

Intelligent Transportation Systems Construction Engineering and Inspection Training for Dynamic Message Signs: Module 2: Testing and Types of Inspection

Welcome

Welcome to the Intelligent Transportation Systems Construction Engineering and Inspection Training for Dynamic Message Signs (called “DMS”) training, Module 2: Testing and Types of Inspection. This CBT contains audio, so adjust your speakers accordingly. This CBT contains audio, so please adjust your speakers accordingly. This CBT contains interactive elements. An alternate version is available on the resources page. The Knowledge Check Questions allow you two chances to try and answer the question correctly. To begin, select the start button or press Shift + N on your keyboard.

Material Inspection

During the review of equipment submittals, check the FDOT APL website under the Specification 700 - Highway Signing, for the approved Dynamic Message Signs. For Surge Protective Devices, see Specification 620 - Grounding and Lightning Protection. You can find a link to the FDOT APL website on the Resources page.

Activity – Pre-Construction

CEI personnel, contractors, and testing staff must take part in the following meetings prior to the commencement of ITS field work or the first-time installation of a device. These meetings are the Pre-Installation meeting, the Pre-Operation meeting, and the Pre-integration meeting.

A Pre-Installation meeting with those closest to the work is a good opportunity to review and discuss specific responsibilities, project documents such as plans, technical special provisions, the Statewide Inspection Guide List, the Statewide Critical Requirement List, submittals, the device inspection checklist, and testing and acceptance requirements.

Physical Inspection

Failure to follow safety requirements can be costly to you, either as the worker who could be injured or the employer who could be fined. You must follow the Occupational Safety and Health Administration (OSHA) requirements when performing physical inspection.

OSHA 1910.67 on Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms specifies that a personal fall arrest or travel restraint system that meets the requirements in Subpart I of this part shall be worn and attached to the boom or basket when working from an aerial lift.

OSHA 1926.501 on fall protection systems specifies that each employee who is constructing a leading edge six (6) feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, or personal fall-arrest systems.

OSHA 1926.503 on fall protection training specifies that the employer shall give a training program for each employee who might be exposed to fall hazards.

Additionally, installed cat walks must meet the proper OSHA and FDOT Standard Specification for Road and Bridge Construction. Ensure to include the cat walk in the design following Design Standard 18300, if needed.

Testing and Inspection

There are a variety of tests involved with the installation of DMS. First, if a proposed and approved sign is not on the APL, or if it is a new model of sign, a Factory acceptance test might be necessary. The factory acceptance test is conducted at the factory where the DMS is made. The contractor will submit a test procedure for acceptance and the approved test plan will be conducted on the sign at the factory.

The contractor will also submit a test plan for the Pre-Installation test. This test occurs once the contractor receives the signs. This test includes verifying that no damage occurred during shipping.

Subsystem testing is testing the sign without its network components. System testing tests the sign when connected to the ATMS "SunGuide" software to verify proper operation. As with the other tests, the contractor must submit test plans for approval.

Finally, the Acceptance test is performed. Once complete, the project can be accepted.

Occasionally, the contractor will select a new model sign or project requirements may need something that is not already on the APL. While the documentation might say the sign meets all the requirements, a Factory Acceptance Test may still be needed. Factory Acceptance tests include, but are not limited to, weather resistance, communications protocols, font, color, visibility, and door alignment.

The manufacturer will conduct the approved test procedure. Once complete, the signs will be shipped to the project contractor. Representatives from the Department, the contractor, and the CEI personnel may be invited to the DMS manufacturer facility to witness the Factory Acceptance tests. Additionally, a third-party test may be substituted for the Factory Acceptance test if that test covers the requirements of the project.

Test Plans

The contractor or his/her representative will perform the actual testing with the Construction Engineering Inspection personnel on hand as an observer.

The approved test plans and procedures will show the individual test steps and the expected outcome of each step. If each test step has performed successfully, the CEI personnel will sign off that the test has been performed properly.

The Construction Engineering Inspection personnel should note the firmware version being tested and verify that it is the same as that listed in the project submittal.

