Special Specification 6422
Over-height Vehicle Detection and Warning System

1. DESCRIPTION

Furnish, install, integrate, and test Over-height Vehicle Detection and Warning Systems (OVDWS) as shown on the plans or as directed. Assemble and install OVDWS according to manufacturer guidelines and recommendations.

The system must detect any over-height components of the vehicle and any load hauled by the vehicle. Over-height components of the vehicle or hauled load must be detected despite material type, density, size, or shape. The system must include warning devices directing operators of over-height vehicles to take appropriate corrective action to avoid a collision with any conflicting structures. Any necessary connections with the system must be integrated as part of this Item. The system must communicate operational and alert information with a communication network as specified by the Engineer.

Ensure the system is comprised of all items of hardware, software, interconnect cabling, cabinets, and enclosures required to provide an operational system to detect and warn over-height vehicles upstream of a potential clearance violation. The equipment furnished and installed under this Item must include the following:

- infrared transmitters and receivers, or approved equal,
- local controller,
- local camera for image or video confirmation capture,
- communication contract closure I/O, as specified,
- controller enclosure and ancillary equipment,
- mounting hardware, and
- cabling as required.

Furnish, assemble, fabricate or install materials referenced under this Specification that are new, corrosion resistant, and in strict accordance with the details shown on the plans or as directed. Transmitter can also be known as Remote and Receiver can also be known as Master.

2. MATERIALS

Ensure materials and construction methods comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 442, “Metal for Structures”
- Item 445, "Galvanizing"
- Item 618, “Conduit”
- Item 620, "Electrical Conductors"
- Item 624, “Ground Boxes”
- Item 627, “Treated Timber Poles”
- Item 628, “Electrical Services”
- Item 636, “Aluminum Signs”
- Item 644, “Small Roadside Sign Support and Assemblies”
- Item 647, “Large Roadside Sign Supports and Assemblies”
- Item 656, “Foundations for Traffic Control Devices”
- Item 684, “Traffic Signal Cables”
- Item 685, “Roadside Flashing Beacon Assemblies”

- Item 687, "Pedestal Pole Assemblies"
- Item 6004, "Networking Intelligent Transportation System (ITS) Communications Cable"
- Item 6006, "Electrical Components"
- Item 6062, "Intelligent Transportation System (ITS) Radio"
- Item 6063, "Intelligent Transportation Systems (ITS) Solar Power System"
- Item 6064, "Intelligent Transportation System (ITS) Pole with Cabinet."

3. EQUIPMENT

3.1. Over-height Detection.

3.1.1. **Detector Performance.** Provide a complete system which detects dynamically crossing objects across an elevated horizontal plane configured at a height determined by a nearby object or structure. The detection system must be positioned ensuring it only detects objects moving in one travel direction. If this is not possible, the Contractor must notify the Engineer and receive approval of the installation. The detection system must use infra-red, red source technology, or approved equal at locations shown on the plans. Alternate detection technology may be used with the approval of the Engineer. Furnish units with an effective detection range of 10 ft. to 200 ft. with a reaction speed range of 1 mph to 75 mph for a 2.5 in. diameter object that extends 1 in. above the height of the detectors. Provide detection system that negates the effect of ambient light and an internal environmental control that reduces operational failure from fog condensation and insects.

3.1.2. **Over-height Detector Unit.** Furnish solid state units with printed circuit boards and regulated power. Unless otherwise approved, furnish units not exceeding a maximum overall size of 18 in. width x 19 in. length x 10 in. depth.

3.1.3. **Housings.** Provide medium duty anodized aluminum, fiberglass, or equivalent housing not less than 1/8 in. thick, rated National Electrical Manufacturer's Association (NEMA) 3R or better.

3.1.4. **Access.** Provide transmitter, and receiver units required to operate the equipment. The enclosure must maintain its structural integrity for the operational life of the equipment and allow access for control adjustment and electrical interconnection without the use of any special tools.

