SPECIAL SPECIFICATION
CCTV Field Equipment

1. **Description.** Furnish and install closed circuit television (CCTV) field equipment.

2. **Materials.** Provide new, corrosion resistant materials in accordance with the details shown on the plans and this item.

   Provide CCTV field equipment including, but not limited to, the following:
   - Color video camera units.
   - Camera lenses, filters, control circuits and accessories.
   - Camera housings.
   - Medium duty pan and tilt units.
   - Camera control receivers.
   - Video and camera control and power cable harnesses, connectors and coaxial cable.
   - Equipment for accommodating presets.
   - Source ID Generator.
   - When shown on the plans, Local Control Panel.

A. **Functional Requirements.** Provide CCTV Cameras in accordance with NTSC and EIA-170A. Conform the system limiting resolution to FCC regulations for broadcast signals. Provide clear, low-bloom and low-lag video pictures under all conditions from bright sunlight to nighttime scene illumination of 0.1 ft.-candle (fc.). Maintain color quality by a continuous through the lens automatic white balance for color temperatures from 2850ºK to greater than 5100ºK with less than 10 IRE units unbalance.

   Provide field equipment that operates in all weather conditions and able to withstand a wind load of 80 mph without permanent damage to mechanical and electrical equipment, unless otherwise shown on the plans.

   Provide equipment from the same manufacturer at each field location.

B. **Electrical and Mechanical Requirements.**

   1. **Video Camera Unit.** Provide color video cameras of solid state design, and that meet the following requirements:
      - Use Digital Signal Processing (DSP):
        - For digital zoom;
        - For Auto/Manual long-term integration (exposure) control, with built-in frame buffer;
        - For Auto-focus;
        - For built-in I.D. Generator, with white letters and black outline.
• **Image Pickup Device:** 1/4 in. single chip interline transfer solid state color matrix CCD microlens sensor

• **Pickup Device Blemishes:** When viewing a uniform white field, there must be no blemishes for any iris opening producing any signal level between 7.5 and 100 IRE.

• **Sensitivity:** Maintain full p-p video with 0.1 fc. 3200°K incandescent illumination on the image device face plate with AGC off.

• **Resolution:** > 350 lines vertical and > 460 lines horizontal, measured per EIA-170A Standard.

• **Over Exposure Protection:** The camera must not sustain any permanent damage when pointed directly at strong light sources, including the sun, for brief periods of time.

• **Encoded NTSC Video Signal Format:** EIA-170A Standard, video output 1 Volt p-p composite. Must have up to 16 dB AGC.

• **Output Impedance:** 75 Ohms ± 5%.

• **Aspect Ratio:** 4:3.

• **Geometric Distortion:** Zero.

• **Signal to Noise Ratio (AGC Off):** 55 dB minimum (weighted at 4.5 MHz).

• **Sensor with a minimum of 768(H) X 493(V) pixels.**

• **Lens must be integral to camera assembly.**

• **Electronic Shutter Speed:** software selectable, remotely.

2. **Camera Lens.** Provide an integral lens assembly for each camera with the following features:

   • An f/1.6 or better glass multi-coated zoom lens. The lens must have variable focal length from 3.9 mm to 85.8 mm.

   • Provide motorized iris control with manual override with each lens.

   Provide a lens with capabilities for remote control of zoom, focus and iris operations. Provide mechanical or electrical means to protect the motors from overrunning in extreme positions. The lens and controller system must be capable of both auto iris, and remote manual iris operation. Iris must be “motorized”, as opposed to “auto iris” type, for system control compatibility.

3. **Camera Housing.** Furnish and install an environmental resistant and tamperproof housing pressurized to 5 psi dry Nitrogen with Schrader purge fitting and 20 psi relief valve for each camera.

   Except for the viewing window, construct the enclosure from 6061-T6 standard aluminum tubing with a wall thickness of 0.20 in. ± 0.03 in. Label internal wiring properly. Use a gas-tight connector at the rear plate of the housing.
The internal humidity of the housing must be less than 10%, when sealed and pressurized. Securely place desiccant packs inside the housing to absorb any residual moisture and maintain internal humidity at 10% or less.

Provide a low pressure sensor in the camera to put a “low-pressure” annotation on the video signal through the internal I.D. generator.

Construct the viewing window in such a way that unrestricted camera views can be obtained at all camera and lens positions.

Provide a sun shield to shield the entire housing from direct sunlight and vertical rainfall. Construct it in such a way as to allow the free passage of air between the housing and the shield, but it must not form a “sail” to place an excessive load on the pan/tilt unit in high winds.

Provide with an internal 15 W. low temperature heater with its own thermostat control in each housing.

Provide lightning protection as shown on the plans in each housing.

4. **Pan-Tilt Unit.** Furnish and install a medium duty, anodized aluminum weatherproof pan-and-tilt unit at each camera site on top of the camera pole. Provide a mounting plate to install the unit on the pole. Design the mounting for the camera housing and the pan-and-tilt unit to withstand the wind loading specified in Section 2.A.

Provide a unit with vertical movement of + 40° to – 90° and horizontal movement of 360° full, contiguous rotation movement. Tilt speed must be 20° per sec. and the pan speed must be up to 100° per sec. Provide a unit that is capable of simultaneous pan-and-tilt movements.

Provide a unit with a load rating compatible with that of the camera housing, camera and cabling under wind conditions specified in Section 2.A. and acceleration/deceleration conditions specified. Provide analyses of the loading on the pan-and-tilt assembly based on the above criteria.

Use Stepper motors.

Provide pan-and-tilt units that have seals and gaskets to protect the motors, gears, and cables. Provide seals and gaskets that are resistant to ozone, ultraviolet radiation, and other pollutants inherent to local environmental conditions.

5. **Local Control Panel.** Provide Local Control Panel that meet the following specific requirements without use of a laptop:
   - Pan Left.
   - Pan Right.
   - Tilt Up.
   - Tilt Down.
   - Zoom In.
• Zoom Out.
• Focus Near.
• Focus Far.
• Manual and Auto Iris control.
• Iris Open.
• Iris Close.
• Pan/Tilt Position preset.
• Camera Power (Latching).
• Remote white balance control.
• Auto and Manual white balance control.
• Zoom and focus position preset.

6. **Control Receivers.** Mount the camera control receiver inside the camera unit. It must execute camera and lens functions and must also forward communication of commands for the pan/tilt functions to the pan/tilt control receiver. Mount the pan/tilt control receiver inside the pan/tilt unit. Provide camera and pan/tilt functions that are operable via RS-422 serial communications.

Provide control receivers that receive the command data from the camera controller and decode the digital command data signals transmitted through the communication transmission interface, perform error checking and act on valid data to drive the pan/tilt unit and the camera controls. Detail the communications transmission interface on the plans. Provide control receivers that are fully compatible with the existing camera controller shown on the plans.

Provide control receivers that meet the following specific requirements:

• **Camera remote control functions:** Provide units with, as a minimum, control and drive circuits for the following functions:
  
  • **DSP Functions:** Zoom, Long-Term Exposure, Auto-Focus, Auto/Manual focus Control, I.D. Generator Operation, and Alarm function Control.
  
  • Pan/Tilt Position preset.
  
  • Pan Left.
  
  • Pan Right.
  
  • Tilt Up.
  
  • Tilt Down.
  
  • Zoom and focus position preset.
  
  • Zoom In.
  
  • Zoom Out.
  
  • Focus Near.
  
  • Focus Far.
- Manual and Auto Iris control.
  - Iris Open.
  - Iris Close.
- Camera Power (Latching).
- Remote white balance control.
- Auto and Manual white balance control.
- One auxiliary output (unless specified otherwise in the plans).
- **Controller Address:** Provide each unit with a unique programmable address. Provide units that respond to the central command if and only if they are addressed.

- **Power Supplies:** Provide power supplies required to operate the camera, pan/tilt, and lens movements and include them with the housing, camera control receiver, and pan/tilt unit.

- **Communications Interface:** Provide a camera control receiver that interfaces to the communications backbone through an EIA-232C/D port. When indicated on the plans, provide communications signals, data exchange protocol and timing that is compatible with the communications equipment and with the existing master controller in the satellite building. Use a minimum 9600 Baud data rate. Data must be sent asynchronously as either 8 bit with no parity, or 7 bit with parity. Each block of data must include a camera identifier and be accompanied by a checksum calculated on the entire block. Blocks with a bad checksum must be NAKed. Block with a good checksum must be ACKed. If the field unit must transmit data to the control unit at the Satellite Building, it must raise the RTS line and keep it raised until all data has been sent. Provide a field unit that will not transmit data unless the CTS line from the communications equipment is raised. Provide the camera control receiver connectors and harness to connect to the communications equipment interface. Supply complete hardware interface and protocol description to the Department as part of the required documentation.

  Provide RS-232 to RS-422 external powered converter that is an integral part of the video communication junction box.

- **Power Input:** 115 VAC plus or minus 10%, 60 Hz ± 3 Hz, 50 W. Maximum.

- **Connectors:** Provide and install connectors which are compatible with the communications equipment interface. Use Connectors for connections at the pan/tilt mechanism. Make connections through a pigtail with a connector on it coming out of the bottom center of the pan/tilt unit. Provide the connector on the pigtail that is an AMP type connector. Provide connections down to the pole to the transmission cables to this connector. Supply mating connectors. Provide connector pins and mating connectors that are plated to ensure good electrical connection and resist corrosion. Use pressure tight multi-conductor MS-type cable connectors for camera connections.
7. **Source ID Generator.** Provide the built-in I.D. Generator that inserts camera ID over each of the camera generated videos.

Submit a list of proposed camera identification text to the Engineer for approval before the ID is programmed.

Once programmed, the programmed ID must automatically be displayed with its associated video signal.

Provide the source ID generator that will automatically “pass through” video in case of equipment failure.

When indicated on the plans, provide the source ID generator that is compatible with the existing camera controller shown on the plans.

8. **Video Communication Junction Box.** Install the video communication junction box in the CCTV equipment cabinet or in the surveillance cabinet, as shown on the plan and as directed by the Engineer. Provide the video communication junction box that contains the lightning protection devices for data, power, and video. The junction box must be grounded very well to the earth ground. Provide the junction box that has connectors for inputs and outputs for data, power, and video. Make testing and connections to communication devices through these external connectors.

9. **Surge Protection.** Provide the camera installation that meets the following requirements:
   - Pole mounting adapter -- Electrically bonded to pole.
   - Pan/tilt mechanism -- Electrically bonded to adapter.
   - Camera housing -- Electrically bonded to pan/tilt unit.

10. **Power and Control Cable Surge Protector.** Protect each power conductor and each control conductor (including return conductors) by the appropriate surge protector. House the protective devices in each of the surveillance cabinets.

11. **Power Requirements.** Provide CCTV field equipment that meets its specified requirements when the input power is 115 VAC ± 10%, 60 Hz ± 3 Hz. The maximum power required must not exceed 350 W.

    Provide equipment operations that are not affected by the transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

12. **Primary Input Power Interruption.** Provide CCTV field equipment that meets the requirements in Section 2.1.4. “Power Interruption” of the NEMA Standard TS2 for Traffic Control System.

13. **Power Service Transients.** Provide CCTV field equipment that meets the requirements of Section 2.1.6., “Transients, Power Service” of the NEMA Standard TS2.
14. **Wiring.** Provide wiring that meets the requirements of the National Electric Code. Provide wires that are cut to proper length before assembly. Do not doubled-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

Provide coaxial cable between the camera and the communications equipment interface that is of the RG-59 type with a stranded center conductor and 100% shield coverage. Provide coaxial cable that has a cellular polyethylene dielectric.

15. **Transient Suppression.** Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

16. **Power Service Protection.** Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

17. **Fail Safe Provision.** Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment.

18. **Modular Design.** Provide CCTV field equipment that is modular in design to allow major portions to be readily replaced in the field. Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

19. **Connectors and Harnesses.** Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and/or appropriately mark wires to and from the connectors.

Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

C. **Environmental Design Requirements.** Provide equipment that meets its specified requirements during and after subjecting to any combination of the following conditions.

- Ambient temperature range of 0°F to 140°F.
- Temperature shock not to exceed 30°F per hour during which the relative humidity must not exceed 95%.
- Relative humidity range not to exceed 95% over the temperature range of 40°F to 110°F.
- Moisture condensation on exterior surfaces caused by temperature changes.
Provide camera and environmental housing assemblies that perform to stated specifications over an ambient temperature range of –35°F to +130°F and a humidity range of 0% to 100% condensing. The camera must operate without sustaining damage over temperature range of –35°F to 140°F.

3. **Construction Methods.**

   A. **General.** Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

   Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

   B. **Electronic Components.** Provide electronic components in accordance with Special Specification, “Electronic Components”.

