

ITS CEI TRAINING: Microwave Vehicle Detection System (MVDS)

Module 4 – Testing and Acceptance

Welcome

Welcome to the Intelligent Transportation Systems Construction Engineering and Inspection Training for Microwave Vehicle Detection Systems, Module 4, Testing and Acceptance. This training contains audio, so please adjust your speakers accordingly. This CBT contains interactive elements. An alternate version is available on the resources page. To begin, select the start button or press Shift+N on your keyboard.

Types of Testing

The Construction Engineering Inspection, or CEI, personnel could be required to oversee the following tests: Field Acceptance Test, Subsystem Test, System Test, and the 30 Day Acceptance Test. It is important that the CEI personnel review the contract documents because the types of tests could vary for each project.

Typically, for the Microwave Vehicle Detection System, or MVDS, a factory acceptance test is not required. The FDOT Traffic Engineering Research Laboratory performs verification testing of the MVDS against the FDOT Standard Specifications for Road and Bridge Construction. MVDS models that are approved are given an Approved Products List Certification number. CEI services should verify that the MVDS detector is on the FDOT Approved Products List, or APL.

The Field Acceptance Test plans, Subsystem Test Plans, System Test Plans, and the 30 Day Acceptance Test Plan shall be developed by the Contractor. The plans will be approved by the Engineer of Record, or EOR, and the Department prior to testing.

Test Plans

The MVDS subsystem will be tested to ensure that the installed products meet all of the contractual requirements. A test plan will be provided for each of the following tests: Field Acceptance Test, Subsystem Test, System Test and 30 Day Acceptance Test. The test plans must be submitted for Department approval in advance of any testing. The plans will be reviewed by CEI services, District Network Administrator, and the District Traffic Management Center Manager. The Contract will specify when the test plans are to be submitted for review and approval.

The format of the test plan will be a step-by-step procedure. All calibrated tools and equipment required for testing will be supplied by the Contractor. Each test step will yield an actual result. The Inspector will compare the actual result with the expected result.

If the device does not exhibit the expected test results from any test step, then the device will be determined as having failed the test. A Test Discrepancy Report will be generated by the Contractor and submitted to the Inspector.

The Contractor will either resolve the issue or replace the device in kind. The complete test must be repeated on the repaired or replaced device. If the device exhibits 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.

The contractor or his representative will perform the actual testing with CEI 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 been performed successfully, CEI personnel will sign off that the test has been properly performed.

CEI services should note the firmware version being tested and verify that it is the same as that listed in the project submittal. CEI services should verify that the test equipment matches the test plan and that the calibration certificate has been submitted. The serial number of the MVDS detector should be documented on the test plan.

Types of Testing – Field Acceptance Test

The **Field Acceptance Test** is a test that is performed in the field by the contractor or Design-Build firm and witnessed by the Department representative and the designated CEI person. In the Field Acceptance Test, individual components of the MVDS are tested to ensure that they operate correctly. On-site field acceptance tests verify that the device is correctly installed, functioning, integrated, and configured. This test includes the inspection of installation quality, lightning protection, power systems, and power supply in accordance with the contract and all applicable standards.

Usually, the vendor's software is used for this local testing, which requires the use of a laptop connected either directly to the device or connected through the Layer 2 Managed Field Ethernet Switch, or MFES. The system is tested in accordance to FDOT-approved test plans to show the system is installed properly and interfaces with other systems in its working environment.

This test is also known as a Site Acceptance Test or Stand Alone Test. This test is performed when the MVDS device is properly installed at the site and all power, grounding, and communication connections, or MFES connections, are established. This test should be performed on all MVDS devices prior to starting any other test. It is the responsibility of CEI personnel to ensure this test is run in accordance with the FDOT-approved test plans and that the device being tested is the same as the device listed in the plans and test plan documents.

Before CEI services is called to oversee the test, the Contractor must properly calibrate the detector. Please note that not all MVDS devices are self-calibrating. Also note that self-calibrating MVDS devices need to be checked every time before the field acceptance test, to ensure the correct calibration for the device being tested.

Most MVDS devices will detect movement and display “blips” despite not being properly calibrated. All calibration steps are to be carried out to avoid spending unnecessary time in the field to troubleshoot calibration problems.

The FDOT Standard Specifications for Road and Bridge Construction Section 660-2.2 requires that presence detectors provide a minimum detection accuracy of 98%. An FDOT project RFP or Modified Special Provision or MSP might specify MVDS accuracy for volume and speed measurement. In that case, the RFP or MSP accuracy requirement for the MVDS device will apply in place of FDOT Standard Specification Section 660.

To compute traffic volume, make a manual count of all vehicles in each lane for a period of five minutes or longer as needed, to count a combined total of one hundred vehicles. Record the results for each lane and compare to the count for the same period collected by the MVDS unit. The total count of all lanes combined shall be within 95% accuracy for the device to pass the volume portion of the field acceptance test.