3.1.5. **Controller Unit.** Provide a local remote terminal unit (RTU) controller unit that controls the system at the design location shown on the plans or as directed. The local controller unit must continuously monitor detector inputs for a positive over-height detection reading. When the detectors sense an over-height vehicle, the controller must activate the warning components of the system. Circuit breaker protection must be incorporated into the controller. Provide user-configurable settings on the controller for adjusting the duration of the activation of the warning components to accommodate anticipated travel conditions. The controller unit may be located in the detection unit housing or in a separate enclosure.

3.1.6. **Camera Unit.** Provide a local network digital camera at the design location when shown on the plans meeting the following minimum requirements:

- video resolution: 1920x1080,
- frames per second: 120 fps,
- lens: 2 megapixel (16:9),
- light sensitivity: 0.05,
- sensor size: 1 / 2.8" progressive scan RGB CMOS,
- temperature: -40°F to 140°F
- day and night function,
- two alarm inputs,
- wide dynamic range (WDR)
- local storage, and

- power over Ethernet (PoE).

The camera unit must interface with the local controller unit, warning components, and over-height detection unit. The camera unit must be activated by the OVDWS Controller upon a positive over-height detection reading. Upon receipt of over-height detection reading, the camera unit must capture video and a minimum of four still images showing the over-height vehicle in the scene. Size and resolution of video and images must be user configurable as per the camera specification. Images must be in an industry standard format such as JPG and must not require a proprietary media player to view as per the camera specification. Use camera's pre and post alarm video buffering features and edge storage to enable the captured images to clearly show the specific vehicle detected.

3.1.7. **Mounting Infrastructure.**

3.1.7.1. **Mounting Provisions.** Furnish mounting hardware that securely attaches detection equipment to a vertical steel pole, steel beam, concrete column, or timber pole that does not require any machining operation. The attachment must not stress or deform the unit and must prevent the movement of the unit in any direction by the force of developed wind. Furnish mounting hardware that has the capability of adjustment to the angular orientation of the optical axis in both the horizontal and vertical plane over an angular range of ± 5°.

3.1.7.2. **Support Structure.** Mount OVDWS equipment on existing or new support structures as detailed on the plans or as directed. Support structures may consist of pedestal poles, illumination poles, ITS poles, cantilever overhead sign bridges, overhead sign bridges, or monotube sign bridges. Ensure the selected structure supports the dead weight of the equipment, resists dynamic external forces and allows for detectors to be adjustable in the vertical plane. New support structures will be paid for under their respective Items.

3.1.7.3. **Mounting Location.** Install all poles and foundations outside of the clear zone or behind barrier protection as shown on the plans or as directed.

3.2. **Warning Components.**

3.2.1. **Warning Signs.** Integrate static signs as shown on the plans or as directed that provides advance notification of low clearance ahead and directs detected over-height vehicles to take appropriate action. The static sign assembly must conform all essential elements of the sign to Texas MUTCD standards.

3.2.2. **Flashing Beacons.** Integrate a minimum of 2 flashing beacons with each Warning Sign, Dynamic Message Sign, Portable Changeable Message Sign as shown on the plans. Flashing beacons must conform with Item 685, "Roadside Flashing Beacon Assembly."

3.2.3. **Dynamic Message Signs.** When shown on the plans or as directed, integrate OVDWS with existing or new dynamic message signs according to manufacturer recommendations.

3.2.4. **Portable Changeable Message Signs.** When shown on the plans or as directed, for temporary or works zone applications, integrate OVDWS with portable changeable message signs (PCMS) according to manufacturer recommendations.

3.2.5. **Blank Out Signs.** When shown on the plans or as directed, integrate with existing or new LED blank out signs according to manufacturer recommendations.

3.2.6. **Audible Alarms.** When shown on the plans or as directed, install, and integrate audible alarms according to manufacturer recommendations.

3.2.7. **Communication Interface.** Provide a hardwired or low latency wireless I/O communication link between the OVDWS controller and the various warning components, as shown on the plans or as directed, and is supported by the OVDWS. Hardwire communication link may consist of fiber optic, shielded traffic signal conductors, or Ethernet cable. Wireless communication link may consist of 900 MHz Ethernet spread spectrum radio, 2.4 GHz, or 5 GHz broadband radio.

