DULLES CORRIDOR METRORAIL PROJECT

EXTENSION TO DULLES AIRPORT / ROUTE 772

(DP044.0 – CIVIL – PROJECTWIDE – DMS SIGNAGE)

100% ITS ACCEPTANCE TEST PLAN FOR DMS SIGNING & FIBER OPTIC CABLE

PREPARED BY:

Capital Rail Constructors

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COMMONWEALTH OF VIRGINIA
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1. Scope

This document identifies the tests and site inspections that will be conducted to verify the proper construction, integration and operation of the Dynamic Message Signs (DMS), Fiber-optic cable and associated electronic equipment installed for the Dulles Rail – Phase 2: Extension to Dulles Airport / Route 772. The locations of these DMS units and the type of information they will provide are listed in the following list. (The stationing provided in this list is roadway construction stationing.)

1. Departure Zone Sign 1 DMS – STA 553+25 WB
2. Departure Zone Sign 2 DMS – STA 565+25 WB
3. Departure Zone Sign 3 DMS – STA 577+25 WB
4. Departure Zone Sign 4 DMS – STA 589+00 WB
5. Parking Information Sign – STA 616+00 WB

The documents governing this work have been prepared by Capital Rail Constructors (CRC), the Design-Builder of the Dulles Corridor Metrorail Project - Phase 2. The documents include:

- The design drawings for the DMS units and the DMS communications infrastructure and the requirements therein;
- This Acceptance Test Plan and its Appendices; and
- Other applicable documents identified in Section 2.

It is anticipated that these documents will be used by a Contractor to procure the signs and communications equipment, and construct this DMS system.

1.1 Exclusions

The scope of the testing identified in this document does not include tests of standard construction materials (concrete, rebar, structural steel, etc.), and equipment and other materials from the qualified products list. It also excludes testing associated with the assembly or installation of this material and equipment.

2. Applicable Documents

The testing identified in this Acceptance Test Plan will be conducted to verify compliance with the ITS design plans and the requirements of the documents indicated in this section.

2.1 Design Requirements for Fiber Optic Cable Communications System

The design requirements for the Fiber optic cable and the associated communications elements are identified in the following documents:

- **Capital Rail Constructors ITS Drawings in Design Package DP -10 (October, 2015)**
- **Capital Rail Constructors ITS Drawings in Design Package DP-44 (October, 2015)**
- **MWAA *Design Manual 2010***

- **MWAA *Airport Communications System (ACS) Design Manual* (No Date)**
- **BICSI *Telecommunications Distribution Methods Manual* (TDMM) (11th Edition 2006)**
- **Virginia Department of Transportation *Road and Bridge Standards* (2007)**
- **VDOT Road and Bridge Standards (2008)**

- **2.1.1 Capital Rail Constructors - Design Package DP -10 RFC Plans (2015)**
  - ITS Plans on Sheets N00A-ITS-100 thru 108, N08-ITS-208, N09-ITS-201 thru 207

- **2.1.2 Capital Rail Constructors – Design Package DP-44 100% Plans (2015)**
  - ITS Plans on Sheets N00A-ITS-401 thru 410, N08-ITS-408, N09-ITS-401 thru 411, N10-ITS-401 thru 412

2.1.2 ***MWAA Design Manual 2010.***

- ***Section 22 Power Distribution – Section 22.3.7 (This section also applies to FO cables)***
  - Manhole and handhole spacing shall be …not more than 500' apart.'
  - Handholes and manholes in streets shall meet Virginia Department of Transportation Standards.

2.1.3 Airport Communications System (ACS) Design Manual. Chapter 4 of this manual applies to Outside Plant – Fiber. The following subsections apply to this project:

XII. Permits
XIII. Testing
XIV. Labeling
XV. Documentation

2.1.4 BICSI TDMM Manual – (11th Edition 2006, or newer) Fiber optic cable testing procedures using an Optical Time Domain Reflectometer (OTDR)[1]. This is the industry standard method of testing fiber optic cable.

