Special Specification 6409
LED Wrong Way Driver System (Thermal)

1. DESCRIPTION

Furnish, install, relocate or remove LED Wrong Way Driver System WWDS at locations shown on the plans or as directed.

2. MATERIALS

2.1. **General**. Except as allowed for relocation of LED Wrong-Way Driver System (WWDS) equipment, ensure all equipment and component parts are new and in an operable condition at time of delivery and installation. Ensure all WWDS within the project are from the same manufacturer. WWDS equipment is further classified by the type of functions they can perform.

Provide WWDS that is compatible with existing infrastructure and software located in the Department's Traffic Management Centers (TMCs) across the state or as directed.

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 620, "Electrical Conductors"
- Item 644, "Small Roadside Sign Supports and Assemblies"
- Item 656, "Foundations for Traffic Control Devices"
- Item 687, "Pedestal Pole Assemblies"
- Item 6006, "Electronic Components"
- Item 6062, "Intelligent Transportation System (ITS) Radio"
- Item 6063, "Intelligent Transportation System (ITS) Solar Power System."

2.1.1. **Components**. The system is composed of these principal items as shown on the plans or as directed:

- Wrong Way sign (R5-1a);
- LED strips for flashing red lights when a wrong way driver is detected;
- Detector(s) for detecting wrong way drivers;
- Flash Controller;
- Power Source for powering any lights and equipment;
- Sign Support and Foundation;
- Communications for system status / configuration and wrong way driver alerts; and
- Camera for visual confirmation of wrong way driver event.

2.2. **Functional Requirements**. Furnish a WWDS that provides a highly visible, enhanced warning for alerting WWDS. Upon activation by thermal imaging cameras and sensors of a wrong way driver, the WWDS flash controller will activate and flash all red lights simultaneously. The light will flash synchronously and then cease operation after a programmable timeout. When shown on the plans or as directed, the WWDS equipment will also send alerts including visual confirmation.

Ensure equipment is designed to protect personnel from exposure to high voltage during installation, operation and maintenance. If 120 V AC /60 Hz power is not available and solar power must be used, ensure all components can operate on DC power, so a power inverter is not needed.

2.2.1. **Sign**. Provide a WRONG WAY sign (R5-1a) of appropriated size in accordance with Standard Highway Sign Designs for Texas (SHSD) and Texas Manual on Uniform Traffic Control Devices (TMUTCD).

2.2.2. **Flashing Red Lights**. As shown on the plan or as directed, provide flasher controller that turns on the LEDs. Active vehicle warning indications must be visible in a direct line of sight at distances over 1000 ft. during the day, and over 1 mi. at night.

2.2.2.1. **LEDs**. Mounted around the entire border of the sign.

2.2.3. **Detector**. Program the detector to provide trigger outputs only when a wrong way driver is detected traveling between 1 to 100 mi. per hr. Unless otherwise shown on the plans or as directed, provide thermal imaging cameras and sensors for detection.

2.2.4. **Flash Controller**. The programmable flash controller with Integrated Solar Charger is housed within the NEMA Type 4 Control Cabinet, and must:

- Have a contact-closure point to accept a trigger from the detector;
- Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two lights;
- Flash the LEDs 50 to 60 flashes per min.;
- Have multiple programmable function options:
  - Run 24 hr. per day, seven days per week,
  - Run from dusk to dawn,
  - Run for a programmable time period when activated via switch, button contact closure or when triggered from an external detector such as a wireless transmitter, RVSD, presence detector or loop detector with a compatible sensor output,
  - Run on a timeclock schedule that is programmed to the controller and determines days of the week and times of the day that the sign flashes, and
  - Run a “fail safe” operation when the detector fails and will remain in this state until communication is re-established with the detector;
- Provide multiple levels of LED brightness through LED drive current control;
- Automatically adjust the LED drive current control to optimize brightness for the ambient lighting conditions;
- Automatically adjust the LED duty cycle to save battery during nighttime operation;
- Have the LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time;
- Include an integrated Real Time Clock (RTC) with on-board battery or supercapacitor backup;
- Have the capability of TCP/IP communications for programming with Windows-based software or web browser;
- Be capable of solar charging the system battery, including a completely drained battery pack;
- Automatically provide Low Voltage Disconnect (LVD) to protect batteries when needed;
- Automatically provide Load-Reconnection once battery levels have been restored to an acceptable value;
- Include a minimum of two General Purpose Inputs and Outputs (GPIO);
- Be internally housed in its own NEMA Type 6 enclosure;
- Be independently replaceable of other control panel components; and
- Can monitor internal temperature.

2.2.5. **Power Source**. If 120 V AC /60 Hz power is not available, provide a solar power system that must power for all the entire WWD System. Unless otherwise shown on the plans or as directed, size solar power system with batteries for a 3-Day Autonomy in accordance with Item 6063 “Intelligent Transportation System (ITS) Solar Power System.” Ensure maximum solar insolation regardless of installation location. If a post-top mounting system is used, provide 360° of rotational direction adjustment.