3.3. **Environmental Considerations.**

3.3.1. **Meteorological Conditions.** Provide equipment that operates and meets all the requirements of this Specification under the following atmospheric conditions:

- temperature: -13°F to 131°F (-25°C to 55°C),
- relative humidity: 0 to 100%,
- rain: 2 in. per hour rate,
- snow: 5 in. per hour rate,
- fog: 200 ft. visibility, and
- wind velocity: AASHTO 2013 LTS Design Spec, "Wind Velocity and Ice Zones."

3.3.2. **Dust.** Furnish equipment that meets an outdoor rating of IP65 or better for total protection against dust.

3.3.3. **False Alarm Conditions.** Furnish detection equipment with dual-beam or better technology to lower risk of false alarms.

3.3.4. **Sun Angle.** Furnish equipment that operates properly when the sun is outside 10° axis of the receiver unit in its installed configuration. Provide documentation stating this requirement is met.

3.3.5. **Shadow Effect.** Furnish equipment that ensures light intensity caused by the shadow of passing clouds will not interfere with the proper operation of the equipment.

3.5 **System Communication Requirements.**

3.5.1. **Local Communication.**

3.5.1.1 **Wireless I/O Radio.** Where shown on the plans or as directed, provide an industrial grade low latency wireless I/O radio communications link between the OVDWS controller and flashing beacon assembly or alternate warning component. The wireless I/O radio unit must meet the following:

- outdoor rating of IP 67, or better,
- use the 900 MHz, 2.4 GHz, or 5GHz frequency,
- support Type C outputs (normally open and normally closed),
- support 3 terminals per relay (common, NO, NC),
- support multiple user-programmable channels,
- support High Gain antenna, and
- require a maximum of 7W power supply.

The wireless I/O device must be compatible with the manufacture of the OVDWS system.

3.5.1.2 **Physical Hard-Wired Connection.** Where shown on the plans or as directed, provide hard-wired communication using shielded traffic signal conductors, in accordance with Item 684 "Traffic Signal Cables", to communicate with the OVDWS unit.

3.5.2. **Backhaul Communication.**

3.5.2.1 **Wireless Communication.** Where shown on the plans or as directed, provide an industrial grade wireless radio communication link between the OVDWS equipment and the Department network in accordance with Special Specification, "Intelligent Transportation System (ITS) Radio."

3.5.2.2 **Fiber Optic Communication.** Where shown on the plans or as directed, provide fiber optic interface equipment at OVDWS controller cabinet and install fiber optic cabling to integrate with Department fiber optic network in accordance with Special Specification "Intelligent Transportation System (ITS) Fiber Optic Cable."

3.5.2.3 **Cellular Router.** Where shown on the plans or as directed, the Department will provide for contractor installation cellular connection equipment to communicate with the unit remotely.

3.6 **Interface with Third Party Software.**

3.6.1. **Description.** The Department uses specialized software called Lonestar™ for traffic management purposes. In addition, State operated programs collect data of over-height vehicle detections.

3.6.2. **Communication Protocol.** As indicated on the plans or as directed, the supplied OVDWS controller unit must propagate all events, including alarms, faults, images, and status, to the Department, as defined in the CVM-VCS Protocol document version 2.0.0 available through Over-height Vehicle Detection System link on the Department's website (http://www.txdot.gov/business/resources/engineering-software.html), for use by third party software.

3.6.3. **Communication Requirements.** In accordance with Section 3.5., "System Communication Requirements," of this Item, and as indicated on the plans or as directed, the OVDWS must communicate to the traffic management center. The Department will use third-party software to collect and analyze this data. All events, including alarms, faults, and status, must be transmitted from the OVDWS controller to the Department via any of the communication interfaces described in Item 3.5.2 as defined in the CVM-VCS Protocol document version 2.0.0 available through the Over-height Vehicle Detection System link on the Department's website (http://www.txdot.gov/business/resources/engineering-software.html). Ensure that the OHVDS system messages for all events, including alarms, faults, and status, adhere to the CVM-VCS Protocol document version 2.0.0 available through the Over-height Vehicle Detection System link on the Department's website (http://www.txdot.gov/business/resources/engineering-software.html).

4. CONSTRUCTION

4.1. **General.** Provide and install all OVDWS equipment, materials, including mounting equipment or kit, calibration and test equipment. Ensure OVDWS operate and function. Use the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design for ease of maintenance, with all component parts readily accessible for inspection and maintenance.