2.1.5 Virginia Department of Transportation - *Road and Bridge Standards* 2007 Edition.

- Section 238 – Electrical and Signal Components
- Section 700 – General, including the requirements of Section 700 related to:
  - Grounding electrodes
  - 703.02 (d) 3.a. - Main AC Power input (Transient Protection), and
  - 703.02 (d) 4.k. - RFI Filter

3. Overview of the Acceptance Test Plan

[1] The OTDR is used to test the power loss in the cable at the splices and connectors as well as the power loss within the cable between splices and connectors.

The Contractor shall coordinate, integrate and test the following devices in conjunction with the Dynamic Message Sign System:

- Dynamic Message Signs
- Fiber Optic Cable

The Contractor is NOT responsible for testing of the fiber optic / network switch. The Contractor shall purchase the network switches and modules that will be installed in the DMS Cabinets, and provide these units to MWAA for initial testing and configuration. Acceptance of these units will be determined by MWAA. After they have been accepted and configured MWAA will return these units to the Contractor for installation in the DMS cabinets. Any issues with the proper operation of these units will be investigated and corrected by MWAA.

3.1 Basic Requirements of the Acceptance Test Plan

Acceptance testing shall include:

- Site Inspections,
- DMS Cabinet Operations,
- Dynamic Sign Inspections,
- DMS Operations and 30-day Operational Tests, and
- Fiber Optic Cable Tests.

Detailed descriptions and/or checklists for the inspections and tests for the DMS are contained in Appendices A1 thru A4. The Fiber Optic Cable tests are described in Appendix B.

MWAA will assign a representative to witness and sign off on all tests[2]. The designated representative is the only one authorized to witness and sign off that each test is complete. The Contractor shall follow the notifications in Section 4 of this document and shall allow the MWAA representative to adjust the proposed schedule of tests by up to seven days to allow for availability of personnel. A completion notice shall also be required.

The Contractor shall submit documentation indicating successful passing of each test to the MWAA through the MWAA representative. The results will be compared with the performance criteria and any deficiencies that must be corrected will be identified.

The inspections and tests contained in these Appendices are identified in the following paragraphs.

3.1.1 Appendix A1 - DMS Site Inspection Checklist

The initial inspections that shall take place at each DMS site are itemized in the check lists that cover various aspects of the work. Inspections A thru H may be conducted after work is completed at the site, but before power is available to it.

A. Junction boxes and Conduits

[2] The MWAA representative may be a CRC Staff member.

B. Site clean-up and work pads
C. Sign Support Structure
D. DMS Communications Cabinet
E. Power Wiring and Cables
F. Load Center
G. Disconnect (Safety Switch)
H. Communications Cabling

3.1.2 Appendix A2 - DMS Cabinet Operations Tests

These inspections and tests shall take place at the DMS Power and Communications Cabinet at each DMS site after power to that cabinet is made available. It verifies that the voltage at the cabinet is acceptable, and that the electrical components are functioning properly.

3.1.3 Appendix A3 – Dynamic Sign Inspections

As part of the procurement cost of each sign, each Dynamic Message Sign shall be inspected by a representative of the Sign Manufacturer after it has been installed on its sign support structure and connected to the power service in the DMS power and communications cabinet. A sample copy of the inspection procedure is included in Appendix A3. The manufactures representative will provide a copy of the results of these inspections to the MWAA representative that will witness the tests.

3.1.4 Appendix A4 – DMS Operations and 30-Day Operational Tests

These operational tests are divided into four parts:

Part 1 – Operational Tests at Individual Signs will be initiated at the control cabinet for that sign. They will test the operation and response of each sign to simulated power and communications problems.

Part 2 – Operations Tests using the Central Sign Control Software will be conducted after communications have been established between the signs and the desktop computer where the central control and message development software resides. They will be conducted with each sign individually to verify that messages can be placed on that sign manually or through the use of a preprogrammed schedule. They will also verify that power and communications interruptions will not adversely affect the performance of this system.

Part 3 – Operations Tests Demonstrating Control of Multiple Signs will assesses the ability of the system to control multiple signs simultaneously by placing appropriate messages on each sign and changing these messages as a group.