   C. **Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.


7. **Warranty.** Provide a warranty in accordance with Article 6, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty”.

8. **Measurement.** This Item will be measured as each unit furnished, installed, and tested.

9. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “CCTV Field Equipment”. This price is for equipment, cables and connectors; documentation and testing; and labor, materials, warranty, training and incidentals.
SPECIAL PROVISION
TO
SPECIAL SPECIFICATION
CCTV Field Equipment

For this project, “CCTV Field Equipment,” is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 1. Description. the first paragraph is voided and replaced by the following:

Furnish and install closed circuit television (CCTV) field equipment in designated field locations and equipment cabinets as shown on the plans, in accordance with this Item and as directed.

Article 2. Materials. the first paragraph is supplemented by the following:

Provide CCTV Field Equipment that is fully compatible with Lonestar™ in order to interface with the existing equipment and software located in the TransGuide Operations Control Center.

Article 2.A. Functional Requirements. is voided and replaced by the following:

A. Functional Requirements. Provide CCTV cameras that meet the following criteria:

1. 525 lines per frame, interlaced 2:1, per EIA-170A Standard.
2. No discernible interlace jitter or line pairing on the viewing monitor.
3. Frame frequency of 30 frames per second.
4. Width to height aspect ratio of 4:3.
5. System limiting resolution that conforms to FCC regulations for broadcast signals.
6. System capable of providing clear, low-bloom and low-lag video pictures under all conditions from bright sunlight to nighttime scene illumination of 0.85 foot-candle (fc) with full video AGC (Automatic Gain Control) off.
7. Color quality that is maintained by a continuous through the lens automatic white balance for color temperatures from 2850K to greater than 5100K with less than 10 IRE units unbalance.
8. Operational in all weather conditions and able to withstand a wind load of 80 mph without permanent damage to mechanical and electrical equipment.
9. Equipment that is identical at each field location and completely interchangeable.
10. Equipment that has the TransGuide communications protocol ported into each unit.

Article 2.B. Electrical and Mechanical Requirements. The bullet Signal to Noise Ratio (AGC Off): is replaced by the following:

**Signal to Noise Ratio (AGC Off):** 50 dB Minimum (weighted at 4.5 MHz)

Article 2.B.2. Camera Lens. is voided and replaced by the following:

2. Camera Accessories. Provide an integral lens assembly for each camera with the following features:

   a. An f/1.4 or better glass multi-coated zoom lens with variable focal length from 3.4 mm to 119 mm (35X zoom lens).

   b. 12X auto/manual digital zoom.

   c. Motorized iris control with manual override with each lens.

   d. Lenses with capabilities for remote control of the zoom, focus and iris operations. Mechanical or electrical means provided to protect the motors from overrunning in extreme positions. Lens and controller system capable of both auto iris and remote manual iris operation. Capabilities of lens for the zoom and focus. Motorized iris as opposed to auto iris type, for system control capability.

   e. Lens wiper assembly with replaceable wiper blade. Provide 2 spare wiper blades for each CCTV supplied.

Article 2.B.3. Camera Housing. is voided and replaced by the following:

3. Camera Housing.

   a. Furnish and install an environmentally resistant, tamper proof pressurized housing with 5 pounds psi dry Nitrogen with Schrader purge fitting and 20 psi relief valve for each camera. Conform to IP-67 Standard.

   b. Maintain internal humidity of housing of 5% or less when sealed and pressurized.

   c. Properly label internal wiring. Use a gas-tight connector at the rear plate of the housing. Seal wiring to the connector with silicon or potting compound.

   d. Construct viewing window in such a way that unrestricted camera views can be obtained at all camera and lens positions.

   e. Provide a sun shield to shield the entire housing from direct sunlight. Provide an additional “eyebrow” type sunshield if directed by the Engineer. Construct the shield in such a way as to allow the free passage of air between
the housing and the shield, but not form a “sail” to place an excessive load on the pan/tilt unit in high winds.

f. Provide entry at the rear and/or bottom for cables and harness, with gaskets at the entry points to prevent moisture entry.

g. Provide a 6 watt low temperature heater with its own thermostat control for each housing.

h. Provide lightning protection for each camera housing, unless otherwise shown on the plans.

i. An alternate design comprised of a camera housing and pan-tilt mechanism manufactured together in a single assembly may be submitted to the Engineer for approval.

**Article 2.B.4. Pan-Tilt Unit.** is voided and replaced by the following:

4. **Pan-Tilt Unit.**

   a. Furnish and install a medium duty, anodized aluminum weatherproof pan-and-tilt-unit at each camera site, conforming to IP-66 Standard. Provide any mounting adapter and/or attachment required to install the pan-and-tilt-unit. Show the bolt pattern on submittal. Design mounting for the camera housing and the pan and tilt unit to withstand a wind load of 80 mph.

   b. Provide a unit capable of vertical movement of +90° to -90° and horizontal movement of 360°, full, continuous rotation movement, a tilt speed of 40° per second, pan speed up to 80° per second, no load, and capable of simultaneous pan-and-tilt movements.

   c. Provide a unit that has a load rating compatible with that of the camera housing, camera and all cabling, under a wind load of 80 mph and acceleration/deceleration conditions specified. Provide analyses of the loading on the pan-and-tilt assembly based on the above criteria.

   d. Use stepper motors.

   e. Ensure that the pan-and-tilt unit has seals and gaskets to protect the motors, gears, and cables and that the seals and gaskets are resistant to ozone, ultraviolet radiation, and other pollutants inherent to all local environmental conditions.

   f. Provide pan-tilt unit with heater that conforms to NEMA 4X Standard.

   g. An alternate design comprised of a camera housing and pan-tilt mechanism manufactured together in a single assembly may be submitted to the Engineer for approval.

**Article 2.B.6. Control Receivers.** the first two paragraphs are voided and replaced by the following:
6. **Control Receivers.**
   
a. Mount the camera control receiver inside the camera unit. Ensure that the camera control receiver will execute all camera and lens functions as well as forward communication of commands for the pan/tilt functions to the pan/tilt control receiver. Mount the pan/tilt control receiver inside the pan/tilt unit.

b. Ensure that when the control receiver receives the data from the camera controller, it decodes the digital command data signals transmitted through the communication transmission interface, checks for errors, and acts on valid data to drive the pan/tilt unit and the camera controls.

Article 2.B.6. **Control Receivers.** the first bullet **Camera remote control functions** is voided and not replaced

Article 2.B.6. **Control Receivers.** the bullet **Communications Interface.** is voided and replaced by the following:

- **Communications Interface.** Ensure that the Camera Control receiver will interface to the TransGuide Operations Control Center through an EIA-232CD port using a 9600 baud data rate. Provide all necessary connectors and harness to connect to the communications equipment interface. Provide the RS-232 to RS-422 self-powered converter, integral to the video communications equipment.

Article 2.B.6. **Control Receivers.** the bullet **Connectors.** is voided and replaced by the following:

- **Connectors.** Provide and install connectors that are compatible with the communications equipment interface. Use an AMP type connector and pin assignments that are compatible with existing installations. Use connectors for connections at the pan/tilt mechanism, and make connections through a pigtail with connector on it, coming out of the bottom center of the pan/tilt unit. Use this connector to make connections to the transmission cables. Supply all mating connectors. Provide all connector pins and mating connectors that are plated to ensure good electrical connection and resistance to corrosion. Use pressure tight multi-conductor MS-type cable connectors for camera connections.

Article 2.B.8. **Video Communication Junction Box.** is voided and replaced by the following:

8. **Video Communication.** Install video communication equipment in the CCTV Equipment Cabinet or in the Fiber Hub as shown on the plans and as directed by the Engineer. Ensure that it meets the following criteria:

   j. Contains all the lightning protection devices for data and video.

   k. Grounded to earth ground.
l. Has connectors for all inputs and outputs for data and video and additional ports for testing video and communications. Use the external connectors for testing and for connections to communication devices.

Article 2.B.10. Power and Control Cable Surge Protector is voided and replaced by the following:

10. Power and Control Cable Surge Protector Protected by the appropriate surge protector as specified in Special Specification, “CCTV Equipment Cabinet”.

Article 2.B.14. Wiring, the second paragraph, last sentence is voided and replaced by the following:

Provide coaxial cable that has a cellular polyethylene dielectric or a cable as recommended by the manufacturer of the CCTV Field Equipment.

Article 2.C. Environmental Design Requirements is voided and replaced by the following:

C.  Environmental Design Requirements. Ensure that equipment conforms to NEMA Standard 2.1.5.1 and meets all its specified requirements during and after being subjected to any combination of the following conditions:

1. Ambient temperature range of -29°F to 165°F.

2. Temperature shock not to exceed 30°F per hour.

3. Relative humidity up to 100%.

4. Moisture condensation on all exterior surfaces caused by temperature changes.

5. Camera and environmental housing assembly performs to stated specifications over an ambient temperature range of -29°F to 165°F in direct sunlight and a humidity range of 0% to 100% condensing. Ensure that the camera will operate without sustaining damage over a temperature range of -29°F to 165°F.

Article 4. Testing is voided and replaced by the following:

4. Testing Requirements.

A. As per TxDOT policy, performance testing is to be done on all materials and equipment not previously tested and approved. If technical data are not considered adequate for approval, samples may be requested for test by the Engineer. The contract period will not be extended for time loss or delays caused by testing prior to final TxDOT approval of any items.

B. Equipment referenced to this specification is subject to Design Approval Tests and Factory Demonstration Tests at the equipment manufacturer’s facility, to determine conformance with all the specification requirements. The Engineer may accept certification by an independent testing laboratory in lieu of the design Approval Tests,
to verify that the Design Approval Tests have previously been satisfactorily completed. Arrange for, and conduct the tests, in accordance with the specification requirements stated herein.

C. Take responsibility for satisfying all inspection requirements prior to submission for TxDOT’s inspection and acceptance. The Engineer reserves the right to have his/her representative witness all Design Approval Tests and Factory Demonstration Tests.

D. Results of each test will be compared with the requirements specified herein. Failure to conform to the requirements of any test will be counted as a defect, and equipment will be subject to rejection by the Engineer. Rejected equipment may be offered for retest, provided all non-compliances have been corrected and retested and evidence thereof submitted to the Engineer.

Article 5. Training is voided and replaced by the following:

5. Training. Conduct a training class (minimum of 40 hours) for up to 10 representatives designated by TxDOT on procedures of installation, operations, testing, maintenance and repair of all equipment specified within these specifications. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer. Customize the training specifically for the TransGuide System.

Article 6. Documentation is voided and replaced by the following:

6. Documentation Requirements. Provide 5 complete sets of operation and maintenance manuals that include the following:

A. Complete and accurate schematic diagrams.

B. Complete installation procedures.

C. Complete performance specifications (Functional, electrical, mechanical and environmental) on the unit.

D. Complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA.

E. Pictorial of component layout on circuit board.

F. Complete maintenance and trouble-shooting procedures.

G. Complete stage-by-stage explanation of circuit theory and operation.

Article 7. Warranty. is voided and replaced by the following:

7. Warranty. The start date of the manufacturer’s standard warranty will begin when the Final Acceptance Test plan commences. Any CCTV field equipment with less than 100%
of its warranty remaining at the beginning of the Final Acceptance Test will not be accepted by the Department.

Guarantee that equipment furnished and installed for this project performs according to the manufacturer’s published specifications. Warrant the equipment against defects and/or failure in design, materials, and workmanship in accordance with the manufacturer’s standard warranty. Assign, to the Department, all manufacturers’ normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Repair or replace, at the manufacturer’s option, defective equipment, during the warranty period at no cost to the Department.

**Article 8. Experience Requirements** is voided and replaced by the following:

8. **Experience Requirements.** Contractor involved in the installation and testing of video equipment as described within these specifications must meet the following requirements:

A. Two years’ experience in the installation and testing of video equipment as described within these specifications.

B. Two installed systems where video equipment, as described within these specifications, is installed and the system has been in continuously satisfactory operation for at least one year. Submit as proof, photographs or other supporting documents, and the names addresses and phone numbers of the operating personnel who can be contacted regarding the system.

C. One video system (which may be one of the two in the preceding paragraph) that can be arranged for demonstration to the Engineer and/or his/her representatives.

**Article 9. Measurement** is voided and replaced by the following:

9. **Measurement.** This Item will be measured as each unit furnished, installed, and tested.

**Article 10. Payment** is supplemented with the following:

10. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “CCTV Field Equipment”. This price is for equipment, cables and connectors; documentation and testing; and labor, materials, warranty, training and incidentals.
SPECIAL SPECIFICATION

CCTV Equipment Cabinet

1. **General.** Furnish and install CCTV Equipment Cabinets at locations shown on the plans, as detailed in this special specification and as directed by the Engineer. These cabinets house the various equipment required for the CCTV and all necessary associated electrical devices.