To compute traffic speed, use a calibrated radar speed gun at the proximate station of the MVDS unit being tested. Collect speed data in the selected lane for eight vehicles during each one-minute period of the fifteen-minute test. Similarly, collect the speed data for each travel lane detected by the MVDS. Compare the total average speed from the manual radar gun versus the average speed from the MVDS during the same period. The compared speed results shall be within 90 to 95% accuracy for the device to pass the speed portion of the field acceptance test.

Express lane MVDS units require higher accuracy because:

- MVDS data will be used as input for the express lane tolling algorithm
- The toll amount of an express lane will be dynamically adjusted based on MVDS traffic data

Accuracy of the express lane data can be increased with closely spaced MVDS units.

Types of Testing – Subsystem & System

Subsystem Testing: The MVDS subsystem test is only conducted if it is required by the contract. The test is performed after the successful completion of the Field Acceptance Test and is performed on all new devices within the project.

The Subsystem test involves the testing of all MVDS detectors that have been installed and integrated into the District’s network. Subsystem tests verify connectivity of the MVDS detector to the Regional Transportation Management Center, or RTMC.

Usually this test is done from the RTMC using the vendor control software. It can also be performed from an Intelligent Transportation Systems Hub shelter, using a laptop connected to the Layer 3 Switch. The software and location used to perform the MVDS subsystem test should be mentioned in the test plans.

System Testing: A System Test is typically required by the contract. System testing is performed on the entire system in the context of the contract and any governing standards. The testing process is concerned with finding errors that result from unanticipated interactions between subsystems and their components. This test is performed from the RTMC using the SunGuide® software. System tests verify the integration of the MVDS detector with SunGuide® software. The System Test is performed after the successful completion of Subsystem Testing on all subsystems within the project.

Types of Testing – 30 Day Acceptance

According to the FDOT Standard Specifications for Road and Bridge Construction, the 30 Day Acceptance Test only applies to the Dynamic Message Signs. However, typically, the contract documents would require that the 30 Day Acceptance Test be conducted for all of the subsystems, not just the DMS subsystem.

The **30 Day Acceptance Test** commences after the System Test has been successfully completed. If any equipment on the subsystem fails to operate during the 30 day period, testing of the entire system will be restarted. The Engineer may select to pause and extend the 30 day test period by the number of days lost by failure and repair time in lieu of restarting the full 30 day test. The Engineer will submit to the Contractor a letter of approval and completion stating the first and last day of the 30 day test period.

The 30 Day Acceptance Test creates an environment whereby the system's operational environment is simulated during the testing. Operational Testing consists of a set of steps that Traffic Management Center operators perform during their day to day operations. For the MVDS system, this would include checking the average speed output of the MVDS device and simultaneously viewing the traffic displayed by the CCTV camera. Also, the automatic alerts should be displayed by the SunGuide® software when the traffic speed falls below the threshold configured in SunGuide®.

Final Acceptance

CEI services will perform an inspection for final acceptance of device installations as part of all work under the Contract in accordance with FDOT Standard Specifications for Road and Bridge Construction, Section 5-11. The inspection will be performed only after satisfactory completion of the 30 Day Acceptance Test.

All punch list items must be completed by the contractor or Design-Build firm prior to the final construction inspection. Upon completion of the final construction inspection of the entire project, when the Engineer determines that the Contractor has satisfactorily completed the work, the Engineer will submit written notice of final acceptance to the Contractor.

The Contractor will transfer warranties and guarantees on all equipment to the Department in accordance with FDOT Standard Specifications for Road and Bridge Construction, Section 608, Manufacturers' Warranties for Traffic Control Signals and Devices.

All documents, firmware and software and spare parts must be furnished to FDOT by the contractor or DB firm. Documents such as User Manuals, Operation Manuals, Troubleshooting and Service Manuals, Assembly and Installation Instructions, Training Materials, Equipment Warranty, FDOT ITS Inspection Checklist, Firmware and Software Licenses, Test Results, Field Inventory List, ITS Facilities Management data, Spare Parts list, IP Address List and any As-Built drawings should be provided to FDOT.

Partial Acceptance

The Engineer may also perform an inspection for partial acceptance in accordance with FDOT Standard Specifications for Road and Bridge Construction, Section 5-10 of a device installation upon its completion in accordance with the Contract Documents. Partial Acceptance occurs when only one system, such as Microwave Vehicle Detection System, is tested and approved.

Prior to performing an inspection for partial acceptance, the Engineer will require the satisfactory completion of the 30 Day Acceptance Test of completed installations in accordance with the requirements of FDOT Standard Specifications for Road and Bridge Construction, Section 611-4. The Engineer will perform an inspection for partial acceptance in accordance with FDOT Standard Specifications for Road and Bridge Construction, Section 5-10 in company with a Contractor's representative, and when applicable, a representative of the agency designated to accept maintenance responsibility.

