintenance, recalibration, system checking, and display modifications required by the Engineer. The Engineer has the option to require a restart of the observation period if a major system flaw or failure occurs.

682-3 Warranty.

682-3.1 General: Ensure that CCTV cameras and video display equipment have a manufacturer's warranty covering defects for a minimum of three years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608. Ensure that the warranty requires the manufacturer to furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department or the maintaining agency within 10 calendar days of notification.

Warranty repairs of the video display control system and related TMC display equipment must commence within 24 hours after notification by the Department.

682-4 Method of Measurement.

The Contract unit price for each CCTV camera or video display device or system, furnished and installed, will include furnishing, placement, and testing of all equipment and materials, and for all tools, labor, operational software packages and firmware, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

The video display equipment shall be measured as each major system component is furnished, installed, made fully operational, and tested in accordance with this Specification or as directed by the Engineer.

682-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

- Item No. 682-1- CCTV Camera—each.
- Item No. 682-2- Video Display Equipment—each.