Intelligent Transportation Systems Construction Engineering and Inspection Training for Dynamic Message Signs

Welcome

Welcome to the Intelligent Transportation Systems Construction Engineering and Inspection Training for Dynamic Message Signs (called "DMS"), Module 1: Overview and Inspection Process. 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 will allow you two chances to try to answer the question correctly.
To begin, select the start button or press Shift + N on your keyboard.

Purpose

This training is designed to show Construction Engineering and Inspection (CEI) firms what a Dynamic Message Sign (DMS) is, what it does, and how it is used on transportation projects. This training will also show you how to inspect a completed installation of Dynamic Message Sign units on Florida Department of Transportation (FDOT) Intelligent Transportation System (ITS) projects, and how to ensure that the contractors have given an approved and properly-configured device.
You will be able to apply this training based on differing conditions in the field; however, not all FDOT ITS projects will deploy the same type of DMS.

Dynamic Message Sign (DMS)
This training will also cover terminology, standards, safety, basic inspection, and documentation that you will need before final acceptance and testing.

Uses for DMS
Older signs use a variety of technology to display messages. These older signs use yellow letters with a black background to display messages. The Florida Department of Transportation (FDOT) has moved to full-color matrix signs for most ITS projects. Some Districts and local agencies may still need the use of monochrome signs on their projects. The full-color matrix signs can display messages in a variety of colors and can display symbols in addition to text.

Dynamic Message Signs (DMS) and Variable Messages Signs (VMS) are almost the same thing. In recent years, DMS has also included displays of full color symbols and images, while the term "Changeable Message Sign" simply refers to the different messages that can be displayed. People will use DMS and VMS interchangeably, depending on their background and the part of the country they are from.
You can select messages for DMS from a message library stored on the sign controller or by creating one at the TMC/Operations Center. If the sign supports the characters and fonts you selected, the message can be displayed.

Typically, Changeable Message Signs (CMS) have limited message options. The sign can change from one message to another but are usually limited. Open/Closed signs for weigh stations and lane-control signs are examples of Changeable Message Signs.

Although not part of this training, Blank Out Signs are prevalent in the industry. These signs are used only when needed. The "No Right Turn" and "Lane Closed" messages are a few examples of when Blank Out Signs are used. These signs are blank when they are not in use. Information conveyed through Blank Out Signs can improve operations and reduce crashes.

Why Use DMS?

Dynamic Message Signs refer to dynamic, changeable, or variable message signs defined as programmable traffic-control devices that display messages composed of letters, symbols, and graphics. Use of Dynamic Message Signs give information about changing highway conditions to improve operations, reduce crashes, and inform travelers. These signs may inform drivers to change travel speed, change lanes, take a detour route, or simply to be aware of a change in current or future traffic conditions. Dynamic Message Signs also display toll amounts and express lane status messages. With this information, motorists can make informed decisions for their traveling needs.

Types of DMS

Dynamic Message Sign (DMS) units include the following types.
Front-Access DMS units are intended for use on arterials. See the Standard Specifications for Road and Bridge Construction, Section 700-4.1.1. Front-Access DMS units must meet the requirements of NEMA TS4-2016, Section 3.2.6. Walk-In DMS units are intended for use on freeways. See the Standard Specifications for Road and Bridge Construction, Section 700-4.1.2. Walk-In DMS units must meet the requirements of NEMA TS4-2016, Section 3.2.8.

Embedded (or static sign DMS) units are covered in Section 700-4.1.3 of the Standard Specifications for Road and Bridge Construction. Embedded DMS units are typically mounted to ground traffic signs, overhead traffic signs, or overhead cantilever traffic signs. Truck Parking signs, some Weigh Station signs, and some toll-pricing signs are examples of embedded signs.

With Front-Access Dynamic Message Signs, you can access the interior components of the sign via doors on the front of the sign. Access to these signs often need a lane closure and might need to be serviced at night.

Walk-In DMS units are typically used on freeways but occasionally an arterial project might use them as well. Access to the sign components is carried out via doors on either side of the sign. Typically, once deployed, technicians use a bucket truck to access the signs via a catwalk. Access to the sign might not require a lane closure, which depends on the sign placement. The technician must have tie-off points on the structure or on the sign to safely exit the bucket and enter the sign; this is an OSHA requirement.

