

Special Specification 6305

Lane-Use Control Signal System Equipment



1. DESCRIPTION

Furnish, install, relocate, or remove lane-use control signal (LCS) system equipment at locations shown on the plans, or as directed.

2. MATERIALS

- 2.1. **General.** Furnish, assemble, fabricate, and install only new materials. LCS systems must meet the requirements of National Electrical Manufacturers Association (NEMA) TS4 (current edition) . Provide LCS with solid state display elements and modules. LCS with mechanical or electromechanical elements or shutters are prohibited.

Provide LCS field equipment that is compatible with existing infrastructure and software located in the Department's Traffic Management Centers (TMCs) across the state.

Furnish and install the following devices and components for each LCS system field site and as shown on the plans:

- LCS (quantity of signals shown on the plans),
- LCS Controller,
- LCS Controller cabinet and foundation with pad,
- Cabling, conduit, and connectors from LCS to controller, and
- LCS system software.

LCS system must self-recover from power failure once power is restored.

- 2.2. **Lane-Use Control Signal.** LCS must comply with the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) and NEMA TS 4 (current edition). Symbols displayed on 18 in. signal faces must have a width and height of at least 18 in. \pm 1/2 in. and be comprised of multiple light-emitting diodes (LED). Provide an LCS with a front that is finished completely in matte black.

LCS must be capable of being independently controlled to display the following indications unless otherwise shown on the plans:

- Steady Red X,
- Steady Downward Green Arrow,
- Steady Yellow X,
- Steady Downward Diagonal Yellow Arrow (Right),
- Steady Downward Diagonal Yellow Arrow (Left) , and
- Blank

- 2.2.1. **Display.** Ensure LCS uses LED technology to display indications on a flat black, non-reflective, rectangular face. LCS must include a dimming feature that automatically adjusts for operation at full brightness during bright ambient light (Day Mode) and reduced brightness during dim ambient light (Night Mode).

The LCS must appear completely blank when not energized. Faint symbols or legends must not be visible under any light condition when power is turned off.

All LED display modules and components must be securely attached to the inside of the LCS enclosure.

LEDs must be rated for 100,000 hr. of continuous operation.

Individual LEDs must be wired such that a catastrophic loss or the failure of one or more LEDs will not result in the loss of the entire display.

- 2.2.2. **LCS Enclosure.** Ensure that the LCS enclosure includes a signal housing, door, fittings, and accessories that are noncorrosive, rust resistant, and capable of withstanding constant exposure to sunlight and corrosive atmospheres. The enclosure and door must be made of 5052-H32 sheet aluminum with a minimum thickness of 0.125 in. The enclosure with door and mounting attachments must provide NEMA 3R protection for internal components and assemblies. Do not use silicone or other sealants to seal joints.

The enclosure door must include a tamper proof hinge and a minimum of 2 captive latches to secure the door closed. The enclosure door seal must include a gasket that mates with a flat surface. The gasket must be made of closed-cell material resistant to ultraviolet, weathering, elevated temperatures, and permanent deformation, and provide a weather-tight seal when the door is closed.

LCS enclosure must be no larger than 36 x 36 in. ($\pm 5\%$) in. unless otherwise shown on the plans.

The entire LCS enclosure must be flat or semi-gloss black. Shiny, reflective or non-black areas must not be visible from the front of the LCS (including door locks). Reflective front faces of any sort are not allowed.

Provide a barrier-type terminal strip or screw connection terminal block in the LCS enclosure for terminating field wires as required. Clearly mark the function of each terminal.

Ensure the housing includes provisions for weather-tight cable entry.

The weight of the LCS enclosure, including all internal electronic components must not exceed 125 lbs.

- 2.3. **LCS Controller.** Provide a LCS controller that is a software-oriented, microprocessor type with resident software stored in non-volatile memory. The LCS controller must retain all programming in nonvolatile memory.