4.2. **Installation.** Install OVDWS system in accordance with the manufacturer's specifications to achieve specified accuracy and reliability. Install OVDWS system ensuring proper operation of the equipment commences within 15 sec. after restoration of power. Install all system components at the locations shown on the plans or as directed.

Before installation of OVDWS, perform a site survey of proposed locations for constructability and notify the Department of any adjustments required due to field constraints.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Contractor to coordinate with local utility companies. Contact information is identified in the General Notes. Consult with the appropriate utility company before beginning such work.

Prevent damage to all components. 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 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 will remain the property of the Department and must 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.

Install foundations, poles, and associated cabinets outside of the clear zone or behind barrier protection.

Install pole, breakaway base, if required, local control cabinet, connectors, wiring, signal beacons, sign, and foundation as shown on the plans, or as directed. Install the flasher controller assembly in the ITS cabinet. Install watertight breakaway electrical fuse holders in all line and neutral conductors at the breakaway base.

Install solar powered systems in accordance with Special Specification 6063 "Intelligent Transportation Systems (ITS) Solar Power System."

4.2.1. **Mounting Infrastructure.** OVDWS to be installed on roadside infrastructure and associated equipment cabinets including, but not limited to, the following:

- Intelligent Transportation System (ITS) pole;
- illumination pole;
- overhead sign structure;
- cantilever overhead sign structure;
- monotube structure
- pedestal pole; and
- timber poles.

Mount the transmitter, and receiver unit to detect the presence of vehicles exceeding the specified vertical height.

Adjustments or additions of attachment hardware, support brackets, offsets, and appurtenances may be necessary for compatibility, as shown on the plans, or as directed. Make all arrangements for connection to the power supply and source including any required permits. Supply and install any required materials not provided by the utility companies (power or communications service provider).

4.2.2. **Foundations.** Construct all foundations for detecting units, and other system support structures in accordance with Item 416, "Drilled Shaft Foundations."

4.2.3. **Alignment.** Allow for directional adjustment and aiming after initial installation. Perform basic alignment of detectors either manually or electronically. Perform this step on the transmitter and receiver unit locations as per the manufacturer's guidelines and recommendations.

4.2.4. **Mechanical Components.** Use stainless steel for all external screws, nuts, and locking washers. No self-tapping screws are allowed unless specifically approved by the Engineer.

Provide corrosion resistant parts, such as plastic, stainless steel, anodized aluminum or brass. Protect all materials used in construction from fungus growth and moisture deterioration. Separate all dissimilar metals by an inert dielectric material.

4.3. **Relocation.** Perform the relocation in strict conformance with the requirements herein and as shown on the plans or as directed. Completion of the work must present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Inspect the existing OVDWS, with a representative from the Department, and document any evidence of damage before removal. Conduct a pre-removal test in accordance with the testing requirements contained in this Item to document operational functionality. Remove and deliver to the Department existing OVDWS that fail inspection.

Before removal of existing OVDWS, disconnect, and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store

power and communication cabling inside the cabinet until it can be relocated. Remove existing OVDWS as shown on the plans only at such time as authorized.

Use care to prevent damage to any support structures. Any components of the OVDWS or support structure damaged or lost must be replaced by the Contractor at no cost to the Department. Contractor to document and report to the Engineer any existing damage to equipment before removal.

Make all arrangements for connection to the power supply and communication source including any permits required for the work to be done under the Contract. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 V. The power connection must meet the requirements of the most current version of the NEC.

4.4. **Removal.** Disconnect and isolate any existing electrical power supply before removal of OVDWS.

Perform removal in strict conformance with the requirements herein stated and as shown on the plans or as directed. Completion of the work must present a neat, workmanlike, and finished appearance.

Any components of the OVDWS damaged or lost must be replaced by the Contractor (with items requiring the approval of the Engineer) at no cost to the Department.

All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location designated on the plan sheets or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

4.5. **Working Drawings.** Before fabrication or ordering mounting equipment, submit for approval 5 prints of the working drawings for attachment of each OVDWS. Vendor cut sheets for mounting kits may be allowed as prints. Show the details of any additional brackets, connections, and methods of attachment.