Embedded Dynamic Message Signs are usually installed in conjunction with other static signs. The embedded sign in the photograph is an example of a front-access unit. The technology involved for all three types are the same - the signs just come in different packages. Depending on the sign, parts might be interchangeable between the different types. If spare parts are included in the project, ensure each type of sign has its own spare parts, unless the parts are known to be common between types.

You should confirm the color and pitch. The single colored “yellow on black background” message sign was the standard in the past. Currently, full color signs are available on FDOT’s Approved Products List (APL). Verify that if a full-color sign was needed, that it was provided. The pitch references the space between the LED pixels on the sign. Because the face of the sign is comprised of various parts, the distance or pitch must be the same all over. Currently, the pitch of a full-color sign is equal to or less than 35mm.

Components of a DMS Installation

The best places to find information about the signs to be installed for a project are the equipment submittals and project plans. The typical FDOT DMS installation will include the following: the Dynamic Message Sign unit itself, the support structure, which will vary by project and sign type; all mounting hardware, which is used to attach the sign to the support structure; the controller cabinet that houses the DMS sign controller, communications interface, power connections, and other related hardware;

the power service, providing electrical power to the controller cabinet and thus the sign; conduits, being the raceways for all associated cables required to operate the sign; the grounding array, installed for the support structure; and the

cables, both electrical and communications to operate the sign. Backup generator connection or automatic transfer switch, confirmation CCTV, field Ethernet switch, and suppression devices, all need to be verified and found to be operational upon final acceptance.

Inspection Methods

Now that we know what a DMS is, the different types we may encounter, and what they are supposed to do, we can start the inspection process.

Document Review will tell us what type of equipment the contractor will be installing on the project. The document review will also tell us all the necessary information for physical specifications, operational specifications, etc. We use this review to verify the contractor is providing what the Department specified as part of the project.

Physical Inspection will tell us if the equipment installed is in fact what the project documents told us we would be receiving. It will also show us if the equipment is damaged in shipment, storage, or during installation. Physical Inspection will also verify other items such as, but not limited to, structures, foundations, grounding, and more.

Functional Inspection will involve sub-systems of the ITS project not specific to the DMS installation and will tell us if all the system pieces are assembled properly. The power, communications network, and possibly the CCTV sub-systems, will be connected at the DMS cabinet. Proper installation and inspection of those sub-systems is vital to the successful completion of the project.

ITS Project – System Engineering Phases

Intelligent Transportation Systems projects consists of several high-level system engineering phases. For a design-build contract, the Construction Engineering Inspection (CEI) personnel gives oversight for both the design and implementation phases. For a design-bid-build contract, the CEI personnel oversees just the implementation phase.

The CEI reviews, inspects, and gives verification for each of the various phases. The Contractor's deliverable for each phase may be a document, a set of plans, the physical installation of a device, or the performance of a test. The following describes some of the deliverables for each phase:

Concept of Operations: This is the Concept of Operations Plan (called "ConOps").
System Requirements: These are the Requirements Traceability Verification Matrix (RTVM) and the Project System Engineering Management Plan (PSEMP).
High Level Design: Has 90% to 100% Plans and Specifications.
Detail Design: Release for Construction Plans and Specifications.
Pre-Installation Testing: Factory Acceptance Test and the Pre-Installation Test Plan.

Field Installation: Inspection of infrastructure and devices.

Device Testing: This is Field Acceptance Testing.
Subsystem Verification: This is Sub-System Testing.
System Verification: This is System Testing. And,
System Validation: This is 30-Day Acceptance Testing.
The inspector must read and reference the project contract to understand the conditions of final acceptance. Some Districts might need specific features and components that other Districts might not.

Document Review

For an inspector, document review is the most time-consuming task before construction begins and during final acceptance.
During the preconstruction period, it is very important to become familiar with the Contract and Request for Proposal documents. Other documents that need approval are based on the System Engineering process. Material approval will be granted through shop drawings.