The LCS controller must support "Central" and "Local" modes of operation. In "Central" mode, a central control computer controls the display. In "Local" mode, laptop computer software and direct inputs to the LCS controller controls the display.

The LCS controller must support the following commands:

- Display command from Central (Central mode),
- Display command from a local laptop computer (Local mode),
- LCS Status request, which reports the following:
 - LCS indication
 - Operating Mode
 - Mode of the displayed message if any (local/central)
 - Status of the photoelectric sensors
 - Light output level (day/night)
 - LCS number, location, or ID
- LED status request, which provides an instantaneous indication of the status of all the LEDs (operational/nonoperational),
- Day/Night switching command,
- Sign off command (set to blank-out), and
- Echo command, which is used to receive indications currently displayed.

The LCS Controller must include error detection and reporting features to guard against incomplete or inaccurate information transmission, such as:

- redundancy checking of all data received from the LCS Master Controller, with positive acknowledgement for all transmissions,
- status monitoring for communication line malfunction or break, and
- content validation of all received transmissions for logic and data errors.

The LCS Controller must provide fail-safe operation that prevents improper display in the case of system malfunction. The system must be capable of automatically blanking all LCS heads when communication is lost for a user-configurable amount of time. Failure of any LCS not directly associated with another LCS or communication line must not affect operation of any other non-associated LCS in the system.

- 2.3.1. **Configuration and Management.** Ensure the LCS system is provided with software that allows local and remote configuration and monitoring. Ensure the system configuration data can be saved to a computer and restored from a saved file. Ensure that display failures are recorded and reported by the LCS system. Ensure the system allows controllers to be reset remotely using NTCIP commands.
- 2.3.2. **Communications.** Ensure the LCS Controller includes a minimum of one 10/100 Base TX Ethernet port and one EIA-232 serial port. Ensure that all communication addresses are user programmable. Ensure the LCS supports NTCIP 1203v3.
- 2.4. **LCS Controller Cabinet.** NEMA traffic controller assemblies used in LCS systems must meet the requirements of NEMA TS2-2016. Model 332, 334, and 336 cabinet assemblies must meet the requirements of Caltrans TEES. Furnish field equipment cabinet in accordance with special specification "Intelligent Transportation System (ITS) Ground Mount Cabinet" or special specification "Intelligent Transportation System (ITS) Pole with Cabinet", applicable to cabinet only.
- Ensure that manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection are provided and readily accessible.
- 2.5. **LCS System Software.** Ensure the LCS system is provided with computer software from its manufacturer that allows an operator to program, operate, exercise, diagnose, and read status of all LCS features and functions using a laptop computer.
- Ensure all licenses required for operation and use of software are included at no additional cost.
- Software updates must be provided at no additional cost during the warranty period.
- 2.6. **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.
- 2.7. **Electrical.** Ensure LCS system components operate on nominal 120 V_{AC}. Provide a transformer with any system device that requires a nominal operating voltage other than 120 V_{AC}.
- 2.8. **Environmental.** All LCS system components must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS4, Section 2. The LCS 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.
- 2.9. **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, conductive metal.

- 2.10. **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).

Provide certification from an independent laboratory that the LCS meets requirements for uniform size of messages, contrast ratios, minimum and maximum luminance, and chromaticity (color coordinated) as listed in section 5 of NEMA TS4 as well as NEMA TS4 environmental requirements for temperature, humidity, transients, vibration, and shock.

Provide certification that LCS electronic equipment meets FCC Class B requirements for electromagnetic interference and emissions.

Ensure the LCS system manufacturer has a quality assurance program for manufacturing LCS as described in this specification. Manufacturer of the LCS must be ISO 9001 certified, or provide a copy of the company quality manual for review.

- 2.11. **Warranty.** Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 5 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 per 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 prior to 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.