The CEI personnel should verify that the test equipment matches the test plan and that the calibration certificate has been submitted.

You will need to test the DMS sub-system to ensure that the installed products meet all the contractual requirements.

You should give a test plan for each of the following tests: Factory Acceptance Test, Pre-Installation test, Field Acceptance Test, Sub-system Test, and System Test. You should submit the test plans for Department approval in advance of any testing. The contract will specify when the test plans should be sent for approval.

The format of the test plan will be a step-by-step procedure. Each step will yield an actual result. The inspector will compare the actual result with the expected result.

If the device does not show the expected test results from any test step, then the device will be found as having failed the test. A test discrepancy report will be generated and submitted to the inspector. The contractor will either resolve the issue or replace the device in kind. If the original device is replaced with a new device, then the test must be repeated on the replacement device.

If the device shows the expected result in each step, then it is considered to have passed the test. The department or the department representative witnessing each test will sign the test procedure.

Testing

Here is a front-access sign undergoing factory acceptance testing. Included in the factory acceptance testing may be tests for visibility, colors, temperature sensors and alarms, fonts and characters, communications protocols, water intrusion, size and weight, and door alignment.

If you find any discrepancy, you should make note of it, even if it is not part of the testing procedure. Many items can be fixed during the testing stage, such as misaligned doors or loose cables. The manufacturer can adjust its processes if necessary. Once factory acceptance testing is complete, the signs are shipped to the project location or to the contractor's holding yard.

Pre-Installation Testing

Signs will be crated or otherwise protected from the factory. The contractor shall make sure proper tools and equipment are available to unload and uncrate the signs and other equipment when they are delivered to the contractor.

Signs and related equipment are to be tested when delivered to the contractor. The contractor will provide an adequate storage facility to unload and test the signs per the project documents. Pre-Installation Testing ensures that any damaged items received during shipment are repaired prior to installation. Testing will be conducted by the manufacturer or its representative.

Testing will include, but is not limited to, verifying the condition of signs and equipment, and taking inventory of equipment and parts. Operation testing includes providing power to the equipment and conducting the pre-approved test procedure. Ample room should be given to conduct testing while being able to view the full face of the sign.

The Pre-Installation Test will need to be provided for approval from FDOT.

The test procedure should include the following steps:

Check the power (power requirement may vary per project and per sign).

Check the grounding system readings.

The DMS turns on and self-tests, whereby the sign and controller performs a self-test automatically; upon startup the results are verified against what is expected with slight differences observed by manufacturer.

For the pixel test, perform testing full-on brightness levels, colors, and characters (verify what the sign is capable of doing prior to this test).

For the message test, use an approved FDOT test message that is displayed and then test that the removal of the approved FDOT test message actually leaves the sign blank.

Verify the uninterrupted power supply (UPS) provided will supply power for the required amount of time and that the DMS works with the power generator.

Connect an appropriately sized generator to the connection in the cabinet and verify operation.

An important thing to look for during Pre-Installation Testing is whether the contractor is using a spreader to distribute the load when unloading the signs. As you can see in this photo, no spreader bar is being used. As a result, the eye bolts can be bent or broken if a spreader bar is not used. The sign documentation will have instructions on how to properly lift the signs.

The contractor should take care to store the signs appropriately. The wood skids used in shipping can be used to place the signs on the ground once unloaded.

You should perform and document any needed repairs. Once testing is completed, signs should then be stored in a manner to avoid damage and so they can be safely transported by the contractor to the install site.

Physical Inspection

Once Pre-Installation Testing is completed and any deficiencies are corrected, it is time to install the signs in the field. There are many activities that need to occur prior to the signs being transported to the job site. Structure and cabinet foundations need to be poured well ahead of the cabinet arrival. After you install the structures and cabinets, the conduit, pull boxes, cables, and other infrastructure items need to be placed and installed properly. All these items have their own FDOT standards and specifications that need to be followed as well.

Dynamic Message Signs and structure installation also require lane closures, so Maintenance of Traffic (MOT) plans need to be submitted and approved and then implemented. DMS and structure installation will sometimes need the complete closure of a highway or interstate to carry out the installation.