During the final acceptance period, the Contractor will submit documents that will be used by the Department's Maintenance Contractor. The inspector should review these manuals, especially the Operations and Maintenance manual, to ensure that they apply to the devices that were installed. Sometimes vendors will send a generic manual with their equipment, which does not necessarily reflect the equipment they shipped. In addition, the inspector should review the warranty of each device to ensure that the make, model, and serial numbers match the installed device. The warranty dates must follow the Contractual requirements.

Document Review – Pre-Construction

A Concept of Operations, also known as ConOps, describes high-level project requirements from the customer and stakeholder perspectives. This document can also serve as a high-level functional requirement guide for the system.
The Engineer of Record team may create a Project System Engineering Management Plan (PSEMP) that enables the Overall Project Manager to manage a project using systems engineering principles and methods.

The Request for Proposal (RFP) is a vital document for any ITS Design-Build project. The project RFP solicits the proposal, which is often made through a bidding process, when FDOT is interested in the procurement of a service or asset. The project RFP is sent to potential contractors, inviting them to submit their business proposals. A key part of allowing bids to be formulated are the project requirements contained within the RFP.

The Requirements Traceability Verification Matrix (RTVM) traces the requirements from the System Validation stage to the Concept of Operations stage in the Systems Engineering process. The CEI personnel should have access to all the various contract-related documents.
Apart from the RFP, all other documents mentioned here are live documents until the final acceptance of the project.

Review the Submittal Data Form (750-010-02) provided by the contractor; it includes device information. CEI personnel are to review the information to ensure the submittal documents match the device and then verify that the device is listed on Florida's Approved Products List (APL).
The Engineer of Record, called the "EOR," is also responsible for making sure the device is on the APL and if any of the submitted project devices are not on the APL, the EOR and the Department must approve the use of these. Devices include the DMS unit, surge protective device, and any cables and connectors.

CAUTION! If the contractor submits a different model and explains the approved model is no longer available, or states "this one is better," etc., CEI personnel must bring this to the attention of the EOR and the Department, as new versions may not have APL numbers. The EOR and the Department must be given the opportunity to review replacement model equipment before contractor procurement.
CEI personnel are responsible for ensuring devices delivered for installation are the same make, model, firmware, etc., that the EOR/Department approved.

Design-Build Document Approval Process

This flow chart describes the document approval process for Design-Build projects. Construction Engineering Inspection personnel ensure that the Contractor submits the documentation the Engineer of Record has approved to the Department. The Department and CEI personnel review and approve or reject the document. If the documentation is not approved, then it will be returned to the Design-Build firm with comments and recommendations.

Here you can see the documentation approval process for a Design-Bid-Build project. The process begins with the Contractor developing the document and then submitting it to the Department. The Department and CEI personnel review the document. If the document is rejected, then it will be returned to the Contractor with comments and recommendations.

Document Review

CEI personnel should ensure project continuity by verifying consistency in all project plans, documents, and submittals. You should perform reviews early in the project to discover any potential issues. The EOR will approve or reject any submittals.
The Department must also approve the sign structure and attachment hardware.

Knowledge Check

You will now complete knowledge check questions to test your comprehension on the material you just learned. For Multiple choice: choose the best answer. There is always one best answer from the options provided. For True or False: if all parts of the statement are true, mark "true"; if any part of the statement is false, mark "false".

Q1

Embedded Dynamic Message Signs are usually:
installed individually on dedicated overhead gantry mountings.
stored inside Walk-In DMS units awaiting emergency deployment in times of power loss.
stored within RTMC facilities awaiting temporary deployment in support of special event maintenance of traffic.
installed connected to or in conjunction with other static signs.
ANSWER IS D. SOURCE: See slide 13 for review.

Q2

Determine whether the following statement is TRUE or FALSE. “A Backup Generator Connection, Confirmation CCTV unit, and Field Ethernet Switch are all typical components of a Dynamic Message Sign installation.”

a. True b. False

ANSWER IS A. TRUE SOURCE: See slide 16 for review.