4.6. **Contractor Experience.** Use installers, testers, and integrators with at least the following requirements:

4.6.1. **Minimum Experience.** Contractor or designated Subcontractor must demonstrate a minimum of 3 yr. of experience where the personnel installed, tested, and integrated various network equipment combined as an ITS system to create an operational function. This may include such systems as high-water detection and warning systems, variable speed limit systems, wrong-way detection and warning systems, roadway weather detection and warning systems, or similar applications of technology requiring specialized equipment, electrical, and networking. Personnel must have written proof of training from the OVDWS equipment suppliers on installation, operations, and testing procedures of all OVDWS equipment before installation.

4.6.2. **Completed Projects.** Contractor or designated Subcontractor must have completed a minimum of three projects with a minimum of five OVDWS devices total consisting of ITS equipment installation and integration. Contractor must work closely with the OVDWS System Manufacturer to perform the installation to meet all the requirements in this Item. The completed system installation must have been in continuous satisfactory operation for a minimum of 1 yr. Contractor must work closely with the Department to meet System Integration requirements for OVDWS.

4.6.3. **Equipment Experience.** Contractor or designated Subcontractor must demonstrate experience from one ITS project (may be from one of the three projects in the preceding paragraph) in which the Contractor personnel worked in cooperation with technical representatives of OVDWS equipment suppliers to perform installation, integration, and testing of OVDWS.

Experience may be substituted with manufacturer experience for one of the ITS projects, provided the manufacturer must be on-site during installation, operational turn-on, and acceptance of the completed OVDWS system.

Submit the names, addresses and telephone numbers of the references that can be contacted to verify the experience requirements given above.

4.7. **Training.** Contractor or designated Subcontractor must conduct a training class for a minimum of 16 hr., unless otherwise directed, and for up to 10 representatives designated by the Department on procedures of installation, operations, programming, hardware settings, IP programming, port settings, testing, maintenance, troubleshooting, and repair of all equipment specified within this Specification. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the project local area. Training must consider operations through the Department's Lonestar software when developing training modules. Coordinate with TxDOT-TRF employee or Department's System Integrator to assist with Lonestar software operations when developing training modules.

Provide training to Department Personnel in the operation, setup, and maintenance of the wireless I/O radio supplied within this Item, local and system configuration programming, and alarm programming. Provide instruction and materials for a maximum of 10 individuals. The User's Guide is not an acceptable substitute for practical classroom training.

4.8. **Testing.** Testing of OVDWS is for the purpose of relieving the Contractor of maintenance of the system. Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, "Legal Relations and Responsibilities," after a successful test period. Contractor will not be required to pay for electrical energy consumed by the system.

4.8.1. **New Installations.** Contractor to use testing tools accepted by OVDWS manufacturer and be familiar with testing procedures identified by the OVDWS manufacture. Unless otherwise shown on the plans or as directed, perform the following tests on the applicable equipment or systems.

4.8.1.1. **Test Procedures Documentation.** Provide five copies of test plan to be completed by the Contractor. Identify the test procedures to include tests identified in Section 4.8.1.2. through Section 4.8.1.6., inclusive and blank data forms to the Engineer for review and comment at least 45 days before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of equipment for tests. Contractor to resubmit, if necessary, revised test procedures for final approval within 10 days before testing. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Record measured test data on the data forms against threshold values, as well as quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the minimum requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy identified during testing by the Contractor. Furnish data forms containing the acceptable range of expected results as well as the measured values.

4.8.1.2. **Demonstration Test.** Conduct a demonstration test on the following equipment at an approved Contractor facility: applicable detection and warning elements including, but not limited to infrared technology, beacons, and dynamic message sign (if used).

4.8.1.3. **Operational Test.** Power on all components of the OVDWS system and run for at least 15 min. Ensure all components contained within the project requirements are operating correctly. Perform the following tests.