Part 4 – 30-Day Operational Tests will be conducted at individual signs to operate the pixels of the sign for an extended time period in order to identify any components of the sign that might be failure prone, and to assess the color uniformity after the burn in period.

3.1.5 Appendix B - Fiber Optic Cable Tests - This appendix identifies the Optical Time Domain Reflectometer (OTDR) tests and inspections of the Communication Network to demonstrate that all hardware, cables, and connections furnished and installed by the Contractor operate correctly and that all functions are in conformance with project requirements.

The Contractor shall neatly assemble the printed and electronic copies of the OTDR results and present them to the CRC. These tests are described in the Appendices to this document. Pretest notifications are required as indicated in Section 4, and a completion notice shall also be required. The Contractor shall submit documentation indicating successful passing of each test to the CRC / MWAA. The CRC will compare the results with the performance criteria and identify any deficiencies that must be corrected.

4. Test Notifications

The Contractor will provide the MWAA with a minimum of 72 hours notice in advance of the Field Operational Tests of the System components, and 5 days notice of the start of any 30-day Operational Test. Seventy-two (72) hours of prior notification shall also be provided prior to any OTDR testing.

The Contractor shall allow the CRC/MWAA to adjust the start of proposed tests by up to seven days to allow for availability of personnel.

Testing shall not begin unless representatives of the MWAA are present to witness the testing, or test witnessing is waived in writing.

Witnessing of checklist components may be performed by MWAA representatives or by individuals from the Dulles rail – Phase 2 QA staff.

5. Display Failures During the 30-Day Operational Tests

After successful completion of the first three parts of the Operations Tests each DMS shall be tested for proper operation for 30 consecutive days. During the testing period, all Contractor provided or installed equipment at each DMS shall operate without failures of any type.

If any component malfunctions or fails to provide the capabilities specified during the 30-day test period, the Contractor shall troubleshoot to find the exact cause of the failure. If the failed equipment is Contractor furnished, the equipment shall be removed and replaced by the Contractor with replacement equipment as appropriate. Troubleshooting by the Contractor shall occur within 48 hours of notification by the CRC or MWAA.

After the component malfunction has been corrected to the satisfaction of the CRC / MWAA, the Contractor may be required to restart the 30-day test period.

In the event of failure in equipment furnished by the CRC or MWAA, the 30-day test will be suspended until the CRC / MWAA hardware failures are corrected, at which time the test will resume.

6. Work Restrictions

The Contractor shall follow MWAA allowable lane/shoulder closure hours and holiday schedule. All lane closures requests shall be submitted to MWAA one week prior for approval. The Contractor shall coordinate with Capital Rail Constructors to ensure work operations and lane closures are not conflicting. All requests shall follow standard Temporary Traffic Control Figures from the Virginia Work Area Protection Manual, Revision 1. If specific requests cannot be accommodated by standard figures, the contractor shall provide site specific work plans to MWAA for approval.

7. Test Equipment

All test equipment for local field operations tests, inspections and OTDR and network cable tests shall be provided by the Contractor. Test equipment that is capable of calibration shall have an up to date calibration certificate.

8. Acceptance for Maintenance

Acceptance for Maintenance and beneficial use of the DMS by MWAA will be governed by the terms of the contract governing the purchase and installation of the DMS units.

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DMS Site Inspection Checklist

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

MASTER CHECK LIST OF ITEMS	PASS DATE	COMMENT No.
Site Work (Sections A, & B)		
Sign Support Structure (Section C)		
Cabinet Components & Wiring Checks (Sections D & E)		
Load Center (Section F)		
Disconnect Installation & Wiring (Sections G)		
Communications Cabling (Section H)		
Manuals and Related Site Equipment Provided to MWAA		

Comments:

_____

_____

_____

_____

_____

_____

Safety Requirements: All inspectors must wear a reflective safety vest in compliance with the VA Work Area Protection Manual, hardhat and safety shoes. Proper safety equipment and procedures must be followed when testing live voltages.