Battery must be replaceable independently of other components.

2.2.6. **Sign Support and Foundation**. If mounting the WWDS on an existing sign support, ensure the system is sized appropriately and can withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

2.2.7. **Communications**. If communications and remote accessible is required, provide TCP/IP options over a radio in accordance with Item 6062 "Intelligent Transportation System (ITS) Radio" or that are compatible with a Department-furnished cell modem.

2.2.8. **Camera**. If visual confirmation is required, provide a camera.

2.3. **Mechanical**. Ensure that all parts are fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum or brass.

Ensure that all screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws.

Ensure equipment is clearly and permanently marked with manufacturer name or trademark and part number as well as date of manufacture or serial number.

Ensure WWDS is modular in design for ease of field replacement and maintenance.

All printed circuit boards (PCB) must have conformal coating.

2.4. **Cabling**. Supply the WWDS with all cabling of the appropriate length for each installation site.

2.5. **Connectors and Harnesses.** External connections exposed to the outdoor environment must be made with weatherproof connectors. Connectors must be keyed to ensure correct alignment and mating.

Ensure all conductors are properly color coded and identified. Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting and conductive metal.

Ensure power and data cable connectors exposed to the elements are IP 67 compliant. Ensure all conductors that interface with the connector are encased in one jacket.

2.6. **Environmental**. All WWDS components must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS2, Section 2.

Provide a WWDS with a design will minimize weight and wind loading when mounted on a sign support. WWDS must be able to withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

2.7. **Documentation**. Provide hardcopy operation and maintenance manuals, along with a copy of all product documentation on electronic media. Include the following documentation for all system devices and software:

- Operator manuals;
- Installation manuals with installation procedures;
- Maintenance and troubleshooting procedures; and
- Manufacturer's specifications (functional, electrical, mechanical, and environmental).

2.8. **Warranty**. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 3 yr. or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any equipment with less than 90% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's

published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Malfunctioning equipment must be repaired or replaced at the Contractor's expense before completion of the final acceptance test plan. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

During the warranty period, technical support must be available via telephone within 4 hr. of the time a call is made by a user, and this support must be available from factory certified personnel.

3. CONSTRUCTION

3.1. **Installation**. Before installation of any equipment, perform a site survey of the proposed locations to determine the optimal positioning of the signs and thermal cameras and sensors to achieve proper operation based on the manufacturer's recommendations. Test wireless links to assure they provide optimal communication between transmitters and receivers. Adjust locations as approved by the Engineer if necessary. If required, remove any existing Wrong Way signs from their mounts to allow the installation of the new signs. Mount WRONG WAY sign in accordance with Section 2B.41 Wrong-Way Traffic Control at Interchange Ramps of the TMUTCD, or shown on the plans or as directed.

Install equipment 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 must be installed in a neat and workmanlike manner.

Provide all mounting hardware and cabling necessary to install and make operational all equipment. Provide only new and corrosion resistant materials. Consider all mounting hardware and cables as subsidiary to this item with no direct payment.

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

Replace any portion of the equipment that is damaged or lost during transportation or installation. Any unused or removed material deemed salvageable by the Engineer will remain on the property of the Department or be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state and local regulations.

The Contractor must complete vendor-provided training on the installation of all equipment before any work begins. The Contractor will provide documentation that they have completed the required training from the equipment manufacturer before final testing of the equipment.

Once installation is complete, contractor will coordinate with equipment manufacturer to ensure thermal camera and sensor are properly positioned and the Wrong Way driver detection zones are accurate. Ensure that all equipment is functioning properly and communicating with manufacturer's cloud server. Testing will begin once proper system functionality is proven.

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

3.2. **Mechanical Components**. Ensure that all fasteners, including bolts, nuts and washers with a diameter less than 5/8 in. are Type 316 or 304 stainless steel and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 in. and over in diameter are galvanized and meet the requirements of ASTM A307. Separate dissimilar metals with an inert dielectric material.

3.3. **Wiring**. All wiring and electrical work supplying the equipment must meet the requirements of the most current version of the National Electrical Code (NEC). Supply and install all wiring necessary to interconnect WWDS equipment to the field cabinet necessary to complete the work. If additional cables are required, the Contractor must furnish and install them at no additional cost to the Department. Provide conductors at least the minimum size indicated on the plans and insulated for 600 V.

Cables must be cut to proper length before assembly. Provide cable slack for ease of removal and replacement. All cable slack must be neatly laced with lacing or straps in the bottom of the cabinet. Ensure cables are secured with clamps and include service loops.

3.4. **Electrical Service**. When shown in the plans, the Contractor is responsible for checking the local electrical service (if available) to determine if a modification is needed for the equipment

3.5. **Grounding.** Ensure all WWDS devices, cabinets, and supports are grounded in accordance with the NEC and manufacturer recommendations.

3.6. **Relocation of WWDS Field Equipment**. 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 WWDS field equipment with a representative from the Department and document any evidence of damage before removal. Conduct testing in accordance with 4.5. Remove and deliver equipment that fails inspection to the Department.