Careful coordination is needed between the contractor, FDOT, and the local agencies to carry out the installation. Interstate and highway closures are quite complicated and expensive tasks to perform, so it is imperative that they only occur once. Verify that all the components are available and correct prior to

trying sign or structure installation. 'Measure twice, cut once,' as the old saying goes. Please visit the Resources page for the different standards and specifications needed to complete the physical inspection.

The CEI Personnel will be involved, along with the contractor, in unloading and staging the shipped DMS. Be aware of damage that could happen during the transport of the sign. Have a dedicated storage area with timbers ready for resting the signs on. Usually, a bracing bar is used to tie two DMS signs together while one truck is reused to stabilize two signs on the ground.

Power to the sign shall be provided within 72 hours after installation to allow the sign's ventilation systems to run.

Physical inspection also includes the structures the DMS is attached to. Verify that all bolts and mounting hardware are attached and installed correctly. The type of structures to be mounted to are cantilever, half span, and full span structures. The half span would cover one direction of travel while the full span would cover both directions of travel. Check the specifications for each structure type for requirements.

Typically, the signs are attached to the support structure prior to installing the structure; this way they can both be installed at the same time. Other contractors may install the structure first and return to install the sign. Either way, make sure all MOT and clear zone requirements are followed.

Make sure all safety requirements are being adhered to during all phases of the installation. The worker in the photograph does not appear to be using personal protective equipment for climbing on top of the sign, which is unsafe and against OSHA requirements.

The DMS unit must be supported and braced while on ground.

Make sure to note any damage involved with transporting or installing the sign. Minor repairs can be made onsite. Some DMS manufactures even ship touch-up paint with their signs so damage like this can be repaired quickly with no added lane closures. Repairs that cannot be carried out at this time need to be documented for repair prior to final acceptance of the project.

Functional Inspection

Once a DMS unit is installed, there are several items that will require inspection.

First you will need to check the power. Power will be provided to the DMS cabinet from a transformer or from an electrical service line. Either way, check the voltages coming into the cabinet where the power wires end. Be familiar with the power requirements of the sign.

Depending on the project and type of signs used, a power distribution panel will exist in the controller cabinet that will feed either AC or DC voltage to the sign itself. Check output voltages on the line side of the breaker.

The Uninterrupted Power Supply (UPS) unit is part of the power system. Ensure the UPS is installed properly, and the batteries are connected. Do not connect the batteries until the main power is provided as the batteries might discharge and their service life will be reduced.

Verify that all communications cables are installed and terminated correctly. There will be a cable from the DMS controller to the sign; this cable may be fiber optic. There will also be communications cables from the Ethernet switch in the cabinet to the DMS controller, as well as a fiber optic cable terminated in the cabinet. Verify that all the cables for the various sub-systems are installed and dressed properly. Before you turn on power to the DMS for the first time, verify the power feed, whether it sources from commercial power or a generator. Verify the correct voltage on the DMS panel before turning it on. The CEI personnel shall verify that all components are installed following the project plans.

The controller cabinet will house the DMS controller, communications equipment, and fiber termination panel. It might house the UPS as well, as shown in this photograph. Sometimes the batteries are housed in a separate cabinet. The controller is used to post messages on the sign; you can perform this either from the controller itself or by the vendor's software. In addition, the vendor's software must be compatible with the SunGuide system software because that is used to post messages on the sign after acceptance.

The inspector must verify that the equipment in the controller cabinet is correct for its location. The sign dimensions will usually need to be entered in to the controller, so it knows what sign it is connected to, and to display messages properly. If the project involves signs of varied sizes, the contractor will sometimes pair up the controllers with the signs during post-delivery testing.

The inspector must also verify that the communications equipment is connected. Although part of a different sub-system, the Managed Field Ethernet switch will need to be installed and configured properly for any central testing to occur. Otherwise, the contractor will have to conduct local testing with a laptop computer connected to the controller.

You should also check cables and terminations. You should note the use of proper crimping and clearances. The doors of the cabinets and placement of other equipment should not be affected by the cables or terminations. Check to ensure proper voltages are present. The sign specifications will have the correct voltages to verify.