Document Review – Post Construction

All of the inspection aspects covered here are also in the newly developed FDOT Field Acceptance Test Procedures, developed by the State Traffic Engineering and Operations Office. Prior to final acceptance, the Contractor will submit the following documentary items obtained from the manufacturer:

1. Operation Manual
2. Troubleshooting and Service Manual
3. Assembly and installation instructions
4. Pictorial layout of components and schematics for circuit boards
5. Parts list
6. Diagram of the field installation wiring
7. Warranty information

Look through the data. Make sure that two copies of the operation manual, trouble shooting and service manual, and the assembly and installation instructions are provided. Some manufacturers combine part or all of these documents, so you may not actually see all three, but make sure that if not provided separately, they are, at minimum, components of a larger, comprehensive manual. Make sure that the manuals for the Microwave Vehicle Detection System detector, Surge Protective Devices, Cables, and the Power Supply are submitted.

As-Built documentation includes completed Punch List, Plans reflecting installed condition, and ITSFM deliverables. The ITSFM deliverables are located on the FDOT website. They include Import Templates, Mapping Files, and Attribute forms.

Ensure that the MVDS Detectors have a manufacturer's warranty covering defects for a minimum of two years from the date of final acceptance by the Engineer in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 5-11 and Section 608. Some manufacturers' standard warranties do not meet the FDOT Standard Specifications. The Contractor may purchase an extended warranty to warrant the product for the specified duration.

Check the project specifications for additional warranty requirements. Make sure information on warranty return service is provided. Make sure the owner is named by the warranty provider. Make sure there is a Warranty for all components including Microwave Vehicle Detectors and Surge Protective Devices. Surge Protective Devices should have a 10 year warranty.

Resources and Documentation

The Statewide Construction Quality Assurance and Quality Control Inspection Guide List is a multi-sectioned document listing important items to be inspected and references the FDOT Standard Plans for further detailed requirements. ITSFM is a statewide database that tracks the inventory of the ITS devices. The information contained in this database includes the make, model, serial number, manufacture date, firmware, MAC address, IP address, geographical location and install date. The FDOT Traffic Engineering Research Lab uses the compliance matrix, CM-660-2.1.2.3-01, to evaluate the Microwave Vehicle Detection devices.

Thanks For Attending

This concludes the Intelligent Transportation Systems Construction Engineering and Inspection Training, for Microwave Vehicle Detection Systems, Module 4, Testing and Acceptance. For more information about Construction Engineering and Inspection Training, please contact the State Traffic Engineering and Operations Office, Transportation Systems Management and Operations Section. Thank you for your time and attention.

Knowledge Check

1. MVDS equipment test plans:
 - a. **are approved before beginning test activity and include step-by-step procedures for testing.**
 - b. are approved after all test activity has been carried out and include probability statistics and sample distributions of failure and acceptance for each device tested.
 - c. are approved after all test activity has been carried out and include actual test results.
 - d. are approved before beginning test activity and include letter grades for each device tested.

2. Determine whether the following statement is TRUE or FALSE.
“The CEI does not review or approve the MVDS test plans submitted by the Contractor. The CEI performs the testing of the MVDS while the Contractor witnesses the testing.”
 - a. True
 - b. **False**

3. Which option below represents the first four testing steps for MVDS units?
 - a. Factory Acceptance Test, Operational Test, Final Acceptance Test, and Burn-In Period, respectively.
 - b. Burn-In Period, Final Acceptance Test, Operational Test, and System Test, respectively.
 - c. System Test, Operational Test, Final Acceptance Test, and Burn-In Period, respectively.
 - d. **Factory Acceptance Test, Field Acceptance Test, Subsystem Tests, and System Test, respectively.**

4. Which type of testing involves conducting an approved, stand-alone equipment installation test at the field site and tests all stand-alone (i.e., non-network) functions of the field equipment using testing tools?
 - a. Factory Acceptance Test
 - b. Field Acceptance Test**
 - c. Subsystem Test
 - d. Burn-In Period

5. This type of test occurs just prior to the Final Acceptance Test.
 - a. Factory Acceptance Test
 - b. 30 Day Acceptance Test**
 - c. System Test
 - d. Subsystem Test

6. Which type of testing is for the purpose of evaluating the entire project's compliance with the RFP requirements and requires all project punch list items to be completed so that after this test the project can be accepted by FDOT?
 - a. Field Acceptance Test
 - b. Burn-In Period
 - c. Final Acceptance Test**
 - d. System Test

7. Post construction, submittal documents include all the following EXCEPT:
 - a. User Manual (two copies)
 - b. Equipment Warranty
 - c. Test Results
 - d. Catalog of all purchase items and prices along with next year's anticipated prices**