- 2.12. **Training.** Conduct a training class for a minimum of 8 hr., unless otherwise directed, for up to 10 representatives designated by the Department on installation, configuration, operation, testing, maintenance, troubleshooting, and repair. Submit a training session agenda, a complete set of training material, the names and qualifications of proposed instructors, and proposed training location for approval at least 30 days before the training. Conduct training within the local area unless otherwise directed. Provide 1 copy of course material for each attendee. Ensure that training includes:

- "Hands-on" operation of system software and equipment;
- explanation of all system commands, their function and usage; and
- system "troubleshooting," operation, and maintenance.

3. CONSTRUCTION

- 3.1. **System Installation.** Install LCS system devices per the manufacturer's recommendations. Submit shop drawings of LCS, mounting brackets, supporting structures, and hardware for review. Completion of the work must present a neat, workmanlike, and finished appearance.

Ensure installation and configuration of software on Department computers is included with the LCS system.

- 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 LCS to the field cabinet and incidentals 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 prior to 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.** The Contractor is responsible for checking the local electrical service to determine if a modification is needed for the equipment.

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

- 3.6. **LCS Placement.** Position LCS and verify that each is capable of being independently controlled to indicate the condition of each lane using the following indications, unless otherwise shown on the plans:

- Steady Red X,
- Steady Downward Green Arrow,
- Steady Yellow X,
- Steady Downward Diagonal Yellow Arrow (Right),
- Steady Downward Diagonal Yellow Arrow (Left), and
- Blank

- 3.7. **Equipment Mounting.** Paint all brackets, anchor bolts, and conduit runs attached to the surface of bridges or sign structures the same color as the bridge beam or truss.

If necessary, mount two 1-1/2 in. aluminum hubs onto the rear of the housing to allow for connection to pipe nipples or other mounting hardware provided by others. Ensure that the inside area of the housing is reinforced at the point where hubs are mounted to prevent fatigue cracks.

- 3.8. **Foundation.** Furnish and install the cabinet foundation with pad as shown on the plans and in accordance with Item 656.

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

Inspect the existing LCS field equipment with a representative from the Department and document any evidence of damage prior to removal. Conduct a pre-removal test in accordance with the testing requirements contained in this Item to document operational functionality. Remove and deliver equipment that fails inspection to the Department.

Prior to removal of existing LCS 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 such time that it can be relocated. Remove existing LCS field equipment as shown on the plans 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 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. Meet the most current version NEC requirements.

- 3.10. **Removal of LCS Field Equipment.** Perform removal in strict conformance with the requirements herein and as shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Disconnect and isolate any existing electrical power supply prior to 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 or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

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

- 3.11.1. **Minimum Experience.** Three years of continuous existence offering services in the installation of LCS systems.

- 3.11.2. **Completed Projects.** Three completed projects where personnel installed, tested and integrated LCS field equipment. The completed installations must have been in continuous satisfactory operation for a minimum of 1 yr.

- 3.11.3. **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.

4. TESTING

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

- 4.1. **Test Procedures Documentation.** Provide an electronic copy of the test procedures and blank data forms 60 days prior to testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will approve test procedures prior to submission of equipment for tests. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms as well as quantitative results. Ensure the data forms are signed by an authorized representative (company official) of the equipment manufacturer.

- 4.2. **Design Approval Test.** Ensure that the RVSD has successfully completed a Design Approval Test that confirms compliance with the environmental requirements of this specification.

Provide a certification and test report from an independent testing laboratory as evidence of a successfully completed Design Approval Test. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification.