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DMS Site Inspection Checklist

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: WORK PADS & OTHER SITE WORK	PASS / FAIL / NA	COMMENT No.
A. Junction Boxes and Conduits:		
1. All Junction Boxes and Manholes have rated, identified cover.		
2. All Junction Box covers are secured if under 100 lbs.		
3. All spare conduits without cables have one or more pull lines.		
4. Bell ends are installed at the ends of conduits carrying cables.		
5. All conduit openings are sealed with waterproof removable sealing compound or approved device.		
B. Other Site Work:		
1. Excessive earth and rock removed and entire disturbed area seeded (if required).		
2. Remove all debris and equipment from the site.		
3. Concrete pads or concrete slab installed in front of cabinets that do not have pavement in front, and all are level & stable.		
4. If used, pad dimensions are at minimum 3'x3'x4".		

Suggested Inspector/Witness Experience: 3-years field experience.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: SUPPORT STRUCTURE	PASS / FAIL / NA	COMMENT No.
C. Sign Support Structure:		
1. Handhole sizes and locations, internal cable attachment points, and cable pass-throughs at top match structural shop drawing. (See Note 1.)		
2. Column base plate(s) level.		
3. Anchor bolts tightened.		
4. Hand-hole covers & chains installed; All screws of same type (hex bolts).		
5. Conduit cut off inside the pole must be between 2" and 12".		
6. Bell ends installed at the open ends of conduits carrying cables.		
7. Ground around foundation stabilized (if unpaved).		
8. Foundation condition is satisfactory.		
9. Pole/Structure is raised off foundation for water drainage.		
10. Cabinet and equipment support brackets are stable.		
11. Ground rod(s) installed.		
12. Galvanized couplings not rusted, pole not rusted. All field cut threads are painted with an approved galvanizing paint prior to assembly.		

Note 1. – This item should be checked prior to the installation of the sign support structure.