4.8.1.3.1. **Detection.** Set up the detection equipment at a mutually agreed upon location to represent a field installation. Set up the detection equipment (infrared sensors) at a separation distance of at least 100 ft. apart. Mount the detection equipment at a height of at least 5 ft. above the pavement but no more than 7 ft. above the pavement. Align the sensors for proper operation. Using a test vehicle of enough height and mass pass through the detection beam. Monitor the OVDWS system controller to identify the test vehicle was registered by the system. Repeat this component test per the manufacturer's recommendation, but not less than 20 times. Record the results on the approved data forms.

4.8.1.3.2. **Warning Signs.** Test the OVDWS system using the configuration setup above. For each passing of the test vehicle the controller should trigger the visual warning device, such as the flashing beacon, DMS, or audible device. Monitor the results and record the results on the approved data forms.

4.8.1.3.3. **Other tests.** Additional tests should be performed based on the Vendor's recommendations that support the OVDWS system meets the functional requirements of this Specification.

4.8.1.4. **Field Acceptance (Stand-Alone) Test.** Conduct a field acceptance test for each unit after installation to demonstrate compliance with the functional requirements with this Specification. Ensure Vendor is present throughout field acceptance test to provide support. Exercise all stand-alone (non-network) functional operations. Notify the Engineer five working days before conducting this test. The field acceptance test must consist of the following.

4.8.1.4.1. **Physical Construction.** Document physical construction is completed in accordance with the plans and specifications.

4.8.1.4.2. **Electrical and Communication.** Document that all connectors for grounding, surge suppression, and electrical distribution are tightened correctly. Document all power supplies and circuits are operating under the proper voltages. Document all power and communications cables are terminated correctly, secured inside the cabinet, and fitted with appropriate connectors in accordance with the latest version of the National Electrical Code (NEC).

4.8.1.4.3. **Proper Equipment Function.** Document that all OVDWS system equipment is operating and functioning in accordance to this Specification. This includes detection, communication between the detection units and the controller, controller functions, warnings, and data logging. Ensure the detection beam heights are in accordance with the plans.

4.8.1.4.4. **Communication with Traffic Management Center Operations.** Test that when the detection units are triggered, and as indicated on the plans, the OVDWS system communicates to the designated traffic management center. Conduct the final test in accordance to the approved test procedures.

4.8.1.4.5. **Other tests.** Additional tests should be performed based on the Vendor's recommendations that support the OVDWS system meets the functional requirements of this Specification.

4.8.1.5. **System Integration Test.** Provide system integration test procedures for proper adjustment and calibration of subsystem components. Proper adjustment and calibration involves documenting settings used to meet functional requirements while providing a margin for adjustment when future conditions change. Coordinate with Department's System Integrator to perform subsystem testing. At a minimum, verify commands and confirms, as well as, detector actuations and occupancy dwell time. Contractor is responsible for being familiar with any existing Department equipment and software. Perform local and offsite testing to ensure communication compatibility of the system to the Traffic Management Center.

Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests.

The failure of any one component material or equipment item in a system integration test is justification for rejecting the entire subsystem. Each subsystem component must function as a complete integrated subsystem for a minimal continuous 72 hr. period during the system integration test.

4.8.1.6. **Final Acceptance Test.** Following completion of the demonstration test, stand-alone test, and system integration test for all subsystems, provide completed data forms containing all collected data, including quantitative results for all tests, a set of "as built" working drawings, and a written request to begin a data communication and final acceptance test. Provide "as built" working drawings to the Engineer indicating the actual material, equipment, and construction of the various subsystem components, including established and calculated XY coordinates based on project control points provided by the Engineer, when shown on the plans or as directed.

Within 10 calendar days of the request, execute a data communications test using a Department supplied software program or Contractor supplied software approved by the Department. The data communications test may be executed by the Engineer or the Contractor with prior approval of the Engineer. The purpose of this test is to verify the communications plant will operate with application software provided by the State.

Perform the data communications test for a period of 72 hr. If a message error or component failure occurs anywhere in the network, resume the test once repairs are completed for a new 72 hr. period. All components of the communications network must operate as an integral system for the duration of the test.

A message error is defined as the occurrence of a parity error, framing error, or data error in any component of the message. The error free message rate is defined as the ratio of the number of messages in which no message error occurs to the number of messages transmitted. The error free message rate must exceed 99.99% for acceptable transmission quality, both for the system as a whole and for each component of the network.