- 4.3. **Demonstration Test.** Conduct a Demonstration Test on applicable equipment at an approved Contractor facility. Notify the Engineer 10 working days before conducting this testing. Perform the following tests:
- 4.3.1. **Examination of Product.** Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this specification.
- 4.3.2. **Continuity Tests.** Check the wiring to determine conformance with the requirements of this specification.
- 4.3.3. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and observation of enough performance characteristics to ensure compliance with this specification.
- 4.4. **Stand-Alone Test.** Conduct a Stand-Alone Test for each unit after installation. The test must exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test.
- 4.5. **System Integration Test.** Conduct a System Integration Test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Supply 2 copies of the System Operations manual before the System Integration Test. Notify the Engineer 10 working days before conducting this testing.
- 4.6. **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 prior to 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 sufficient 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.
- 4.7. **Final Acceptance Test.** Conduct a Final Acceptance Test on the complete functional system. Demonstrate all control, monitoring, and communication requirements and operate the system for 90 days. The Engineer will furnish a Letter of Approval 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.
- 4.8. **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 consecutive 30-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 more than 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.
- 4.9. **Relocation and Removal**
- 4.9.1. **Pre-Test.** Tests may include, but are not limited to, physical inspection of the unit and cable assemblies, and each message the LCS is programmed to display. Include the sequence of the tests in the procedures along

with acceptance thresholds. Rejected test procedures must be resubmitted within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing prior to removal of LCS 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 prior to removal and after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system that failed after relocation, but passed prior to removal.

- 4.9.2. **Post-Test.** Testing of the LCS 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 LCS field equipment has been installed, conduct approved continuity, operation, and stand-alone 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 prior to the day the tests are to begin. Obtain Engineer's approval of test procedures prior to submission of equipment for tests. Send at least 1 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 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 prior to all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved LCS field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise all 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

LCS System will be measured as each LCS field site furnished, installed, relocated, made fully operational, and tested or removed in accordance with these Special Specifications or as directed. LCS Signal Unit will be measured as each LCS Signal Unit furnished, installed, relocated, made fully operational, and tested or removed in accordance with these Special Specifications or as directed.

6. PAYMENT

- 6.1. **Furnish and Install System.** 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 "Lane-Use Control System." This price is full compensation for furnishing, installing, configuring, integrating, and testing the completed installation including all LCS, associated equipment, and mounting hardware necessary for the LCS system site; and for all labor, tools, equipment, any required equipment modification for electrical service, documentation, testing, training, warranty, software, and incidentals necessary to complete the work. Furnishing and installing cabinet, cabinet foundation, conduit, and other items with separate specifications shall be paid separately per their respective Item and specification.

- 6.2. **Furnish and Install Signal Unit.** 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 "Lane-Use Control Signal Unit." This price is full compensation for furnishing, installing, configuring, integrating, and testing the completed installation including individual LCS, associated equipment, and mounting hardware; and for all labor, tools, equipment, any required equipment modification for power service, documentation, testing, training, warranty, and incidentals necessary to complete the work.
- 6.3. **Install Only.** The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Lane-Use Control System (Install)" and "Lane-Use Control Signal Unit (Install)." This price is full compensation for installing, configuring, integrating, and testing the completed installation including signals, controller, cabinet, cables, associated equipment, and mounting hardware; for furnishing and installing cabinet foundation; and for all labor, tools, equipment, any required equipment modifications for electrical service documentation and incidentals necessary to complete the work. Installation of cabinet, cabinet foundation, conduit, and other items with separate specifications shall be paid separately per their respective Item and specification.
- 6.4. **Relocate.** The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Lane-Use Control System (Relocate)" and "Lane-Use Control Signal Unit (Relocate)." This price is full compensation for relocating and making fully operational existing equipment; furnishing and installing additional cables, conduit, or connectors; testing, delivery, and storage of components designated for salvage or reuse; and all equipment, any required equipment modifications for electrical service, labor, materials, tools, and incidentals necessary to complete the work. Relocation of cabinet, cabinet foundation, and other items with separate specifications shall be paid separately per their respective Item and specification.
- 6.5. **Remove.** The work performed in accordance with this Item will be paid for at the unit bid price for "Lane-Use Control System (Remove)" and "Lane-Use Control Signal Unit (Remove)." This price is full compensation for removing existing equipment as shown on the plans; removing cables and connectors; testing, delivery, and storage of components designated for salvage; and all equipment, labor, materials, tools, and incidentals necessary to complete the work. Removal of cabinet, cabinet foundation, and other items with separate specifications shall be paid separately per their respective Item and specification.