Suggested Inspector/Witness Experience: 3-years field experience.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: CABINET COMPONENTS & WIRING CHECKS (Page 1 of 2)	PASS/FAIL/ NA	COMMENT No.
D. Cabinet Body and Fittings:		
1. Technician has access to equipment & equipment fastened to rack. The top shall be no more than 7' above the road or pad.		
2. Cabinet vertical and secured to mounting foundation. Cabinet is stable.		
3. Cabinet has visible label with DMS ID on it.		
4. Door swing OK. Door(s) are able to be opened fully and not obstructed by other structures. Door(s) align properly.		
5. Door gasket is installed and firmly in place.		
6. Cabinet has new filter and properly installed.		
7. All conduit bodies and internal junction boxes have covers.		
8. Cabinet penetrations are made with approved, listed outdoor connectors.		
9. All field cut penetrations for electrical conduits have smooth edges. No uncovered openings in cabinet.		
10. All external and internal conduits are secured.		
11. No openings in cabinet.		
12. Conduits entering cabinet sealed with removable copper mesh after all wires have been installed.		
13. Inside of cabinet clean, no dust or debris.		
14. All interior panels and equipment are secured. All mounting screws present.		
15. Cabinet is locked and owner has key.		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: CABINET COMPONENTS & WIRING CHECKS (Page 2 of 2)	PASS/FAIL /NA	COMMENT No.
E. Power Wiring and Cables:		
1. Wire mounts firmly attached. All wiring neat with no wires lying on cabinet bottom. Wires/cables secured to prevent being pushed against any metal or sharp parts that could chafe or cut wires.		
2. VERIFY PROPER IDENTIFICATION OF ALL WIRES & CABLES.		
a. A nylon self-clinching non-conductive band or approved permanent marking indicating circuit number is present on each wire and each terminated end. Field applied Color-Coded Conductor Tape is applied in half lap turns for a distance of 6".		
b. Incoming power is labeled to identify panelboard and circuit from which served.		
3. Confirm power wiring size per design documents.		
4. Surge suppressors installed for each power cable. Cabinet ground not connected through Surge Suppressor.		
5. All wire termination guards are in place.		
6. No excessive bare copper exposed at termination points.		
7. All load side wires terminated individually.		
8. All conduit ground wires attached to "Ground Bar".		
9. Cabinet is grounded to "Ground Bar".		
10. Bonding bushings installed on all conduits entering Cabinet.		
11. Confirm insulated bushings are installed at all conduit terminations.		
12. Confirm all wiring is terminated, no loose wiring exists.		
13. Ground Bar passes 10-ohm Megger test		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: LOAD CENTER	PASS/FAIL/NA	COMMENT No.
F. Load Center:		
1. Load Center has visible warning label on front door and system voltage is identified with black letters on an orange background.		
2. Load Center has a directory card indicating all circuit designations including "spare" breakers. A typewriter or computer is to be used; no handwritten directories will be accepted.		
3. All unused breaker spaces have filler plates installed.		
4. Breakers snap and stay in position properly.		
5. Load Center has all openings sealed with K.O. Seals.		
6. Ground, neutral, and phase conductors terminated and identified.		
7. Verify proper Phase and Neutral marking. Field applied Color-Coded Conductor Tape applied in half lap turns for a length of 6".		
7. Confirm insulated bushings are installed at all conduit terminations.		
8. Confirm all wiring is terminated, no loose wiring exists.		
9. Confirm power wiring size per design documents.		
10. Load Center main and branch overcurrent devices match design documents.		
11. Load Center short circuit rating matches design documents.		
12. Dirt and debris removed from inside of Load Centers.		
13. Power conductor terminations are (mechanical or compression) type per design documents.		
14. Proper NEC clearance provided for Load Centers.		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: DISCONNECT INSTALLATION & WIRING	PASS/ FAIL/ NA	COMMENT No.
G. Disconnects:		
1. Disconnect has visible warning label on front door and system voltage is identified with black letters on an orange background.		
2. Disconnect/transfer box functions (on/off), fuses provided & grounded. Not rusted.		
3. Service disconnect functions and Overcurrent Protection (fuses) are sized according to NEC.		
4. Disconnect is NEMA 4X		
5. Disconnect is securely mounted independent of electrical conduits.		
6. No excessive copper at termination points.		
7. Verify proper identification of wires. Field applied Color-Coded Conductor Tape applied in half lap turns for a distance of 6". A nylon self-clinching non-conductive band, or approved permanent marking process indicating circuit number is present on each wire at each terminated end.		
8. If disconnect is service entrance disconnect, confirm existence of UL service entrance label and grounding.		
9. Confirm insulated bushings are installed at all conduit terminations.		
10. Confirm power wiring size per design documents.		
11. Confirm disconnects are heavy duty type per design docs.		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

Comments:

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DMS Site Inspection Checklist

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

CHECK LIST ITEMS: COMMUNICATION CABLING	PASS/ FAIL/ NA	COMMENT No.
H. Communication Cabling:		
1. All comm. equipment is installed and secured.		
2. Ethernet switch has IP address clearly labeled		
3. All communication cables are clearly labeled		
4. Verify proper fiber optic strand pair used (i.e.: fibers 1 and 2).		
5. Fibers are terminated in rack mounted enclosure.		
6. Splice covers installed and all rack mounted units screwed in.		
7. Fiber loop to be secured with Ty-Rap on insulation & Velcro rap only on Fiber conductors.		
8. Verify proper length of fiber in cabinet.		
9. Dust caps are installed on spare fibers.		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

NOTE: Tests of Fiber Optic cable for system communications are documented on separate Checklist.

Comments:

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DMS Cabinet Operation Tests

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

DMS CABINET OPERATION TESTS (72-HOUR NOTIFICATION REQUIRED)	PASS/ FAIL/ NA	COMMENT No.
Person Notified, Date and Time		
Perform selected tests from the list below as requested by the MWAA Witness at the DMS Cabinet		
1. Disconnect/transfer box has fuses, functions (on/off), and is properly grounded.		
2. Power outlets are clean & function properly.		
3. Breakers function properly and breakers labeled.		
4. Test GFI receptacle using approved plug-in tester capable of identifying polarity, grounding and simulating a Ground Fault.		
5. Power supply voltage drop from meter to cabinets does not exceed four percent (4%).		
6. Test and record Phase-Phase voltage & Phase-Neutral voltage.		
7. Test and record voltage between neutral and ground at the 120/240 panel under partial load conditions. (I.e.: fan ON.)		