Q3

Which set of components are **NOT** typically needed in a Dynamic Message Sign installation?

a. the DMS unit, support structure, and mounting hardware.
b. the power service, conduits, and grounding array.
c. LIDAR system, Global Positioning System (GPS), and Inertia Measurement Unit (IMU).
d. field ethernet switch, voltage suppression, and Uninterruptible Power Supply (UPS) and batteries.

ANSWER IS C. SOURCE: See slide 15 for review.

Q4

Which inspection method in a DMS project tells us the type of equipment the contractor will be installing on the project? This method informs us of all the necessary information needed to verify the contractor is proving what FDOT specified for the project.

a. Functional Inspection
b. Document Review
c. Physical Inspection
d. Field Acceptance Testing

ANSWER IS B. SOURCE: See slide 17 for review.

Q5

Which inspection method in a DMS project tells us if the DMS equipment installed is in fact what the project document told us we would be receiving? This method informs us if the DMS equipment was damaged in shipment, storage, or during installation.

a. Functional Inspection
b. Document Review
c. Physical Inspection
d. Field Acceptance Testing

ANSWER IS C. SOURCE: See slide 17 for review.

Q6

Which inspection method in a DMS project tells us if the subsystem components of the project are properly connected to the DMS components? This method informs us if the power, communications, and any CCTV subsystems are properly connected at the DMS cabinet to ensure a properly working system.

a. Functional Inspection
b. Document Review
c. Physical Inspection
d. Field Acceptance Testing

ANSWER IS A. SOURCE: See slide 17 for review.

Q7

Which of the following ITS Systems Engineering phases are Design Phase deliverables?

a. Pre-Installation Testing and Field Installation
b. Device Testing and Sub-System Verification
c. System Verification and System Validation
d. Concept of Operations and System Requirements

ANSWER IS D. SOURCE: See slides 21-23 for review.

Q8

Which of the following ITS Systems Engineering phases are Implementation Phase deliverables?

a. High-Level Design of Plans and Specifications
b. Detail Design of Construction Plans and Specifications
c. Field Installation and Device Testing
d. Concept of Operations and System Requirements

ANSWER IS C. SOURCE: See slides 21-23 for review.

Q9

Which document below is best understood to be a high-level description of requirements from the customer and stakeholder perspectives and includes referenced documentation, current system overview, justification and nature of changes, concepts for the proposed system, etc.?

a. Project System Engineering Management Plan (PSEMP)
b. Concept of Operations (ConOps)
c. Project Request for Proposal (RFP)
d. Requirements Traceability Verification Matrix (RTVM)

ANSWER IS B. SOURCE: See slide 26 for review.

Q10

Which document below is best understood as a vital document for all ITS Design-Build projects and communicates project requirements to potential contractors interested in submitting a bid to work on the project?

a. Project System Engineering Management Plan (PSEMP)
b. Concept of Operations (ConOps)
c. Project Request for Proposal (RFP)
d. Requirements Traceability Verification Matrix (RTVM)

ANSWER IS C. SOURCE: See slides 26-28 for review.

Q11

Which document below is best understood as a plan that helps the Overall Project Manager to manage and control a project by using a systems engineering approach as to how project phases are to be developed, delivered, integrated, installed, verified, and supported?

a. Project System Engineering Management Plan (PSEMP)
b. Concept of Operations (ConOps)
c. Project Request for Proposal (RFP)
d. Requirements Traceability Verification Matrix (RTVM)

ANSWER IS A. SOURCE: See slides 26-28 for review.

Q12

Which document below is best understood as a useful means of keeping track of project requirements from the Systems Validation state to the Concept of Operations stage in the systems engineering process?

a. Project System Engineering Management Plan (PSEMP)
b. Concept of Operations (ConOps)
c. Project Request for Proposal (RFP)
d. Requirements Traceability Verification Matrix (RTVM)

ANSWER IS D. SOURCE: See slides 26-28 for review.

Q13

Determine whether the following statement is TRUE or FALSE. “In both the Design-Build and the Design-Bid-Build documental approval processes, both CEI and FDOT personnel must review the document prior to approval.”

a. True b. False

ANSWER IS A. TRUE SOURCE: See slide 32 for review.