Provide all additional test results to the Engineer for review once a successful data communications test has been completed.

Notify the Engineer of any defects suspected in integration or function of material or equipment. Investigate any suspected defects and correct if necessary. Provide a report of finding within two calendar days of notice of any suspected defects. Describe the nature of the any defects reported and any corrective action taken in the report. The integrated subsystems must operate defect free as a single complete system for a minimum of 72 continuous hours during a 30 calendar day review period. If the number of defects or frequency of failures prevents any subsystems from operating as described above, the Engineer may reject the entire subsystems integration test results and resume contract time. Provide any necessary corrections and resubmit subsystems integration test results and a request to begin a final acceptance test which may include "as built" plans and a data communications test.

The system under this Item will not be accepted until the system, inclusive of all subsystems, has operated satisfactorily for a period of 90 days and in full compliance with the plans and specifications after approval of all submitted test results and reports.

4.8.1.7. Consequences of Test Failure. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation before modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 15 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies substantially delaying receipt and acceptance of the unit, will be enough cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or time extension of the contract period.

4.8.1.7.1. Consequences of Design Approval Test Failure. If the equipment fails the design approval test, correct the fault within 30 days and then repeat the design approval test until successfully completed.

4.8.1.7.2. Consequences of Demonstration Test Failure. If the equipment fails the demonstration test, correct the fault within 30 days and then repeat the demonstration test until successfully completed.

4.8.1.7.3. Consequences of Field Acceptance (Stand-Alone) Test Failure. If the equipment fails the stand-alone test, correct the fault within 30 days and then repeat the stand-alone test until successfully completed.

4.8.1.7.4. **Consequence of System Integration Test Failure.** If the equipment fails the system integration test, correct the fault within 30 days and then repeat the systems integration test until successfully completed.

4.8.1.7.5. **Consequences of Final Acceptance Test Failure.** If a defect within the system is detected during the final acceptance test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a 30 consecutive day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime that exceeded 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

4.8.2. **Relocation and Removal.**

4.8.2.1. **Pre-Test.** Conduct operational testing before removal of OVDWS. Test all functional operations, as identified on the plans or as directed, of the equipment in the presence of representatives of the Contractor and the Department. Ensure both representatives sign the test report indicating the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Engineer. Compare test data before removal and test data after installation. The performance test results after relocation must be equal to or better than the test results before removal. Repair or replace those components within the system which failed after relocation, but which passed before removal.

4.8.2.2. **Post Test.** Testing of OVDWS is for the purpose of relieving the Contractor of maintenance of the system. Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, "Legal Relations and Responsibilities," after a successful test period. Contractor will not be required to pay for electrical energy consumed by the system.

Furnish test data forms containing the sequence of tests including all of the data recorded as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days before the day the tests are to begin. Obtain Engineer's approval of test procedures before submission of equipment for tests. Provide at least one copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field sites. At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed per the plans as directed. Complete the approved data forms with test results and provide to the Engineer for review and either acceptance or rejection of equipment. Provide at least 30 working days' notice before all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved system tests on the field equipment with the Department's central control software. The tests will, at a minimum, exercise all remote control functions and display the return status codes from the equipment.

If any unit fails to pass a test, prepare a report and deliver the report to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of time to the contract period.

4.9. **Integration Assistance.** Provide assistance to the Department's current System Integrator for integration of each OVDWS into the District Traffic Management Center.

4.10. **Documentation and Warranty.**

4.10.1. **Documentation Requirements.** Provide a minimum of 2 complete sets of operation and maintenance manuals in bound hard copy format, as well as an electronic copy in Adobe PDF format on a CD/DVD or removable flash drive that include the following:

- complete and accurate wiring schematic diagrams,

- complete installation procedures,
- compliance matrix documenting conformance to this specification,
- complete performance specifications (functional, electrical, mechanical and environmental) on each unit of the system,
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,
- pictorial of component layout on circuit board,
- complete maintenance and trouble-shooting procedures,
- complete stage-by-stage explanation of circuit theory and operation,
- testing procedures and blank test forms,
- recovery procedures for malfunction,
- instructions for gathering maintenance assistance from manufacturer, and
- provide the Department with certification documentation verifying conformance with environmental and testing requirements contained in this special specification. Certifications may be provided by the manufacturer or through independent certified labs.