Before removal of existing WWDS field equipment, 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 WWDS field equipment as shown on the plans or as directed only when authorized by the Engineer.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by the Engineer) at no cost to the Department.

Make all arrangements for connection to power and communications 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.

3.7. **Removal of WWDS Field Equipment**. Perform the removal 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 removal.

Inspect the existing WWDS field equipment with a representative from the Department and document any evidence of damage before removal. Conduct testing in accordance with 4.5.

Disconnect and isolate any existing electrical power supply before removal of existing field equipment.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by 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 shown on the plans, general notes or as directed. The Contractor is fully responsible for any removed equipment until released by the Engineer.

3.8. **Contractor Experience Requirements**. Contractor or designated subcontractor must meet the following experience requirements:

3.8.1. **Minimum Experience.** Two years of continuous existence offering services in the installation of WWDS. Experience must include equipment setup, testing, and troubleshooting.

3.8.2. **Completed Projects.** Two completed projects where personnel installed, tested and integrated WWDS field equipment. The detectors and radios must have been installed outdoors and permanently mounted. The completed installations must have been in continuous satisfactory operation for a minimum of 1 yr.

3.8.3. **Equipment Experience**. One project (may be 1 of the 3 projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

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

4. TESTING

Testing of the installed equipment locations is to relieve the Contractor of maintenance of the equipment. The Contractor will be relieved of the responsibility for maintenance of the equipment in accordance with Item 7, "Legal Relations and Responsibilities"; after all testing is successfully completed.

4.1. Ensure that the following tests are performed on equipment and systems unless otherwise shown on the plans or as directed. The Department may witness all the tests.

4.2. **Performance Test**. Conduct a Performance Test for each unit after installation. Ensure the WWDS meets functional performance requirements of Section 2 by using the following test methods:

Testing of the equipment will consist of the following procedure: once the equipment has been installed and activated, the exit ramp will be closed to traffic. A test vehicle will then be driven the wrong way down the ramp a minimum of 10 times. Once a maximum of 10 successful detections and notifications of the wrong way vehicle are received, the equipment will be accepted as fully tested and ready for operation. To be accepted the last 5 successful tests must be consecutive.

After each equipment location has been installed, the Department and the contractor will conduct approved continuity, stand alone, and system tests on the installed field equipment with laptop equipment.

4.3. **Final Acceptance Test**. Conduct a Final Acceptance Test on the complete functional system. Demonstrate all control, monitor, and communication requirements for 60 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 less than 2 false calls have occurred, the 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, document the acceptance date and project identification information and provide 2 copies to the Engineer.

4.4. **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 30 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 that will substantially delay receipt and acceptance of the unit will be enough cause for rejection of the unit.

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 extension of the Contract period.

4.5. **Relocation and Removal**

4.5.1. **Pre-Test**. Tests may include, but are not limited to, physical inspection of the unit and cable assemblies. Include the sequence of the tests in the procedures along with acceptance thresholds. Contractor to resubmit, if necessary, rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing before removal of WWDS field equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data before removal and 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 that failed after relocation but passed before removal.

4.5.2. **Post-Test**. Testing of the WWDS field equipment is to relieve the Contractor of system maintenance. The Contractor will be relieved of the responsibility for system maintenance in accordance with Item 7, "Legal Relations and Responsibilities" after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing WWDS field equipment has been installed, conduct approved continuity and performance tests. Furnish test data forms containing the sequence of tests including all the data taken 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. Send at least 1 copy of the data forms to the Engineer.

Conduct an approved performance test of the equipment installation at the field sites. At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give 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 with field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise remote control functions and confirm communication with field equipment.

If any unit fails to pass a test, prepare and deliver a report to the Engineer. Describe 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 the Contract period.

5. MEASUREMENT

5.1. This Item will be measured by each furnished, installed, relocated, or removed of the types specified, to provide communication and functionality.

6. PAYMENT

6.1. **Furnish and Install**. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "LED Wrong Way Driver System."

This price is full compensation for furnishing, installing, configuring, integrating and testing the completed installation including WWDS equipment, voltage converters or injectors, cables, connectors, associated equipment and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, software, warranty and incidentals necessary to complete the work.

6.2. **Install Only**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Install Only)." This price is full compensation for installing, configuring, integrating and testing the completed installation including WWDS equipment, voltage converters or injectors, cables, connectors, associated equipment and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, software and incidentals necessary to complete the work.

6.3. **Relocate**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Relocate)." This price is full compensation for relocating and making fully operational existing WWDS field equipment; furnishing and installing additional cables or connectors; for testing, delivery and storage of components designated for salvage or reuse; and all testing, software, equipment, any required equipment modifications for electrical service, labor, materials, tools and incidentals necessary to complete the work.

6.4. **Remove**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Remove)." This price is full compensation for removing existing WWDS equipment; removal of cables and connectors; for testing, delivery and storage of components designated for salvage; and all testing, software, equipment, labor, materials, tools and incidentals necessary to complete the work.