Suggested Inspector/Witness Experience: IMSA Traffic Signal Field Technician Level II or equivalent or better.

Comments:

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DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

Section 1: Introduction

This test procedure describes the field tests for the LED dynamic message sign (DMS) site involved in this project. It is anticipated that these tests would be administered by a representative of the sign manufacturer who has been trained by the sign manufacturer and is fully informed of the features of the signs. If an alternate procedure is used it must be approved by Capital Rail Constructors (CRC) before being used.

The purposes of this test are:

1. Check installation of the sign and related equipment supplied by Daktronics.
2. Check the function of all sign parts and related equipment supplied by Daktronics. Special emphasis is placed on items that, if bad, are not expected to show up as such during normal operation. Examples: The processor board battery, or disconnected earth ground.
3. Prepare the sign for normal operation and eliminate the need for additional visits before normal operation.
4. Record all tests and setup tasks performed at each site, eliminating an additional visit.

   Note: These tests do not cover all software functions or hardware design limits as those tests only need to be done once.

   Perform these tests for every sign site at the completion of installation at the particular site. Use the listed test messages such as the speed limit, moving rows, or moving columns that will not misdirect traffic. This test requires the cooperation of an operator at the central controller with personnel at the sign site.

Test equipment required:

- Boom truck, or other means to access the sign.
- Digital multi-meter.
- Laptop computer with central controller software, misc. other software, and Ethernet patch cable.
- Common hand tools.
- Ground resistance tester.
- Walkie-talkies or cell phones for communication between personnel at the sign and in front of the sign, and the central controller operator.
- Translation table for each display type.

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DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

Section 2: Application Information

This test procedure applies to AF3550 Display series

Section 3: Site Information

1. Contract number and name: _____
2. Field test procedure addendum ED/DD number, if any: _____
3. Sign Site: _____
   (Typically highway number, direction, and mile-post number or intersection.)
4. Sign model number: _____
5. Sign assembly number: _____
6. Sign serial number: _____
7. Sign controller serial number: _____
8. Sign controller DHCP name: _____
9. Site IP address: _____

Section 4: Test Procedures

4.1 Sign Exterior Inspection

1. Check that the face of the sign is properly oriented to the roadway.
   Note: This is an unofficial inspection; Daktronics is not responsible for mounting the sign.
2. Visually inspect the outside of the sign for damage. Inspect the sign mounting.
3. Check that the light sensor is unobstructed.

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DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

4.2 Sign Interior Inspection

1. Make sure the site information in **Section 3** is filled out.
2. Inspect the inside of the sign for damage, loose parts or connections, and signs of water intrusion.
3. Inspect everything on the power supply mounting plate for loose parts or wiring. Check that the earth grounding wires are secure at the surge suppressor and the terminal block.
4. Check conduit entering the sign. They must be sealed inside at the end that enters the sign.

4.3 Power Connection Inspection

1. Turn off power from outside the sign.
2. Check that the hot wire, neutral, and earth ground wires from the 120 V AC power source are connected to terminal block TB41 as shown below:
   - TB41 (pin 1) – Hot (black wire)
   - TB41 (pin 2) – Neutral (white wire
   - TB41 (pin 3) – Earth ground (green wire)
3. Use a safe procedure to check the AC voltage on the terminal block TB41 between the hot (pin 1) and neutral (pin 2) should be between 105 and 125 V AC. Check the voltage from neutral (pin 2) to earth ground (pin 3); it must be less than 10 V AC. Record below:
   - Hot to neutral:_____
   - Neutral to earth ground: _____
4. Restore power to the display

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DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

4.4 Ventilation Test

1. Test the activation of the ventilation system by installing a fiber jumper between the Fiber A and Fiber B of the PLR.
2. After cycling power to the PLR, the fans will activate while in the test mode.
3. Remove the fiber jumper from between Fiber A and Fiber B of the PLR after testing.