2. **Cabinet Design and Requirements.** Furnish, fabricate, and install only materials that are new, corrosion resistant and in strict accordance with the details shown on the plans and in the specification.

Provide CCTV Equipment Cabinet with these external dimensions:

- Height -- 36 in., Width -- 30 in., Depth -- 20 in.

- The height and depth dimensions may be ± 1 in.

Construct CCTV Equipment Cabinet using unpainted sheet aluminum with a minimum thickness of 0.125 in. Use material that meets NEMA standards.

Completely weatherproof the cabinet to prevent the entry of dust and water. Continuously weld all exterior seams of the cabinet and door, and ensure that welds are smooth.

Equip each cabinet with one shelf (30 in. wide x 14 in. deep) mounted 12 in. below the top of the cabinet and one 19 in. rack mounted on back wall of cabinet immediately below the shelf.

Equip the cabinet with circuit breakers, radio interference filters, ground loop isolators, lightning arresters and surge protectors to protect the circuit and the equipment installed in the cabinet.

Provide telephone voice communication type line circuit with telephone jack and wall telephone (2554) for voice communication. Install one jack/telephone with headset including a 50 ft. cord for telephone in cabinet.

Provide cabinet that has one front door with 3 hinges or a full length stainless steel piano hinge, with stainless steel pins spot welded at the top. Mount the hinges so that it is not possible to remove them from the door or cabinet without first opening the door. Extend the bottom of the door opening to at least the bottom level of the back panel.

Brace the door to be able to withstand a 100 lb. per ft. of door height load applied vertically to the outer edge of the door when open. Ensure that there is no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.

Install mechanism that enables the door to be held open at approximately the 90 degree and 180 degree positions.
Fit the cabinet door with a Number 2 Corbin lock and an aluminum or chrome plated handle with a 3/8 in. (minimal) drive pin and a 3 point latch. Design the lock and latch so that the handle cannot be released until the lock is released. Provide a locking ring on the handle so a padlock can be installed in addition to the Corbin lock. Provide two keys for each lock for each cabinet. Ensure that the Corbin lock is located such that it is clear of the arc of the handle.

Provide a gasket to act as a permanent dust and weather resistant seal at the cabinet door facing. Use a non-absorbent gasket material that maintains its resiliency after exposure to the outdoor environment. Use a gasket with a minimum thickness of 3/8 in., located in a channel provided for this purpose either on the cabinet or on the door. A channel formed by an “L” bracket and the door lip is acceptable. Ensure that the gasket shows no sign of rolling or sagging and creates a uniform dust and weather resistant seal around the entire door facing. Any other method is subject to engineering approval during inspection.

Cool and vent the cabinet with a thermostatically controlled fan. Install an adjustable thermostat with an adjustment range of 70°F to 110°F. Provide a press-to-test switch to test the operation of the fan.

Provide a commercially available fan with a capacity of at least 100 cfm. Construct the cabinet with filtered vent openings to allow adequate convection cooling of the electronic components installed in the cabinets. Mount the filter securely and so that any air entering the cabinet must pass through the filter. Provide air intake opening large enough to use the entire filter. Install screen with openings no larger than 0.0125 sq. in. on exhaust vent to prevent entry of insects. Ensure that total free air opening of the vent is large enough to prevent excessive back-pressure on the fan.

Provide a unique 5-digit serial number using 0.5 in. height characters for each cabinet, stamped directly on the cabinet or engraved on a metal or metalized mylar plate epoxied or riveted with aluminum rivets to the cabinet upper right sidewall near the front.

Provide copper ground buses for both the power supply neutral (common) and chassis ground. Each bus bar must provide a minimum of 2 unused terminals with 8-32 X 5/16 in. or larger screws. Jumper the AC neutral and chassis ground buses together with a minimum No. 10 AWG wire. Isolate the logic ground from the AC neutral and terminate on a logic ground bus sufficient to accept 5 No. 20 AWG stranded wires.

Mount and wire two 20 amp circuit breakers in each cabinet. Protect the fluorescent light, GFCI-protected duplex receptacle and fan with one breaker. Protect the CCTV equipment with the other breaker.

Equip the circuit breakers with solderless connectors (enclosed in an indoor service disconnect box) and installed on the sidewall or lower right hand side of the back panel inside the cabinet in such a manner that their rating markings are visible and they are easily accessible.

Install a GFCI-protected duplex receptacle of the 3-wire grounding type which will accept a standard 2-pronged non-grounding plug. Wire this receptacle on the “Load” side of the 20 ampere breaker.
Install a fluorescent light with switch in the cabinet. Wire the light so that it turns on when the cabinet door is opened and turns off when the cabinet door is closed. Provide a switch to turn off any incandescent display that may be used in a controller unit or other equipment.

Except where soldered, provide all wires with lugs or other approved terminal fittings for attachment to binding posts.

Use insulation parts and wire insulation capable of withstanding a minimum of 600 volts.

Place all wiring in a neat and orderly manner and group together with nylon tie-downs.

Cover the power panel with a clear 1/8 in. thick removable cover made from Lexan material. Place so as not to interfere with the functional operation within the cabinet.

Provide a sun shield that shields the entire housing, except the door, from direct sunlight, constructed so that it allows the free passage of air between the cabinet and the shield, but does not form a “sail” placing an excessive load on the cabinet mounting structure in high winds.

Submit the sun shield design for the Engineer's approval prior to fabrication or purchase.

C. Cabinet Environmental Design Requirements. Provide cabinet that meets all of its functional requirements during and after subjection to any combination of the following requirements:

Ambient temperature range of 0°F to 158°F.

Temperature shock not to exceed 30°F per hour, during which the relative humidity does not exceed 95%.

Relative humidity range not to exceed 95% over the temperature range of 40°F to 100°F.

Moisture condensation on all surfaces caused by temperature changes.

D. General Responsibilities. Comply with and do not deviate from this specification except when in possession of a written exception from TxDOT. Should there be a conflict between published standards and the narrative specifications, the more stringent provision applies.

E. Engineering. Provide manufacturer supplied documentation and engineering drawings, including rack face and cable drawings, etc. for the systems specified.

F. Spare Parts. Provide a manufacturer recommended spare parts list with prices. Package the parts as a kit and include 1 kit for every 1 CCTV Equipment Cabinet.

G. Technical Support. Provide manufacturer supplied engineering and field technical support as may be required by TxDOT contractor or representative to ensure reliable equipment installation and operation.

3. Uninterruptible Power Supply. Install in the cabinet an Uninterruptible Power Supply (UPS) having a front panel with indicator and control switches. Install the UPS on a line
device that provides uninterrupted AC power to a load regardless of AC source variations, fluctuations, and loss. Conform to all requirements and standards of the Environmental Protection Agency (EPA), The National Electrical Code (NEC), The Occupational Safety and Hazards Administration (OSHA), The Telecommunications Industry Forum (TCIF), the National Electrical Manufacturer’s Association (NEMA), the Acoustical Society of America (ASA), and the Institute of Electrical and Electronic Engineers (IEEE).

The UPS includes but is not limited to the following components:

- UPS Module
- Rectifier/Charger
- Static bypass switch
- Maintenance bypass switch
- Synchronizing Equipment
- Protective Devices
- Accessories (as specified herein)
- Control and monitoring panels
- Input/Output terminals for Hardwire Connection
- Batteries
- System control section with controls, metering and alarms.

Provide UPS unit consisting of a single UPS rated to supply the full load as specified herein.

Provide equipment identified in this specification as components of the UPS. Provide UPS with an input of 120 VAC single phase, and an output of 600 VA of 120 VAC, 60 Hz, single phase output power for a minimum of 30 min. when a commercial AC power failure occurs.

Provide UPS that consists of standard equipment and meets specified capacity requirements.

A. **UPS Glossary and Definitions.** The following are definitions of terminology used in this specification:

- UPS is defined as an on line device that provides uninterrupted AC power to a load regardless of AC source variations, fluctuations, and loss.

- UPS Module is defined as a Rectifier/Charger and Inverter Unit with associated controls, synchronizing equipment, protective devices and auxiliary equipment required to provide precise AC power. UPS inverter provides 100% of the UPS rated power to the load continuously.
• Rectifier/Charger Unit is defined as that portion of a UPS module containing the equipment and controls necessary to convert input AC power to regulated DC power required for the input power to the inverter unit and for battery charging.

• Inverter Unit is defined as that portion of a UPS module containing the equipment and controls necessary to convert DC power, from the rectifier/charger or battery, to precise AC power for supplying power to a load, continuously 100% of UPS rating.

• UPS System Control Section is defined as that portion of the UPS module containing the metering, alarms, indicators and control functions.

• Static Bypass Switch is defined as a solid-state device used to automatically transfer the critical load to the bypass line in the event the UPS cannot supply continuous power and transfer the critical load back to the UPS when the trouble with the UPS has been corrected with no interruption to the critical load.

• Double Conversion UPS is defined as an on line UPS.

• Maintenance Bypass Switch is defined as the electromechanical device that connects the load directly to the bypass line and isolates the UPS module from the load without any interruption of AC power. Provide a UL508 in a NEMA1, enclosure fused for 30 amps at 120 VAC. (Make before break operation)

B. General Responsibilities for UPS. Do not deviate from this specification except when in possession of a written exception from TxDOT. Should there be a conflict between published standards and the narrative specifications, the more stringent provision applies. Any deviation or failure to comply with any part of this specification and the referenced documents will be considered to be in non-compliance with this specification. Provide engineering and field technical support as may be required by TxDOT contractor or representative to ensure reliable equipment installation and operation.

1. UPS Configuration. Configure the UPS to provide regulated alternating current (AC) power for a critical site load. Ensure that the system is fully coordinated and compatible with electrical, environmental and space conditions at the site.

2. UPS Conformance Standards. Provide only equipment that manufactured in conformance with the National Electric Code (NEC), the Occupational Safety and Health Act (OSHA), the National Electrical Manufacturer's Association (NEMA), the Acoustical Society of America (ASA), and the Institute of Electrical and Electronic Engineers (IEEE) Standards.

3. UPS FCC Registration. Design the equipment to interface and connect to either the public or private contained in FCC Rules and Regulations, Title 47, Part 68.

4. UPS Input. Rated for single phase 120 VAC.

5. UPS Output. Rated for single phase 120 VAC.

6. Continuous Unattended Duty. Design the UPS system for continuous unattended operations.
7. **UPS Physical Requirements.**

Install the UPS in a NEMA type metal enclosure.

Protect wire runs in a manner which separate power and control wiring.

Properly torque all bolted connections of bus bars, lugs and cables to the specified value and mark.

Provide adequate ventilation to ensure that all components are operated within their environmental ratings. Equip all fans with sensors connected to an alarm on the module control panel to indicate a fan failure.

C. **UPS Materials.** Provide new, currently manufactured, defect and imperfection free parts comprising the UPS that have not been in prior service except as required during factory testing.

Provide adequate ventilation to ensure that all components are operated within their environmental ratings. Provide sensors for all fans, connected to an alarm on the module control panel to indicate a fan failure.

Provide electronic components in conformance with Special Specification “Electronic Components”.

D. **UPS Instrumentation.** Equip UPS with instrumentation to provide the following indications:

- Input AC Voltage
- Input Battery Voltage
- Percent of Battery Charge
- Output Voltage
- Output Frequency
- Battery Charge Current
- Output current
- Input current

E. **UPS Alarms.** Provide UPS with following alarm indications as well as dry contacts for each alarm, along with a single summary alarm:

- Input Power Failed
- UPS on Battery
- UPS in By-pass
- Low Battery Voltage
Output failed
Over Voltage (output)
Cooling Fan Failed
Input Breaker Open
Battery Breaker Open
Output Breaker Open

F. UPS Operational Requirements.

1. **Normal Operation.** Electrical energy from the utility company power source is used to supply power to the UPS and the UPS powers the load during normal operations.

2. **Rectifier/Charger.** Provide a solid state device which converts AC power into DC power. Connect the output to the batteries and to the inverter.

3. **Inverter.** Provide solid state inverter which converts DC power to AC power.

4. **Uninterruptible Power.** Automatically effect continuity of electric power within the specified tolerances to the critical load without power interruption, even with a failure or deterioration of the utility power supply.

5. **AC Power Failure.** Automatically supply power from the battery to the inverter in the event of a failure of the AC power supply, with no interruption to or disturbance of the inverter output in excess of the limits of these specifications. Automatically power the UPS, recharge the battery, and supply power to the UPS output when the utility AC power is restored, without interruption or disturbances in excess of the limits of these specifications. Shutdown the UPS automatically and energize an alarm if the battery is exhausted before AC power is reapplied to the UPS.

6. **Static Bypass Switch.** If the logic senses a power failure it will signal the Static switch to switch to a good source. The switch will be transparent to the output power.