Grounding connection and ground arrays should be checked and verified per Standard Specification for Road and Bridge Construction, Section 620, and the proper specification for the structure used. Document any deficiencies and their corrections prior to final acceptance.

More Testing

Once installed, the contractor must schedule the Field Acceptance Test. The Field Acceptance Test will test only the equipment/configuration of a specific DMS location. The test will include items such as power, controller configuration, pixel tests, sensor tests, and other items that will be included in the test plan submitted by the contractor.

The Sub-System Test will also test the specific DMS location. If approved, the Field Acceptance test and Sub-system test can be the same test or follow the same procedures. Keep in consideration that there

might be several different Sub-System Tests performed at each location depending on if there are other ITS devices installed at the location. The Sub-system test may depend on other sub-systems to verify proper operation. For example, the communications network needs to be operational to verify sign operation with SunGuide.

The System Test will test all the different sub-systems together. This will verify that the entire ITS system is operational following the design and contract documents.

No matter what test is being performed, it is the CEI personnel's responsibility to make sure the contractor has submitted the test plan for each test. Once testing begins, the CEI personnel will witness the test. The actual testing will be conducted by the contractor or DMS manufacturer. If there are any failures during the testing, the CEI will need to document those failures to the engineer.

Final Acceptance

Following FDOT's procurement and installation procedures ensures a quality project with years of service life for the taxpayer. Adherence to the specifications and project requirements ensures the contractor provides the correct equipment. Following test procedures and inspections guarantee the equipment is delivered as functional. Following all installation requirements produces a quality, safe installation phase of the project. Once completed, the successful procurement and installation phases of the project contribute to a successful integration phase and final acceptance. Accurate and complete as-built plans will aid in the ongoing maintenance of the project. Verify that data from ITSFM043 is included in the as-built plans.

The DMS is just one part of the many ITS sub-systems in a project. Each sub-system needs close inspection to work properly. The Burn in Test is important and allows the DMS to be used during this period as intended in real conditions. Any issues with LED boards, loose connections, or other sub-systems can directly affect the operation. Quality and prompt inspection helps alleviate problems should they occur. Therefore standalone, sub-system, and central testing are performed - to eliminate problems before they occur - and anything not already seen should appear during the Burn in Test. If any item fails during the burn in testing period, the contractor will be allowed an opportunity to correct the problem. A hardware failure and replacement may need the burn in test to be restarted. Any delay in completing the burn in test can affect final acceptance and contract end dates.

Prior to the DMS unit being transported to the job site, many activities and tasks need to be completed. All of the following must be completed EXCEPT:

- a. cabinet foundations need to be poured
- b. Maintenance of Traffic (MOT) plans need to be submitted and approved
- c. the Field Acceptance Test must be performed on the system
- d. the appropriate pull boxes and cables need to be placed and installed properly

ANSWER IS C.

SOURCE: See slides 22-23 for review.

How quickly should power to the DMS unit be provided after installation to allow the sign's ventilation systems to run? The maximum acceptable time is:

- a. 2 hours.
- b. 12 hours.
- c. 24 hours.
- d. 72 hours.

ANSWER IS D.

SOURCE: See slide 25 for review.

Determine whether the following statement is TRUE or FALSE. "During functional inspection, it is the project contractor that will verify that all system components are installed according to project plans."

- a. True
- b. False

ANSWER IS B. FALSE

SOURCE: See slide 31 for review.

During the Final Acceptance phase of a DMS project, the burn-in testing period should occur:

- a. before standalone, subsystem, and central testing are performed.
- b. after standalone, subsystem, and central testing are performed.
- c. after the standalone testing but before the subsystem and central testing.
- d. after the standalone and subsystem testing but before the central testing

ANSWER IS B.

SOURCE: See slide 40 for review.

Conclusion

This concludes the Intelligent Transportation Systems Construction Engineering and Inspection Training for Dynamic Message Signs, Module 2: Testing and Types of Inspection. Please continue to Module 3: Resources and Documentation. Thank you for your time and attention.