4.5 Functional Test Procedure

1. Turn on power to the sign.
2. Using Display Finder application and laptop find the IP address for the display using the Ethernet interface.
   IP: _____
3. Record the installed firmware version numbers (under Configuration tab (Firmware) in Daktronics Remote Display Configuration), and the dimensions of the sign. If the dimensions of the sign do not match the actual sign size, load the appropriate Translation Table to the sign controller. Record the following information:

   Note: Download the latest version of the firmware if the firmware listed below is not the most current.

   Sign dimension:_____ Firmware:_____

4. Make sure the value (dimming level as shown under Tools tab in Daktronics Remote Display Configuration or Brightness level shown in Venus 1500 V4) indicated by the light sensor appears reasonable for the current ambient lighting conditions. Record below:

Note: Light sensor utilizes digital integrated circuits, which are calibrated at the integrated circuit factory, and do not require additional calibration.

Date:_____Time:_____ Sky conditions:_____

Light sensor readings: 1: _____

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DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

5. Connect to the AF3550 display using the Ethernet port with the IP address set up in 4.6.2. Run the Cycle All test pattern (using Venus 1500 V4).

Note: Check that all pixels display correctly and ensure that each display module ID is in the correct position.

Test patterns:

A. Odd Vertical Bars
B. Even Vertical Bars
C. Odd Horizontal Bars
D. Even Horizontal Bars
E. Odd Diagonals
F. Even Diagonals
G. All Off
H. All On
I. Rotate Columns
J. Rotate Rows
K. Gradient
L. Color Diagonals
M. Module IDs

(If these test patterns are not embedded in the memory of the sign, they should be developed and stored using the Venus 1500 Software.)

6. Display a message (not a test pattern) that will not misdirect traffic and has characters that butt up to the top, bottom, left, and right edges of the sign and verify that it displays correctly. This verifies proper message display capability for this sign size.

7. Run the "All On 100% Burn" test pattern and leave the brightness set to 100%. Using a safe procedure, check and record the AC voltage from the sign TB41 Line to neutral; it should be between 105 and 125 V AC. Also check and record the voltage from neutral to earth ground is less than 10 V AC.

   Hot to neutral:_____Neutral to earth ground: _____

8. Reinstall all enclosure covers.

9. Using Venus 1500 software, verify display is set to automatic dimming. Shine a flashlight into the front facing photocell (light sensor). The display brightness should intensify. This may take a few minutes. *NOTE: This should be done while the display is displaying a test message, not a test pattern. Test patterns are displayed at full brightness and are not depending upon the photocell.*

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Dulles Rail – Phase 2

DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

4.6 Communication Test Procedure

1. If necessary (depends on the device), configure any communication device provided by Daktronics.

2. Have the central controller operator call the sign, download a new test message that will not misdirect traffic and has beacons enabled into the sign controller, and display the message.

3. Verify that the message displays properly on the sign. Then have the central controller operator blank the sign and delete the message; then terminate the call to the sign.

4.7 Final Details

1. If the site is not yet officially accepted and not turned over to the end user for operation at this time, leave the sign.

2. Record if main breaker is left on or off: On:___ Off:___ Date: _____

3. Make sure the site information is filled out: serial numbers, site location, IP address/DHCP name, etc.

4. When the site is officially accepted and turned over to the end user for operation, a representative from the end user should immediately load the correct messages, schedules, and all other variables into the sign controller, and assume responsibility for the operational status of the sign from that time forward. The end user representative should be responsible to ensure the proper messages are present in the sign controller, and the proper messages are displayed at the proper times.

   I.T.S. Technician/Engineer:_____Daktronics, Inc.,

   DATE _____

5. Provide a copy of this form to the CRC representative and return this completed document to Daktronics Project Manager.

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Dulles Rail – Phase 2

DYNAMIC MESSAGE SIGN INSPECTION

DMS Site #/Location: _____ **Date:**_____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

It is acknowledged that the field test procedure has been completed for this site and the display is operational. Any unresolved issues related to this field test procedure are listed below:

Punch List Items

1.
2.
3.
4.