7. **Maintenance Bypass Switch.** Provide UL 508 maintenance bypass switch with power available indicator that allows the complete UPS module to be de-energized without disruption of the load.

Provide maintenance bypass switch that is external to UPS, so that the UPS can be removed without any disruption.

G. **UPS Electrical Requirements.** Provide solid state electronic devices. Hermetically seal all semiconductor devices. Make all relays dust tight; do not use open relays.
Size the UPS to provide a minimum of the required KVA and voltage output. Provide load voltage and bypass line voltage of 120 VAC, 2 wire with a separately derived and isolated (utility) load side ground wire.

1. **Efficiency.** Provide UPS, including the static transfer switch, with an efficiency of no less than 85% at the least efficient load.

2. **Component Ratings.** The maximum working voltage, current, and di/dt of all solid state power components and electronic devices must not exceed 75% of their rating. Provide electrolytic capacitors that are computer grade and operated at no more than 90% of their voltage rating.

3. **Battery.** Provide UPS battery that is contained inside the UPS cabinet and have a capacity to support the rated load as specified at temperature of 50°C. Provide 5 year batteries at manufacturer's rated standards.

4. **Rectifier.** Provide UPS that will recharge the battery in 8 hours or less with the UPS operating in normal condition, loaded to 100% capacity and the batteries completely discharged.

5. **Electrical Characteristics.** Provide UPS with the following electrical characteristics:

   a. **Input.**

   | Voltage Range:          | ±10% of nominal input          |
   | Frequency Range:        | ±10% of nominal input (60 Hz)  |
   | Current In-Rush Limiting: | Five times (5X) full load         |
   | Magnetizing Sub-cycle In-Rush: | Five times (5X) normal full rated input current maximum |
   | Power Factor:           | 0.9 lagging or better at steady state |
   | Current Limit:          | Maximum of 110% normal full load input current |
   | Battery:                | Nominal Factory Setting        |

   b. **Output.**

   | Voltage Adjustment Manually | ±5% manually          |
   | Frequency Regulation:       | 0.1%                  |
   | Voltage Transients:         |                        |
   | 20% Load Step:              | ±4%                   |
   | 30% Load Step:              | ±5%                   |
   | 50% Load Step:              | ±8%                   |
   | Loss of AC Input:           | ±1%                   |
   | Manual Transfer @ 100% load:| ±4%                   |
   | Voltage Transient:          | To within 1% of output voltage |
   | Recovery time:              | Rating within 20 milliseconds |

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Voltage Adjustment Manually: ±5% manually
Range:
Harmonic Content: Max 5%, total
                  Max 3%, any single harmonic
Overload: 125% of full load rating for 10 min.
           150% of full rated load for 30 sec
Current Limit: 150% of full pad current
Fault Clearing: Sub-cycle current of at least 300% of normal full load current

c. **Grounding.** Electrically isolate the UPS module AC output neutral from the UPS chases and bond at the derived isolated output ground terminal. Provide the UPS module chassis with an equipment ground system terminal.

d. **Breakers.** Provide the UPS module with both an AC and DC output circuit breaker sized to allow the performance as specified herein and to provide proper fault protection. Provide the rectifier/charger with an input circuit breaker of the frame size and trip rating to supply full rated load to the critical load and recharge the battery at the same time. Provide the circuit breaker with an undervoltage trip so that the circuit breaker will open automatically when the control voltage is lost.

e. **Surge Suppression.** Equip the UPS with transient voltage surge suppression as defined by the IEEE 587/ANSI C62.41, category A and B. Transient Protection, Grounding, Bonding, and Shielding Requirements for Equipment.

H. **UPS Environmental Requirements.** Provide UPS that does not generate noise in excess of 68db measured 4 ft. from the nearest surface of the cabinet. Provide UPS capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics:

   Operating Ambient: 32°F to 104°F
   Temperature:
   Relative Humidity: 0 to 95%, non-conden.
   Altitude: 0 to 10,000 ft.(AMSL)

I. **UPS Submittals.** Provide a complete engineering submittal in a paragraph-by-paragraph response format to include documentation supporting all claims made by the manufacturer.

1. **Compliance.** Include following details when indicating compliance with specification:
   
   • Indicate compliance on a paragraph-by-paragraph basis.
   
   • Make reference to appropriate documentation, as an attachment to the bid package.
   
   • Include referenced documentation supporting this claim as an attachment to the bid package.
2. **Exception.** Where Exception is stated, propose an alternate product or specification. Include the following details for each exception statement:

- State the specification claimed by the manufacturer for the product being proposed.
- Make reference to appropriate documentation.
- Include the referenced documentation supporting this claim as an attachment to the bid package.

3. **Supporting Documentation.** Include documentation supporting the manufacturer's claims with the bid package, consisting of:

- Appropriate and specific test data.
- Certified performance data (including information on component ratings, heat rise and dissipation)
- Specification data.
- Detail drawings, including cabinet and/or rack face drawings, circuit drawings, and cable diagrams.
- Product literature.
- Installation instructions.
- System configuration with single line drawings with all circuit breakers identified by number.
- Functional relationship of various equipment’s comprising the UPS unit including weights and dimensions

J. **UPS Spare Parts.** Provide a list of recommended spare parts with prices.

K. ** UPS Documentation.** Provide printed literature and brochures describing the equipment. Include two copies of all the following literature with each UPS system furnished:

- Complete operator's manual.
- Complete maintenance and repair manual.
- Complete installation manual with drawings.
- Detailed start-up instructions.
- Complete parts manual.
- Schematics of the complete UPS System including all printed circuit boards or modules.
• Circuit diagrams.
• Wiring diagrams.
• Copy of Factory Test and QC Documents.
• Trouble Point of Contact and Phone Numbers.
• Registration Documents.
• Recommended Spare Parts List (assembled as a kit).


7. **Measurement.** This Item will be measured as each unit furnished, installed and tested in accordance with this Special Specification.

8. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “CCTV Equipment Cabinet”. This price is full compensation for cables and connectors, cabinet mounting brackets and hardware, documentation and testing, all labor, materials, training, equipment and incidentals.
SPECIAL SPECIFICATION
Camera Pole Structure

1. Description. Provide camera pole designed, fabricated, and delivered as described in this specification and as shown on details found in plans. Design to conform to AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals”, with Interim Specifications thereto and with additional interpretations as applied by the Department.

2. General.

(1) Construct the structure according to this specification and instructions on the plans.

(2) Fabricate and weld in accordance with Item 441, “Steel Structures”. Ensure that all welded joints develop the full required strength of the member.

(3) Submit two prints of the shop drawings showing the fabrication and erection details for each support to the Engineer.

Prepare the drawings on sheets 22 x 34 in. in size, with 1- 1/2 in. left margin and other margins of 1/2 in.

Include on each sheet a title in the lower right corner which includes the same sheet index data shown in the lower right corner of the project plans, names of the fabricator and contractor, and sheet numbering.

Submittal of drawings for only one support is acceptable when 2 or more supports in the submittal are of identical design and dimensions.

The Contractor is responsible for the correctness and completeness of the drawings and for shop fit and field connections, even after the drawings are approved by the Department.

(4) Fabricate the camera pole to a design wind speed of 200 MPH plus a 1.3 gust factor. Inscribe the wind speed permanently on a surface visible after erection of the pole base plate.

3. Anchor Bolts.

(1) Provide anchor bolts that conform to the requirements in the standard drawings and comply with the requirements of ASTM A36 if 1 in. or less in diameter, and with ASTM A193-B7 or A687 if greater than 1 in. in diameter. If designated A36M55, provide bolts that comply with the requirements of Item 449, “Anchor Bolts”, Article 449.3 “Medium-Strength, Mild Steel Anchor Bolts”. Dimensions are based on the foundation size and design wind speed specified on the plans.
(2) Install anchor bolts with standard nut anchorage. Provide nuts that comply with the requirements of ASTM A563 Grade A or better, heavy hex. Provide washers that comply with the requirements of Item 447, “Structural Bolting”.

(3) Provide two circular steel templates for each assembly, shipped without the anchor bolts attached if necessary. Tack weld the lower nut to the lower template. The upper template may be re-used providing it stays in place until the concrete has achieved its initial set.

(4) Galvanize or paint the upper 14 in. of all anchor bolts. If painted, use 2 coats of a zinc-rich coating containing a minimum of 95% zinc and meeting Federal Specification DOD-P-21035A. Galvanize or paint with the same zinc rich paint any exposed nuts. Use galvanized washers.

(5) Provide anchor bolts whose threads are rolled or cut according to unified coarse thread series except for ASTM A193-B7 bolts which are 8 pitch thread series. If rolled, ensure that the diameter of the unthreaded portion is not be less than the minimum pitch diameter nor more than the maximum major diameter of the threads. Ensure that threads have Class 2 fit tolerances. Tap galvanized nuts after galvanizing.

(6) Coat threads of anchor bolts with pipe joint compound prior to installation of upper nuts when erecting pole. After poles are plumbed and in permanent alignment, clean the exposed upper threads of painted bolts and apply an additional coating of zinc-rich paint to seal the bolt thread-nut joint.

(7) Provide mill test reports and/or laboratory test certifications to show that the materials conform to these requirements.

4. Poles.

(1) Provide a tapered shaft for the pole. An octagonal shaft is permissible. Circumferential welds, other than at the ends of the shafts, are not permitted. Grind or smooth the exterior of longitudinal seam welds to the same appearance as other shaft surfaces. Weld longitudinal seam welds with a minimum of 60% penetration and with complete penetration when within 6 in. of circumferential base welds. Construct pole section with a maximum of 2 longitudinal seam welds. Use low hydrogen electrodes, or the equivalent in wire and flux for automatic welding. Preheat components before welding pole to the base plate in accordance with ANSI/AWS D1.1 Structural Welding Code.

(2) Provide material for pole shafts that conforms to the requirements in the standard drawings and complies with the requirements of ASTM A570 Grade 50, or A572 Grade 50, or A607 Grade 50, or A595 Grade A, or if designated A36M50 with the requirements of Item 442, “Metal for Structures”. Ensure that materials supplied under the A570 Grade 50 or A595 Grade A specifications meet their associated chemical and bend test requirements with the further stipulation that the materials must meet a minimum yield of 50 ksi and a minimum elongation of 18% in 8 in. or 23% in 2 in. prior to brake or tube forming operations. A570 Grade 50 material in thicknesses up to 5/16 in. is also acceptable providing it meets the above stated chemical, bend test, yield, and elongation requirements.
A595 Grade A material which can be shown by tests to have a minimum of 50 ksi yield adjacent to base welds after fabrication will also be acceptable.

(3) Provide mill test reports and/or laboratory test certifications show that the materials conform to these requirements.

(4) Secure a galvanized metal cap to the top of all poles using galvanized or stainless steel welds.

5. Finish.

(1) Provide a galvanized camera pole.

(2) Round or chamfer to approx. 1/16 in. all sheared or cut edges and all other exposed edges that are to be painted or galvanized.

(3) Provide proper filling, venting, and draining during the cleaning and galvanizing operations for camera poles required to be hot-dip galvanized.

Hot dip galvanize all parts, with the exception of the lower portion of the anchor bolts, nut anchorages, and the top and bottom templates, after fabrication in accordance with ASTM A123. Ensure that all screws, nuts, bolts, washers, shims, and the upper portion of the anchor bolts if galvanized are in conformance with the specifications of ASTM A153, Class C or D, unless otherwise specified. Repair any part of the camera pole assembly, from which the galvanizing has been knocked or chipped to bare metal in fabrication or transit, by applying galvanizing-repair compounds in accordance with the manufacturer's recommendations. Ensure a neat appearance of the assembly after the galvanizing repair is completed.

6. Delivery.

(1) The use of the detailed drawings does not relieve the supplier of the responsibility for providing proper fit of camera pole assembly components.

(2) Furnish from the supplier 2 copies of mill certificates reflecting the physical and chemical properties of the base metal of the pole, base plate, and anchor bolts. Also, provide four certified copies of the galvanizing test report.

(3) Identify all items of a shipment with a weatherproof tag. At a minimum, include on tag the manufacturer, contract number, and date and destination of shipment.

7. Measurement. This Item will be measured as each unit complete in place, excluding foundations.

8. Payment. The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for at the unit price bid for “Camera Pole Structure”. This price will be full compensation for furnishing, fabricating, and erecting the camera pole structure, for furnishing and placing anchor bolts, nuts and washers, for furnishing and placing electrical conduit in the foundation; and for all the other details and incidentals necessary to provide a camera pole structure in accordance with the
specifications, plans and approved shop drawings, complete in place and ready for the attachment of the camera, except as shown below.