Identify material which is copyrighted or proprietary in nature as part of the documentation submittal. The Department will comply with sensitive material and secure submittal documentation to the extent possible under Texas Government Code, Chapter 552 pertaining to Texas Public Information Act.

4.10.2. Warranty. Guarantee equipment furnished and installed to perform according to the manufacturer's published specifications. Warrant equipment against defects or failure in design, materials, and workmanship in accordance with the manufacturer's standard warranty. Supply equipment with at least 1 yr. of manufacturer's warranty and end no sooner than final project acceptance. Any equipment with less than 1 yr. manufacturer's warranty will be rejected. The workmanship of installing, connecting, and performance of this device must be guaranteed for 1 yr. after final acceptance of the project by the Department.

Repair or replace OVDWS System equipment at the Contractor's expense before completion of the final acceptance test plan if a malfunction or failure. Furnish replacement parts for all equipment within 15 days of notification of failure by the Department.

5. MEASUREMENT

This Item will be measured by each system furnished, installed, relocated, integrated, removed, made fully operational, tested, or removed in accordance with this specification and as directed.

6. PAYMENT

6.1. 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 "Over-height Vehicle Detection and Warning System (OVDWS)," "Install Over-height Vehicle Detection and Warning System (OVDWS)," "Relocate Over-height Vehicle Detection and Warning System (OVDWS)," and "Remove Over-height Vehicle Detection and Warning System (OVDWS)."

Pole foundations for support structures will be paid for in accordance with Item 416, "Drilled Shaft Foundations." New conduit will be paid for in accordance with Item 618, "Conduit." New electrical conductors will be paid for under Item 620, "Electrical Conductors." Ground boxes will be paid for in accordance with Item 624, "Ground Boxes." Treated timber poles will be paid for in accordance with Item 627, "Treated Timber Poles." New electrical services will be paid for under Item 628, "Electrical Services." New static warning signs will be paid for in accordance with Item 636, "Aluminum Signs." Small roadside sign support assemblies will be paid for in accordance with Item 644, "Small Roadside Sign Support and Assemblies." Ground mounted signs and support will be paid for in accordance with Item 647, "Large Roadside Sign Supports and Assemblies." Flashing beacons will be paid for in accordance with Item 685, "Roadside Flashing Beacon Assemblies." Pedestal pole assemblies will be paid for under Item 687, "Pedestal Pole

Assemblies." New metal ITS poles will be paid for in accordance with Special Specification, "Intelligent Transportation Systems (ITS) Pole with Cabinet." Solar power systems will be paid for in accordance with Special Specification 6063, "Intelligent Transportation Systems (ITS) Solar Power System."

6.2. Furnish and Install. This price will be full compensation for furnishing and installing all new system components including materials, internal electrical conductors, connectors and mounting hardware; integration with existing roadway infrastructure (as required) and communication network; integration with warning signs and for all labor, tools, equipment, testing, documentation, permits, and incidentals necessary to complete the work.

6.3. Install Only. This price is full compensation for transportation and installation of Department furnished OVDWS; furnishing and installing any mounting equipment, internal electrical conductors, connectors; integration with existing roadway infrastructure (as required) and communication network; integration with warning signs, power grounding and lightning suppression systems, and for all labor, tools, equipment, testing, documentation, permits, and incidentals necessary to complete the work.

6.4. Relocate. This price is full compensation for relocating and making fully operational an existing OVDWS as shown on the plans or as directed; storing the OVDWS when required; replacement or repair of damaged components; disposal of unsalvageable material and will include the cost of furnishing all labor, materials, tools, testing, equipment, permits, and incidentals.

6.5. Remove. This price is full compensation for removing existing OVDWS as shown on the plans or as directed; testing and decommission; disposal of unsalvageable material and for all labor, tools, equipment, and incidentals.

6.6. Cellular routers are not included as paid for under another item or furnished by the Department.

All pertinent adjustments or additional materials required by mounting infrastructure will not be paid for directly but will be subsidiary to this Item. All pertinent OVDWS training is subsidiary to this Item.