Foundations will be paid for under Item 416, “Drilled Shaft Foundations”.
SPECIAL SPECIFICATION
T1 Ethernet Extender Equipment

1. **Description.** Furnish, install, and make fully operational T1 Ethernet Extender Equipment at designated locations as shown on the plans and as detailed in accordance with this specification. Use equipment from the same manufacturer at each location.

2. **Materials.** Each T1 Ethernet Extender Equipment consists of a Subscriber Unit (installed in CCTV cabinet) and a Provider Unit (installed at TransGuide) and any necessary cables, software, power supplies or other equipment or firmware that is associated with the operation of these units. Provide T1 Ethernet Extender Equipment that meets the following requirements.

   A. **General Requirements.** Provide only equipment that is new, corrosion resistant and in strict accordance with the details shown on the plans and in the specifications.

   B. **Ethernet Port Configuration.** Provide T1 Ethernet Extender Equipment with one Ethernet port that has the following features:
      - 10/100Base-TX
      - RJ-45 female connector
      - Automatic and user-selectable speed setting
      - Automatic and user-selectable half/full duplex setting
      - Light-emitting diode (LED) link status indicator
      - LED activity status indicator
      - LED 10/100 status indicator

   C. **T1 Interface Requirements.** Provide T1 Ethernet Extender Equipment that has the following T1 interface features:
      - 1 T1 RJ48 8-position jack (un-channelized T1)
      - Alarm and diagnostic information

   D. **Regulatory Approvals.** Provide T1 Ethernet Extender Equipment that has been certified to the following regulatory standards:
      - Product Safety: Underwriters Laboratories (UL) Standard 1950 or 60950
      - Electromagnetic Emissions: Federal Communications Commission (FCC) Part 15, Class A

   E. **Dimensions.** Provide T1 Ethernet Extender Equipment that does not exceed the following maximums:
3.2 cm (1.25 inches) High, 14 cm (5.5 inches) Wide, 11.5 cm (4.5 inches) Deep
Weight: .45 Kg (1 lb.)

F. Operating Power. Provide T1 Ethernet Extender Equipment that meets the following power specifications:
   - 120 V AC @ 1A
   - 60 Hz

G. Environmental. Provide T1 Ethernet Extender Equipment that is designed to operate in the following environmental conditions:
   - 0ºC to 50ºC operating temperature range
   - -40ºC to 70ºC storage temperature range
   - 5% to 95% relative humidity (non-condensing)

3. Construction.

   A. General. Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

   Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.


   C. Mechanical Components. Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used.

   Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass.

   Protect materials from fungus growth and moisture deterioration.

   Separate dissimilar metals by an inert dielectric material.


6. Warranty. Guarantee that equipment furnished and installed for this project will perform according to the manufacturer's published specifications. Warrant equipment against defects and/or failure in design, materials and workmanship in accordance with the manufacturer's
standard warranty. Assign to the Department all manufacturers’ normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Repair or replace defective equipment, at the manufacturer’s option, during the warranty period at no cost to the Department. Provide equipment with 95% of the manufacturer's standard warranty remaining on the date that equipment invoices are submitted by the Contractor for payment. Any equipment with less than 95% of its warranty remaining will not be accepted by the Department.

7. **Experience Requirements.** Personnel involved in the installation and testing of the “T1 Ethernet Extender Equipment” must meet the following requirements:

- Two years experience in the installation and testing of T1 based Ethernet circuits.
- Two installed systems where T1 based Ethernet circuits, as described within these specifications, are installed and the systems have been in continuously satisfactory operation for at least 1 year. Submit photographs or other supporting documents as proof, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the systems.
- One system with T1 based Ethernet circuits (which may be one of the two in the preceding paragraph) which the Contractor can arrange for demonstration to the Engineer and/or his representatives.

8. **Training.** Conduct a training class (minimum of 4 hours) for up to 10 representatives designated by Texas Department of Transportation on procedures of installation, operations, testing, maintenance and repair of all equipment specified within these specifications. Submit to the Engineer for approval 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer. Customize the training specifically for the TransGuide System.

9. **Measurement.** This Item will be measured as each set (consisting of Subscriber Unit and Provider Unit) installed, and tested.

10. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “T1 Ethernet Extender Equipment”. This price is compensation for equipment, cables and connectors; documentation and testing; and labor, materials, warranty, training and incidentals.
SPECIAL SPECIFICATION

Wireless Ethernet Radio (Local) Link

1. Description. Furnish and install Wireless Ethernet Radio (WER) (Local) Link in the 5.8 GHz frequency as shown on the plans, as detailed in the Special Specifications, and as directed by the Engineer. Provide all similar WER’s from the same manufacturer.

Furnish, assemble, fabricate or install new, corrosion resistant materials in strict accordance with the details shown on the plans and in the specifications.

Provide an interference analysis for each WER link to identify potential sources of interference. Adjust antenna polarities and channel plans on equipment to minimize interference from other sources. If the interference analysis shows possibility for interference along any wireless link, conduct in-field monitoring to determine if actual interference exists.

Include licenses for all equipment, where required, for any software or hardware in the system.

Supply a medical statement as to the safety of the unit to the general public (example: Pacemakers, etc.).

2. Functional Requirements. Provide the Wireless Ethernet Radio (Local) Link to be a point to point, license-free, dynamic modulating radio with an effective aggregate throughput of 105 Mbps. Ensure the WER uses Dynamic Frequency Selection technology and manual selection ability. The Dynamic Frequency Selection must continually adapt to avoid interference.

Ensure that the WER (Local) Link is capable of providing acceptable data throughput operation in “Line of Site”, “Near Line of Site”, and “Non Line of Site” installation locations.

Ensure the WER (Local) has an Ethernet port that can be used for configuration. Provide an auto-sensing Ethernet port for the connectivity.

Ensure the WER (Local) is integrated with a flat panel antenna in a rugged weatherproof housing that can be mounted with the antenna either vertical or horizontal.

Ensure the power and signal cables are UV Resistant Polyethylene jacketed coax cable.

Ensure the radio is software configurable via WER GUI or SNMP through the Ethernet port.

Ensure the WER (Local) Link, consists of both Outdoor and Indoor Units, and is integrated with a flat panel antenna in a rugged weatherproof housing that can be mounted with the antenna either vertical or horizontal.
A. Ensure the WER (Local) meets the following requirements:

**Radio**
- Output power: -18dBm to +27dBm
- Frequency Range: 5.725 GHz to 5.850 GHz
- Receive Sensitivity: Adaptive between -94 dBm and -69 dBm
- Channel Size: Configurable to 5, 10 or 15 MHz
- Wireless Data Rate (Mbps): Dynamically variable up to 105 Mbps (aggregate)
- Range: Up to 155 miles (250 km)
- Duplex scheme: Time Division Duplex (TDD)
- Modulation: Dynamic; adapting between BPSK and 64 QAM
- Error Correction: FEC (Forward Error Correction)
- Antenna: Integrated with 23 dBi gain/8 degrees
- System Gain: Up to 167 dB using integrated 23dBi antenna
- Security: Proprietary or optional FIPS-197 compliant 128/256-bit AES Encryption
- Certification: Federal Communications Commission (FCC)

**Ethernet**
- Protocol: IEEE 802.3
- Data throughput (aggregate): Up to 35 Mbps (5 MHz Channel)
- Latency: <3 ms average each direction
- Interface: 10/100 Base T (RJ-45) – auto MDI/MDIX
- Quality of Service: 802.1p (2 levels)
- T1/E1 interface: Single T1/E1 port; G703/G704,G823/G824

**Management**
- System management: Internet or SNMP v1/v2c/v3 MIBII and proprietary from manufacturer
- LED indicators: Activity, Power status, and Ethernet link status

**Installation**
- Link optimization: Built-in GUI and voltage output information
- Connection distance: From radio to primary network connection up to 330 ft.
- Lightning protection: 2 required, one within outdoor radio and one at cable entrance point to the network

**Physical**
- Weight: no more than 11.8 lbs with bracket
- Dimensions: not larger than 14.5” W x 14.5” H x 3.75” D
- Power supply: part of indoor unit
Power
Supply: Integrated with indoor unit
Source: 90-240 VAC, 50-60 Hz/36-60V DC
Consumption: 50 Watts maximum

Environmental
Operating temperature: -40 Deg F to + 140 Deg F
Humidity: 0-95 % non-condensing
Wind speed: 202 mph

Regulatory
Safety: UL60950-1; IEC60950-1; CSA-C22.2 No. 60950-1
Radio: 5.8 GHz; USA CFR 47 Part 15.247
Electromagnetic Compatibility: USA CFR 47 Part 15 Class B

B. System Installation. Provide and install all materials, including support, calibration and test equipment, to ensure an operating and functional wireless system link. This will include installation of WER equipment with power and data cables, and power and grounding system. Prior to beginning installation, inspect each site to verify suitability of installation and submit installation design and grounding and lightning protection design to the Engineer for approval prior to installation. This installation shall include:

1. System Power and Grounding. Describe proposed grounding and lightning protection design. Connect equipment to the 115 Volt circuits provided at the sites. Bond all equipment racks in accordance with manufacturer’s installation specification. Ground all equipment racks to the single-point ground for the site. Provide grounding and lightning protection for all cable runs on the support tower and at the equipment entry point.

2. System Optimization. Following installation of the completed system, optimize the equipment at each site in accordance with the specifications to provide a complete, operational system.

C. Software. Provide any and all programming and software required to support the WER system. Install the programming and software in the appropriate equipment at the time of acceptance testing, and shall be used in the acceptance testing.

Provide software updates free of charge during the warranty period.

D. Power Requirements. Provide equipment that is not affected by transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

1. Wiring. Provide wiring that meets the requirements of the National Electrical Code. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not doubled-back wire to take up slack. Lace wires neatly into cable with nylon
lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

2. **Transient Suppression.** Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

3. **Power Service Protection.** Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

   Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

4. **Fail Safe Provision.** Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure shall be within 5 sec. after resumption of power.

E. **Mechanical Requirements.** Provide printed circuit boards that are coated with a clear-coat moisture and fungus resistant material (conformal coating).

1. **Modular Design.** Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

   Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2. **Connectors and Harnesses.** Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and/or appropriately mark wires to and from the connectors.

   Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

   Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

3. **Construction.**

   A. **General.** Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

   Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

   B. **Electronic Components.** Provide electronic components in accordance with Special Specification, "Electronic Components".
C. **Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

D. **Documentation Requirements.** Provide documentation in accordance with Article 4, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty”.

E. **Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test all WER to ensure compliance to all FCC and Department specifications.

Additional testing requirement is as follows:

1. **System Testing.** Conduct System Testing at the manufacturer's facility as well as after installation at the designated TXDOT locations.

   Test each hop of the proposed system. This shall include transmit power and frequency, receiver performance and frequency, proper operation of switch over, proper operation of alarms and switches and bit error rate (BER) testing for the configured hop. Prior to beginning the manufacturer's test, provide TXDOT with a copy of the test procedure as well as the proposed test date(s).

   Following completion of equipment installation and operational optimization, submit the Acceptance Test Plan to TXDOT for review and Approval. During the official Acceptance Testing, provide the technical staff to conduct the measurements and adjustments called for in the testing. TXDOT shall participate in the testing as the Official Test Witness. Provide each page of the Acceptance Test Document for data recording of the test results, and the name of Contractor's representative conducting the test as well as a suitable field for the test date and signature of TXDOT Test Witness. Upon TXDOT Approval of the Test Plan and the Test Schedule, begin the Acceptance Test. This must include:

2. **System-level Testing of the System Paths.** Ensure testing of the installed system paths include:
   - Measure and record the transmitter/receiver channel frequency and polarity.
   - Measure and record the transmitter power.
   - Measure and record the receiver fade margin.
   - Perform a one hour Bit Error Rate Test (BERT) on the primary equipment and record results.
   - Verify the operation of all local alarm and control points using the alarm/monitoring equipment provided.

3. **System-level Test.** Following testing of the individual equipment, test each hop on an end-to-end basis and perform a BERT on the primary equipment.
Test and verify the operation of the alarm and monitor equipment in accordance with the Acceptance Test criteria.

F. Experience Requirements. The Contractor or designated subcontractors involved in the installation and testing of the WER shall, as a minimum, meet the following requirements:

Two years experience in the installation of WER System.

Two installed WER systems where Systems have been in continuously satisfactory operation for at least 1 year. The Contractor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the system.

One project (may be one of the two in the preceding paragraph) which the Contractor or subcontractor can arrange for demonstration to the Engineer.

Provide necessary documentation of subcontractor qualifications pursuant to contract award.

G. Technical Assistance. Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with WER system equipment installation and communication system configuration.

Do not execute the initial powering up of the WER equipment without the permission of the manufacturer's representative.

H. Training. Conduct a training class (minimum of 8 hours) for up to 10 representatives designated by TxDOT on procedures of installation, operations, testing, maintenance and repair of all equipment specified within these specifications. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer. Customize the training specifically for the TransGuide System.


4. Measurement. This Item will be measured as each Wireless Ethernet Radio (Local) Link furnished, installed, made fully operational with the TransGuide system and tested in accordance with these specifications or as directed by the Engineer. Each Link is comprised of the radios, mounting brackets, wiring, power supplies, etc. needed at each end to establish a Link.

5. Payment. The work performed and material furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for each “Wireless Ethernet Radio (Local) Link”. This price shall include all equipment described under this Item with all cables and connectors, mounting assemblies, all documentation and testing; and shall include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.
SPECIAL SPECIFICATION
Installation of Dynamic Message Sign System

1. **Description.** Transport, install and test Department furnished Dynamic Message Sign(s) (DMS), controller and equipment cabinet(s).

2. **Materials.** Provide all materials not supplied by the Department necessary for the DMS installation. All materials provided by the Contractor must be new. Include a task in the project schedule for delivery of Department furnished materials and provide a minimum of 30 days notice to the Department for pick up of Department furnished materials. Unless otherwise shown on the plans, DMS will be stored by the Department for pick up at location(s) shown on the plans.

Ensure that all materials and construction methods necessary to complete the installation conform to the requirements of this Item, the plans and the pertinent requirements of the following Items:

- Item 432, “Riprap”
- Item 441, “Steel Structures”
- Item 445, “Galvanizing”
- Item 449, “Anchor Bolts”
- Item 618, “Conduit”
- Item 620, “Electrical Conductors”
- Item 656, "Foundations for Traffic Control Devices"

3. **Construction.**

   **A. Installation.** Perform a site survey in advance of the proposed DMS location in order to determine the horizontal and vertical angles of the sign for optimum legibility, based on the manufacturer’s recommendations.

   Install DMS on overhead sign structures in accordance with this Item and the lines, grades, details and dimensions as shown on the plans or as directed. Maintain safe construction practices. Ensure the mechanical execution of work complies with NEC, Article 110.12. Equipment shall be installed in a neat and workmanlike manner.

   Adjustments and/or addition of sign attachment hardware, support brackets and appurtenances, such as walkways, conduit, etc., may be necessary for compatibility with specified sign positioning recommended by the manufacturer, as shown on the plans, or as directed. All adjustments and/or additional materials will not be paid for directly but will be subsidiary to this Item.

   Prevent damage to all sign components. Replace any portion of the sign assembly that is damaged or lost during transportation or installation. Do not use any materials furnished by the Department on any work which is not required by and which does not
constitute a part of the contract. Materials not used which were furnished by the Department must be returned undamaged to the location from which the materials were obtained upon completion of the work. Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

Stockpile all materials designated for reuse or to be retained by the Department within the project limits or at a designated location as directed.

Equipment to be installed at each DMS field site shown on the plans may include, but not be limited to, the following:

- Dynamic Message Sign (DMS), controller and cabinet (provided by the Department)

- Cabling and connectors from power source to DMS connection point as specified by the DMS manufacturer (Provided by the Contractor).

- Cabling and connectors from telecommunications source to DMS connection point as specified by the DMS manufacturer when required (Provided by the Contractor).

- Communications as shown on the plans

- Power and communication cabling and connectors from controller to DMS shall follow NEMA TS4, Section 4, “CONTROLLER TO SIGN INTERFACE” (cables and termination provided by the Contractor)

Make all arrangements for connection to the power supply and telecommunications source including any required permits. Supply and install any required materials not provided by the utility companies (power or communications service provider).

Construct the foundation for DMS Controller cabinets, when required as shown on the plans, in accordance with Item 656, "Foundations for Traffic Control Devices", unless otherwise directed. Include a 6 ft. X 6 ft. X 5 in. (L X W X D) riprap maintenance pad with foundation, unless otherwise directed. Provide a 5/8-in. diameter by 8 foot copper clad steel ground rod in the foundation of each DMS Controller cabinet.

After the signs have been erected, wash the exterior of the entire sign with a biodegradable cleaning solution, approved by the Engineer, to remove all dirt, grease, oil smears, streaks, finger marks, and other foreign particles.

B. Technical Assistance. Ensure that a manufacturer's representative is available to assist the Contractor's technical personnel at each sign installation site. The manufacturer's representative must provide technical assistance in following areas:

- Site survey for horizontal and vertical angles of sign’s mounting orientation

- Sign to structure installation (final responsibility of the Contractor, see 3.C. Working Drawings.)
· Sign Controller cabinet installation
· Sign to controller cabling

Do not execute the initial powering up of the sign(s) without the permission of the manufacturer's representative.

C. Working Drawings. Before fabrication submit for approval 5 prints of the working drawings for attachment of each DMS. Show the details of any additional sign brackets, sign support connections, and methods of attachment of the signs to the sign support. Have a licensed professional engineer sign, seal and date the working drawings.

D. Testing. Testing of the sign system is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the sign system in accordance with Item 7, "Legal Relations and Responsibilities", after all testing is successfully completed.

After delivery of the DMS to the storage site, an approved demonstration test will be conducted prior to transporting the sign to the installation site. Have a manufacturer’s representative available to assist with making all necessary connections and preparations for this testing.

After all signs have been installed, the Department and the DMS manufacturer will conduct approved continuity, stand alone, and DMS system tests on the installed field equipment with central, remote, and laptop equipment. A final acceptance test will be conducted to demonstrate all control, monitor, and communication requirements for 90 days. The Engineer will furnish a Letter acknowledging the final acceptance testing commencement date stating the first day of the final acceptance test. The completion of the final acceptance test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects. Assume responsibility only for test failures directly related to the work in accordance with this Item. Upon completion of successful final acceptance testing, permanently mark acceptance date and project identification information inside the controller cabinet. The Department will pay for electrical energy consumed by the system.

4. Measurement. This Item will be measured as each DMS system installed and tested.

5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Installation of Dynamic Message Sign System” of cabinet mounting type specified (pole mounted, foundation mounted or wall mounted). This price is full compensation for transportation and installation of DMS; furnishing and installing any new mounting hardware, and DMS controller cabinet foundation when required; storing the DMS when required; cleaning and testing the DMS; replacement/repair of damaged components;
disposal of unsalvageable material and for all manipulations, labor, tools, working drawings, equipment and incidentals.

New overhead sign supports or relocation of existing overhead sign supports will be paid for under Item 650, “Overhead Sign Supports.” New drilled shaft foundations will be paid for under Item 416, “Drilled Shaft Foundations.” Sign walkways will be paid for under Item 654, “Sign Walkways.”
SPECIAL PROVISION
TO
SPECIAL SPECIFICATION
Installation of Dynamic Message Sign System

For this project, Special Specification for “Installation of Dynamic Message Sign System,” is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 2. Materials** is voided and replaced by the following:

2. **Materials.** Provide all materials not supplied by the Department necessary for the DMS installation. All materials provided by the Contractor must be new.

Ensure that all materials and construction methods necessary to complete the installation conform to the requirements of this Item, the plans and the pertinent requirements of the following Items:

- Item 618, “Conduit”
- Item 620, “Electrical Conductors”
- Item 656, "Foundations for Traffic Control Devices"

**Article 3. Construction, Section A. Installation.** The sixth paragraph is voided and replaced with the following:

Equipment to be installed at each DMS field site shown on the plans may include, but not be limited to, the following:

- Dynamic Message Sign (DMS) (provided by the Department)
- Cabling and connectors from power source to DMS connection point as specified by the DMS manufacture (Provided by the Contractor).
- Cabling and connectors from telecommunications source to DMS connection point as specified by the DMS manufacture when required (Provided by the Contractor).
- Telco communications when required
  - Telco dial-up phone line (Provided by the Contractor).
  - Modem (provided by the Department.)
- Sign controller cabinet when required
Controller and Cabinet when required (provided by the Department).

Sign controller cabinet foundation (Provided by the Contractor).

Communication cabling and connectors from Controller to DMS (cables and termination provided by the Department)

Power cabling from cabinet to DMS (Provided by the Contractor)

**Article 3. Construction, Section A. Installation.** The eighth paragraph is voided and replaced with the following:

Construct the foundation for DMS Controller cabinets, when required, in accordance with Item 656, "Foundations for Traffic Control Devices", unless otherwise directed. Provide a 5/8-inch diameter X 8 feet copper clad steel ground rod in the foundation of each DMS Controller cabinet.
SPECIAL SPECIFICATION

Radar Vehicle Sensing Device (RVSD)

1. **Description.** Furnish and install overhead radar vehicle sensing device (RVSD) system as shown in the plans, as detailed in the special specifications and as directed.

   Ensure after the setup, there are no external tuning controls of any kind, which will require an operator.

2. **Materials.** Ensure the RVSD will automatically configure the maximum number of lanes shown on the plans by determining lane boundaries, concrete or metal barriers and detection thresholds. Ensure sensor will automatically configure the number of lanes in the presence of barriers, medians and work zones. Ensure sensor will automatically calibrate vehicle speed, detection levels, and sensitivity. Ensure the RVSD detects vehicle volume, speed and occupancy in all weather conditions without performance degradation. Ensure the RVSD is remote accessible; provides multiple connectivity options for integration into the existing system, and supports the communications protocols identified in Section 2.D “Communication”.

   Provide the RVSD that automatically tunes out stationary objects, such as traffic barriers and retaining walls, prior to completing the configuration. Provide documentation on the auto-configuration and auto-calibration processes.

   Provide an RVSD that does not cause interference or alter the performance of any known equipment.

   Furnish all new equipment and component parts in an operable condition at the time of delivery and installation.

   Provide design to prevent reversed assembly or improper installation of connectors, fasteners, etc. Design each item of equipment to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

   Include licenses for all equipment, where required, for any software or hardware in the RVSD system.

   Provide all RVSD from the same manufacturer.

   Provide RVSD firmware that is upgradeable by external local or remote download.
A. **Sensor Performance.** Ensure the RVSD provides accurate, real-time volume, average speed and occupancy data. Ensure the RVSD provides user configurable settings for a collection interval from 20 sec. to 15 min. and polling intervals from 20 sec. to 1 hr. Ensure the detections are correctly categorized into a minimum of 3 user definable length-based classifications. Ensure vehicle detections occur at a range of 9 ft. to 200 ft. from the RVSD. Ensure the RVSD unit or accompanying field equipment provides a minimum of 3 hours of local storage for detection interval settings of 20 seconds to 15 minutes in local storage to reduce data loss during communications outages. Ensure the RVSD transfers locally stored data to the Traffic Management Center’s Transportation Sensor System (TSS) when communication is restored.

Transportation Sensor System (TSS) Protocol Document (TSS-Protocol) is available through the “TSS Tools” link on the Department’s website, URL:

http://www.dot.state.tx.us/services/information_systems/engineering_software.htm

Ensure the RVSD operates in side-fire mode. When operating in side-fire mode, a single RVSD must simultaneously detect traffic in the maximum number of lanes as shown on the plans.

Ensure the RVSD maintains accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light. Ensure RVSD operation continues in rain or snow up to 4 in. per hour, and the device will not experience degraded performance when encased in 1/2 in. of ice.

Ensure volume data is accurate within 5% of actual for any direction of travel in nominal conditions. Ensure individual lane accuracy is within 10% of actual during nominal conditions. Nominal conditions exist when traffic is flowing at speeds greater than 10 miles per hour, with less than 10% truck traffic per lane and at least 30% of each vehicle visible above roadway barriers for true sensor detection.

Ensure average speed data is accurate within 5 MPH for any direction of traffic for all conditions involving more than 16 vehicles in an averaging interval. Ensure speed accuracy for individual lanes is within 10 MPH of actual for all traffic conditions and similar intervals. Provide true speed detection without the requirement to enter average vehicle lengths for the speed calculation.

Ensure speed data is accurate for individual vehicle measurements. Ensure 50% of all measurements are within one MPH of actual, and 85% is within 5 MPH.
Ensure occupancy data is accurate within 20% of the actual occupancy for any lane when occupancy is less than 30%. For example, if the actual occupancy in a lane is 20%, the measured occupancy must be between 16% and 24%.

Ensure classification data is accurately determined for 90% of detected vehicles.

Provide test data, using methods required in Section 3.F., demonstrating or proving performance.

B. Performance Maintenance. Provide RVSD that does not require cleaning or adjustment to maintain performance. Ensure it does not rely on battery backup to store configuration information. Ensure the RVSD, once calibrated, does not need recalibration to maintain performance over entire operational temperature range unless the roadway configuration changes. Provide remote connectivity to the RVSD to allow operators to change the unit’s configuration, update the unit’s firmware programming and recalibrate the unit automatically from a centralized facility.

C. Cabling. Supply the RVSD with a connector cable of the appropriate length for each installation site.

Ensure the connector meets the MIL-C-26482 specification. Provide an environmentally sealed shell backshell that offers excellent immersion capability, and is designed to interface with the appropriate MIL-C-26482 connector. Encase all conductors that interface with the connector in a single jacket and ensure the outer diameter of this jacket is within the backshell’s cable O.D. range to ensure proper sealing. Ensure the backshell has a clampbar style strain relief with enough strength to support the cable slack under extreme weather conditions. Provide the MIL-C-26482 connectors that provide contacts for all data and power connection.

If communication is conducted over the RS-485 or RS-232 bus, the communication cable must be Belden 9331, or an equivalent cable with the following specifications:

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz <= 26pF/Ft
- Nominal Conductor DC Resistance @ 68°F <= 15 ohms/1000Ft
- Single continuous run with no splices allowed
- Terminated only on the two farthest ends of the cable

D. Communication. Ensure that the RVSD provides communication options that include RS-232, RS-485 or TCP/IP. Provide a RVSD which has the ability to support a variety of baud rates from 9600 to 115200.

Ensure the RVSD provides built in RS-232, RS-485 and an internal serial communication port. Each communication port must support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200. Additionally, the RS-232 port must be full-duplex and must support true RTS/CTS hardware handshaking for interfacing to various communication devices.
Data Packets. The RVSD must produce data packets containing, as a minimum:

- One or more detection zones
- Collection interval durations
- Sensor ID
- 32-bit time stamps indicating end of collection interval
- Total volume by detection zone
- Average speed in each detection zone during the collection interval. Speed value units must be selectable as either miles per hour or kilometers per hour
- Occupancy in each detection zone during the collection interval, reported in 0.1% increments
- A minimum of 3 vehicle classifications reported as number of vehicles of each classification identified in each detection zone during the collection interval

E. Operating System Software. Provide the RVSD to also include graphical user interface software that displays all configured lanes and provides visual representation of all detected vehicles. The graphical interface must operate on current Department core operating system software. The software must automatically select the correct baud rate and serial communication port from up to 15 serial communication ports. The software must also operate over a TCP/IP connection and support a dial-up modem connection.

When required to interface with Traffic Management Center software, the RVSD system software must meet Transportation Sensor Subsystem Protocol requirements as documented in latest version available on the Department’s website.

The software must give the operator complete control over the configuration process.

The operator must have the ability to save the configuration information to a file or reload the RVSD configuration from a file using the graphical user interface software.

Using the installation software the operator must be able to:
- change the baud rate on the sensor by selecting baud rates from a drop-down list
- add response delays for the communication ports to allow for communication stabilization.
- switch between data pushing and data polling, and
- change the RVSD’s settings for Flow Control from none to RTS/CTS and vice versa.

The operator must be able to upload new firmware into non-volatile memory of the RVSD over any supported communication channel including TCP/IP networks.
F. **Software.** Provide any and all programming and software required to support the RVSD system. Install the programming and software in the appropriate equipment at the time of acceptance testing. Complete and pass acceptance testing using a stable release of the programming and software provided.

Provide software update(s) free of charge during the warranty period.

G. **Manufacturing Requirements.** Ensure the assembly of the units adheres to industrial electronic assembly practices for handling and placement of components.

The RVSD must undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Include the following tests:

- Functionality testing of all internal subassemblies
- Unit level burn-in testing of 24 hours duration or greater
- Final unit functionality testing prior to shipment

Provide test results and all associated data for the above testing, for each purchased RVSD by serial number. Additionally, maintain and make available manufacturing data for each purchased RVSD by serial number.

Externally, the RVSD must be modular in design to facilitate easy replacement in the field. Ensure the total weight of the RVSD does not exceed 5 lbs.

Ensure all external parts are protected against corrosion, fungus growth and moisture deterioration.

H. **FCC.** Ensure the RVSD has Federal Communications Commission (FCC) certification. Display the FCC-ID number on an external label. Ensure each RVSD is Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.245 or 15.249 as a field disturbance sensor. Display this certification on an external label on each device according to the rules set out by the FCC.

Provide the RVSD system that is FCC certified under Part 15, Subpart C, Section 15.245 or 15.249 for low-power, unlicensed, continuous radio transmitter operation. Assure that the RVSD system will not cause harmful interference to radio communication in the area of installation. If the operation of the RVSD system causes harmful interference, correct the interference at the Contractor’s expense.

Provide the RVSD that transmits in the 10.50 – 10.55 GHz or 24.00 – 24.25 GHz frequency band and meets the power transmission and frequency requirements specified under sections 15.245 and 15.249 of CFR 47 across the operating temperature of the device and over time as the sensor ages.

Provide documentation proving compliance to all FCC specifications.
I. **Support.** Ensure installers and operators of the RVSD are fully trained in the installation, auto-configuration and use of the device.

The manufacturer must train installers and operators to correctly perform the tasks required to ensure accurate RVSD performance. The amount of training necessary for each project will be determined by the manufacturer (not less than 4 hours) and must be included, along with training costs, in the manufacturer’s quote. In addition, provide technical support to provide ongoing operator assistance.

J. **Power Requirements.** Provide the RVSD that operates either at 12 VDC to 28 VDC or at 12 VAC to 24 VAC from a separate power supply to be provided as part of the bid item and ensure it does not draw more than 10 watts of power each.

Provide the separate power supply or transformer that operates from 115 VAC ±10%, 60 Hz ±3 Hz.

Provide equipment operations that are not affected by the transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

K. **Wiring.** Provide wiring that meets the requirements of the National Electric Code. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not double-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

L. **Transient Suppression.** Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

M. **Power Service Protection.** Provide equipment that contains readily accessible, manually re-settable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

N. **Fail Safe Provision.** Provide equipment that is designed such that the failures of the equipment will not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure will be within 15 sec. after resumption of power.

O. **Mechanical Requirements.** Enclose the RVSD in a Lexan polycarbonate, ultraviolet resistant material. The unit must be classified as watertight according to the NEMA 250 Standard.

Provide the RVSD that will withstand a drop of up to 3 ft. without compromising its functional and structural integrity.
Do not use silicone gels or any other material for enclosure sealing that will deteriorate under prolonged exposure to ultraviolet rays. Ensure the overall dimensions of the box, including fittings, do not exceed 13 in. x 9 in. x 9 in. Ensure the overall weight of the box, including fittings, does not exceed 15 lbs.

Coat all printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

Ensure external connection for telecommunications and power be made by means of a single military style multi-pin connector, keyed to preclude improper connection.

1. **Modular Design.** Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

   Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2. **Connectors and Harnesses.** Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and appropriately mark wires to and from the connectors.

   Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

   Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

3. **Environmental Requirements.** Provide RVSD capable of continuous operation over a temperature range of –35°F to +165°F and a humidity range of 5% to 95% (non-condensing).

3. **Construction.**

   A. **General.** Provide equipment designed and constructed with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

      Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

   B. **Mounting and Installation.** Install the RVSD according to manufacturer’s recommendations to achieve the specified accuracy and reliability.

      Verify, with manufacturer assistance, the final RVSD placement if the RVSD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.
Include, at a minimum, radar detector unit, enclosures, connectors, cables, junction box, mounting equipment and hardware, controller interface boards and assemblies, local and remote software, firmware, power supply units and all other support, calibration, and test equipment for the RVSD system.

Furnish the RVSD with bracket or band designed to mount directly to a pole or overhead mast-arm or other structure. Ensure the mounting assembly has all stainless steel, or aluminum construction, and supports the load of the RVSD. Incorporate for the mounting assembly a mechanism that can be tilted in both axes, then locked into place, to provide the optimum area of coverage. Ensure the mounting bracket is designed and installed to prevent sensor re-positioning during 80 mph wind conditions.

Proper placement, mounting height and orientation of the RVSD systems must conform to the manufacturer's published requirements for the system provided. Install the RVSD units as shown on the plans. Analyze each proposed pole location to assure that the RVSD installation will comply with the manufacturer’s published installation instructions. Advise the Engineer, before any trenching or pole installation has taken place, of any need to move the pole from the location indicated in the plans in order to achieve the specified detector performance. Confirm equipment placement with the manufacturer before installing any equipment.

Ensure alignment, configuration and any calibration of the RVSD takes less than 15 minutes per lane once mounting hardware and other installation hardware are in place. Install RVSD units such that each unit operates independently and that detectors do not interfere with other RVSD units or other equipment in the vicinity.

C. Electronic Components. Provide electronic components in accordance with Special Specification, "Electronic Components".

D. Mechanical Components. Provide external screws, nuts and locking washers that are stainless steel. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.


Provide documentation ensuring emissions from the RVSD equipment are not harmful to the public.

Provide additional test reports, for each of the following requirements:

1. **NEMA 4X Testing.** The RVSD enclosure must conform to test criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Provide third party enclosure test results for each of the following specific Type 4X criteria:

   - External Icing (NEMA 250 Clause 5.6)
2. **NEMA TS2-1998 Testing.** The RVSD must comply with the applicable standards stated in the NEMA TS2-1998 Standard. Provide third party test results for each of the following specific tests:

- Shock pulses of 10g, 11 ms half sine wave
- Vibration of .5 Grms up to 30 Hz
- 300 V positive/negative pulses applied at 1 pulse per second at minimum and maximum DC supply voltage
- Cold temperature storage at -49°F for 24 hours
- High temperature storage at +185°F for 24 hours
- Low temp, low DC supply voltage at -30°F and 10.8 VDC
- Low temp, high DC supply voltage at -30°F and 26.5 VDC
- High temp, high DC supply voltage at 165°F and 26.5 VDC
- High temp, low DC supply voltage at 165°F and 10.8 VDC

F. **Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test all RVSD to ensure that they comply with all FCC and Department specifications.

Ensure the RVSD meets functional performance requirements of Section 2.A (Sensor Performance) by the following methods:

Verify volume accuracy by performing a manual count on each lane of detection. When compared to the manual counts, the sensor counts must meet performance requirements as stated in Section 2.A.

Verify speed accuracy with laser speed gun provided by TxDOT, radar gun provided by contractor, or by video speed trap using the frame rate as a time reference. Vehicle speeds should be collected and averaged over a minimum of 10 vehicles. When compared to the average speeds collected via laser, the sensor speed data must meet performance requirements as stated in Section 2.A.

G. **Experience Requirements.** The contractor or subcontractor involved in the installation and testing of the RVSD must, as a minimum, meet the following experience requirements:

Two years continuous existence offering services in the installation of RVSD systems.
Two installed RVSDs where systems have been in continuously satisfactory operation for at least 1 year. Submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel of the business or agency owning the system who can be contacted by the Department regarding the system.

Provide necessary documentation of contractor or subcontractor qualifications pursuant to contract award.

H. **Technical Assistance.** Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with RVSD equipment installation and communication system configuration.

Do not execute the initial powering up of the RVSD without the permission of the manufacturer's representative.

I. **Training.** Provide training in accordance with Article 3, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

J. **Warranty.** Provide a warranty in accordance with Article 6, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

4. **Measurement.** This Item will be measured as each unit complete in place.

5. **Payment.** The work performed and material furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Radar Vehicle Sensing Device.” This price is full compensation for furnishing all equipment described under this Item with all cables, connectors, mounting assemblies, interface devices; all documentation and testing; all labor, materials, tools training, warranty, equipment, and incidentals.
SPECIAL PROVISION

TO

SPECIAL SPECIFICATION

Radar Vehicle Sensing Device (RVSD)

For this project, Special Specification, “Radar Vehicle Sensing Device (RVSD)” is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 2. Materials. The first paragraph is voided and replaced by the following:

Materials. Ensure the RVSD will automatically configure the maximum number of lanes shown on the plans by determining lane boundaries, concrete or metal barriers and detection thresholds. Ensure sensor will automatically configure the number of lanes in the presence of barriers, medians and work zones. Ensure sensor will automatically calibrate vehicle speed, detection levels, sensitivity, and vehicle direction. Ensure the RVSD detects vehicle volume, speed, occupancy, and direction in all weather conditions without performance degradation. Ensure the RVSD is remote accessible; provides multiple connectivity options for integration into the existing system, and supports the communications protocols identified in Section 2.D “Communication”.

Article 2. Materials. A. Sensor Performance. The first, seventh and eighth paragraphs are voided and replaced by the following three paragraphs respectively:

A. Sensor Performance. Ensure the RVSD provides accurate, real-time volume, average speed, occupancy, and vehicle direction data. Ensure the RVSD provides user configurable settings for a collection interval from 20 sec. to 15 min. and polling intervals from 20 sec. to 1 hr. Ensure the detections are correctly categorized into a minimum of 8 user definable length-based classifications. Ensure vehicle detections occur at a range of 9 ft. to 250 ft. simultaneously from the RVSD. Ensure the RVSD unit or accompanying field equipment provides a minimum of 3 hours of local storage for detection interval settings of 20 seconds to 15 minutes in local storage to reduce data loss during communications outages. Ensure the RVSD transfers locally stored data to the Traffic Management Center’s Transportation Sensor System (TSS) when communication is restored.

Ensure per vehicle speed data is accurate within 5 MPH for 90% of measurements. Provide true speed detection via dual radar speed trap without the requirement to enter average vehicle lengths for the speed calculation.

Ensure the RVSD automatically configures vehicle direction and that vehicle direction is accurately determined for 90% of wrong-way vehicles. This data shall be available simultaneously and in addition to other data as called for in this specification.
Article 2. Materials. D. Communication. The third and fourth paragraphs are voided and replaced by the following two paragraphs respectively:

**Interval Data Packets.** The RVSD must produce interval data packets containing, as a minimum:

- One or more detection zones
- Collection interval durations
- Sensor ID
- 32-bit time stamps indicating end of collection interval
- Total volume by detection zone
- Average speed in each detection zone during the collection interval. Speed value units must be selectable as either miles per hour or kilometers per hour
- Occupancy in each detection zone during the collection interval, reported in 0.1% increments
- A minimum of 8 vehicle classifications reported as number of vehicles of each classification identified in each detection zone during the collection interval
- Volume in up to 15 user-defined speed bins
- Volume for both directions of traffic
- Average headway in seconds
- Average gap in seconds
- 85th percentile speed in either miles per hour or kilometers per hour
- Vehicle count for correct and wrong-way vehicles in separate correct and wrong-way bins

**Event Data Packets.** The RVSD must produce event (per vehicle) data packets containing, as a minimum:

- Sensor ID
- Lane Assignment
- Per vehicle speed value in either miles per hour or kilometers per hour. Wrong-way vehicles will show a negative speed value
- Vehicle length
- Classification using up to 8 user defined classes
- 32-bit time stamps indicating end of collection interval
- Range

Article 2. Materials. O. Mechanical Requirements. The third paragraph is voided and replaced by the following:

Do not use silicone gels or any other material for enclosure sealing that will deteriorate under prolonged exposure to ultraviolet rays.

Ensure the overall dimensions of the box, including fittings, do not exceed 14 in. x 11 in. x 4 in. Ensure the overall weight of the box, including fittings, does not exceed 5 lbs.
Article 3. Construction. F. Testing. The fourth paragraph is voided and replaced by the following:

Verify speed accuracy with laser speed gun provided by TxDOT, radar gun provided by contractor, or by video speed trap using the frame rate as a time reference. Vehicle speeds should be collected and compared to the per vehicle speed measurement generated by the RVSD. When compared to the speeds collected via laser, the sensor speed data must meet performance requirements as stated in Section 2.A.

Verify direction accuracy by ensuring that all lanes are configured with the correct directionality. Following this configuration, reverse the direction on one lane and verify that the number of vehicles detected in that lane are correctly placed in the wrong-way detection bin. When compared to the manual counts for this lane, the wrong-way sensor counts must meet the performance requirements as stated in Section 2.A.
SPECIAL SPECIFICATION
Wireless Ethernet Radio (Backhaul) Link

1. Description. Furnish and install Wireless Ethernet Radio (WER) (Backhaul) Link in the 5.8 GHz frequency as shown on the plans, as detailed in the Special Specifications, and as directed by the Engineer. Provide all similar WER’s from the same manufacturer.

Furnish, assemble, fabricate or install new, corrosion resistant materials in strict accordance with the details shown on the plans and in the specifications.

Provide an interference analysis for each WER link to identify potential sources of interference. Adjust antenna polarities and channel plans on equipment to minimize interference from other sources. If the interference analysis shows possibility for interference along any wireless link, conduct in-field monitoring to determine if actual interference exists.

Include licenses for all equipment, where required, for any software or hardware in the system.

Supply a medical statement as to the safety of the unit to the general public (example: Pacemakers, etc.).

2. Functional Requirements. Provide the Wireless Ethernet Radio (Backhaul) Link to be a point to point, license-free, dynamic modulating radio with an effective aggregate throughput of 300 Mbps. Ensure the WER uses Dynamic Frequency Selection technology and manual selection ability. The Dynamic Frequency Selection must continually adapt to avoid interference.

Ensure that the WER (Backhaul) Link is capable of providing up to 99.999% link availability in “Line of Site”, “Near Line of Site”, and “Non Line of Site” installation locations.

Ensure the WER (Backhaul) has an Ethernet port that can be used for configuration. Provide an auto-sensing Ethernet port for the connectivity.

Ensure the WER (Backhaul) is integrated with a flat panel antenna in a rugged weatherproof housing that can be mounted with the antenna either vertical or horizontal.

Ensure the power and signal cables are UV Resistant Polyethylene jacketed coax cable.

Ensure the radio is software configurable via WER GUI or SNMP through the Ethernet port.
Ensure the WER (Backhaul) Link, consists of both Outdoor and Indoor Units, and is integrated with a flat panel antenna in a rugged weatherproof housing that can be mounted with the antenna either vertical or horizontal.

A. Ensure the WER (Backhaul) meets the following requirements:

**Radio**
- **Output power**: Up to 25 dBm
- **Frequency Range**: 5.725 GHz to 5.850 GHz
- **Receive Sensitivity**: Adaptive between -98 dBm and -58 dBm
- **Channel Size**: Configurable to 5, 10, 15 or 30 MHz
- **Wireless Data Rate (Mbps)**: Dynamically variable up to 300 Mbps (aggregate)
- **Range**: Up to 124 miles (200 km)
- **Duplex scheme**: Time Division Duplex (TDD) and Half Duplex Frequency Division Duplex (HD-FDD), Dynamic or Fixed Ratio
- **Modulation**: Dynamic; adapting between BPSK single and 64 QAM dual
- **Error Correction**: FEC (Forward Error Correction)
- **Antenna**: Integrated with 23 dBi gain/7 degrees
- **System Gain**: Up to 168 dB using integrated 23dBi antenna
- **Security**: Proprietary or optional FIPS-197 compliant 128/256-bit AES Encryption
- **Certification**: Federal Communications Commission (FCC)

**Ethernet**
- **Protocol**: IEEE 802.3
- **Data throughput (aggregate)**: Up to 40 Mbps (5 MHz Channel)
  - Up to 84 Mbps (10 MHz Channel)
  - Up to 126 Mbps (15 MHz Channel)
  - Up to 300 Mbps (30 MHz Channel)
- **T1/E1 Latency (one way)**: As low as 2.2 ms
- **Ethernet Interface**: 10/100/1000 Base T (RJ-45) – auto MDI/MDIX, optional 1000 Base SX
- **T1/E1 Interface**: Supports up to two T1/E1 Ports
- **Quality of Service**: 8 Queues
- **T1/E1 interface**: Up to two T1/E1 ports; G703, G823/G824

**Management**
- **System management**: Internet or SNMP v1/v2c/v3 MIBII and proprietary from manufacturer
- **LED indicators**: Activity, Power status, and Ethernet link status

**Installation**
- **Link optimization**: Built-in GUI and voltage output information
Connection distance: From radio to primary network connection up to 330 ft.
Lightning protection: 2 required, one within outdoor radio and one at cable entrance point to the network

**Physical**
- **Weight**: no more than 12.1 lbs. with bracket
- **Dimensions**: not larger than 14.5” W x 14.5” H x 3.75” D
- **Power supply**: part of indoor unit

**Power**
- **Supply**: Integrated with indoor unit
- **Source**: 90-240 VAC, 50-60 Hz/36-60V DC
- **Consumption**: 55 Watts maximum

**Environmental**
- **Operating temperature**: -40 Deg F to + 140 Deg F
- **Humidity**: 0-95 % non-condensing
- **Wind speed**: 202 mph

**Regulatory**
- **Safety**: UL60950; IEC60950; EN 60950; CSA-C22.2 No. 60950
- **Radio**: FCC Part 15, Sub-part C15.247, EN 302502
- **Electromagnetic Compatibility**: USA FCC Part 15, Class B

B. **System Installation.** Provide and install all materials, including support, calibration and test equipment, to ensure an operating and functional wireless system link. This will include installation of WER equipment with power and data cables, and power and grounding system. Prior to beginning installation, inspect each site to verify suitability of installation and submit installation design and grounding and lightning protection design to the Engineer for approval prior to installation. This installation shall include:

1. **System Power and Grounding.** Describe proposed grounding and lightning protection design. Connect equipment to the 115 Volt circuits provided at the sites. Bond all equipment racks in accordance with manufacturer’s installation specification. Ground all equipment racks to the single-point ground for the site. Provide grounding and lightning protection for all cable runs on the support tower and at the equipment entry point.

2. **System Optimization.** Following installation of the completed system, optimize the equipment at each site in accordance with the specifications to provide a complete, operational system.

C. **Software.** Provide any and all programming and software required to support the WER system. Install the programming and software in the appropriate equipment at the time of acceptance testing, and shall be used in the acceptance testing.
Provide software updates free of charge during the warranty period.

D. Power Requirements. Provide equipment that is not affected by transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

1. Wiring. Provide wiring that meets the requirements of the National Electrical Code. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not doubled-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

2. Transient Suppression. Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

3. Power Service Protection. Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

   Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

4. Fail Safe Provision. Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure shall be within 5 sec. after resumption of power.

E. Mechanical Requirements. Provide printed circuit boards that are coated with a clear-coat moisture and fungus resistant material (conformal coating).

1. Modular Design. Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

   Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2. Connectors and Harnesses. Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and/or appropriately mark wires to and from the connectors.

   Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

   Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.
3. **Construction.**

   **A. General.** Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

   Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

   **B. Electronic Components.** Provide electronic components in accordance with Special Specification, "Electronic Components".

   **C. Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

   **D. Documentation Requirements.** Provide documentation in accordance with Article 4, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty”.

   **E. Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test the WER to ensure compliance to all FCC and Department specifications.

   Additional testing requirement is as follows:

   **1. System Testing.** Conduct System Testing at the manufacturer's facility as well as after installation at the designated Department locations.

   Test each hop of the proposed system. This shall include transmit power and frequency, receiver performance and frequency, proper operation of switch over, proper operation of alarms and switches and bit error rate (BER) testing for the configured hop. Prior to beginning the manufacturer's test, provide the Department with a copy of the test procedure as well as the proposed test date(s).

   Following completion of equipment installation and operational optimization, submit the Acceptance Test Plan to the Department for review and Approval. During the official Acceptance Testing, provide the technical staff to conduct the measurements and adjustments called for in the testing. The department shall participate in the testing as the Official Test Witness. Provide each page of the Acceptance Test Document for data recording of the test results, and the name of Contractor's representative conducting the test as well as a suitable field for the date and signature of the Department Test Witness. Upon Department Approval of the Test Plan and the Test Schedule, begin the Acceptance Test. This must include:
2. **System-level Testing of the System Paths.** Ensure testing of the installed system paths include:

- Measure and record the transmitter/receiver channel frequency and polarity.
- Measure and record the transmitter power.
- Measure and record the receiver fade margin.
- Perform a one hour Bit Error Rate Test (BERT) on the primary equipment and record results.
- Verify the operation of all local alarm and control points using the alarm/monitoring equipment provided.

3. **System-level Test.** Following testing of the individual equipment, test each hop on an end-to-end basis and perform a BERT on the primary equipment.

   Test and verify the operation of the alarm and monitor equipment in accordance with the Acceptance Test criteria.

F. **Experience Requirements.** The Contractor or designated subcontractors involved in the installation and testing of the WER shall, as a minimum, meet the following requirements:

   Two years’ experience in the installation of WER System.

   Two installed WER systems where Systems have been in continuously satisfactory operation for at least 1 year. The Contractor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the system.

   One project (may be one of the two in the preceding paragraph) which the Contractor or subcontractor can arrange for demonstration to the Engineer.

   Provide necessary documentation of subcontractor qualifications pursuant to contract award.

G. **Technical Assistance.** Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with WER system equipment installation and communication system configuration.

   Do not execute the initial powering up of the WER equipment without the permission of the manufacturer's representative.

H. **Training.** Conduct a training class (minimum of 8 hours) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance and repair of all equipment specified within these specifications. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer. Customize the training specifically for the TransGuide System.
I. **Warranty.** Provide a warranty in accordance with Article 6, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

4. **Measurement.** This Item will be measured as each Wireless Ethernet Radio (Backhaul) Link furnished, installed, made fully operational with the TransGuide system and tested in accordance with these specifications or as directed by the Engineer.

   Each Link is comprised of the radios, mounting brackets, wiring, power supplies, etc. needed at each end to establish a Link.

5. **Payment.** The work performed and material furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for each “Wireless Ethernet Radio (Backhaul) Link”. This price shall include all equipment described under this Item with all cables and connectors, mounting assemblies, all documentation and testing; and shall include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.