Printed Name of Daktronics Technician	Signature	Date
Printed Name of Customer	Signature	Date
Printed Name of Contractor	Signature	Date
Printed Name of Customer Representative	Signature	Date

DAKTRONICS PERSONNEL MUST RETURN THIS COMPLETED DOCUMENT TO THE DAKTRONICS CONTRACT SERVICE COORDINATOR.

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Dulles Rail – Phase 2
DMS Operations and 30-Day Operational Tests

DMS Site #/Location: _____Date:_____

Lead Technician: _____Witness: _____

Witness: (Print & Sign Name)_____

INTRODUCTION

These Operations Tests assess the ability of the signs to resume their functionality after interruptions in the power and communications systems, and correctly report errors and irregularities to the control computer monitoring the operation of these signs. The 30-day test will evaluate the appearance of the signs after a 30-day period of continuous use.

PART 1 – OPERATIONS TESTS AT INDIVIDUAL SIGNS

1. **Tests at Each Installation Site**
   These tests will be conducted at each sign will be initiated at the control cabinet for that sign. They will test the operation and response of the signs when there are power and communications problems.

   Test 1.1 – Resumption of Message Display After Power Failure (Note the power failure is also assumed to knock out communications with the sign)
   a. Select a suitable test message and activate that message on the sign.
   b. Turn off all power to sign.
   c. Restore Power after two (2)-minutes.
   d. Verify that the sign resumes display of the selected message.

   Test 1.2 – Resumption of Message Display After Partial Power Failure
   a. Select a suitable test message and activate that message on the sign.
   b. Disconnect "one side" of the 240/120V power supply.
   c. Restore Power after two (2)-minutes.
   d. Verify that the sign resumes display of the selected message.

   Test 1.3 – Message Display Continues During Communications Failure
   a. Select a suitable test message and activate that message on the sign.
   b. Disconnect the communications link to the sign.
   c. Restore communications after two (2)-minutes.
   d. Verify that the sign resumes display of the selected message.

DMS Site #/Location: _____ **Date:** _____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name) _____

PART 2 – OPERATIONS TESTS USING THE CENTRAL SIGN CONTROL SOFTWARE

2. **Tests Initiated at the Airport's Control Room for The Signs**
   Conduct these tests after the communications have been established between the signs and the desktop computer where the central control and message development software resides. These tests require one person in the field at the sign, and one person at the computer where the control software resides.

   Test 2.1 – Sign Recognition

   a. Verify the control software recognizes the presence of each sign.
   b. Program the system to: display a test message (test message #1); to new test message (test message #2) at a future time; and to end the display of test message #2 and resume the display of test message #1 at a time further in the future.
   c. Verify that the display of the selected test message begins and ends at the scheduled times.
   d. Repeat steps a thru c for a manually initiated sign message change.

   Test 2.2- Sign Recognition after Power Failures

   e. Repeat steps a and b in Test 2.1
   f. During the display of the test message #2 turn off the power to the sign. Turn the power back on before the message is scheduled to end.
   g. Verify that test message #2 ends at the appropriate time.

   h. Repeat steps a and b.
   i. During the display of test message #2 turn off the power to the sign. Turn the power back on after test message #1 is scheduled to resume.
   j. Verify that sign displays test message#1.

   k. Check the control software to verify that appropriate error messages have been reported and/or broadcast for the "power failures" in the preceding steps.

DMS Site #/Location: _____ **Date:** _____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name) _____

Part 3 – OPERATIONS TEST DEMONSTRATING CONTROL OF MULTIPLE SIGNS

3. **Control of Multiple Signs**
   This test assesses the ability of the system to control multiple signs by placing appropriate messages on each one and changing these messages.

   Test 3.1 - Multiple Sign Control

   a. Display an appropriate test message on all of the signs. The Departure Zone Signs should all display the same message (test message "DZ"), but because of its different configuration the Parking Information Sign will display a different message (test message "P"). Use the control software to schedule the display of new messages that are unique to each sign (i.e.: test message DZ1, DZ2, DZ3, DZ4, and P1) at a specified future time, and to end a second specified time when they would resume the display of test messages "DZ" and "P".
   b. Verify that the message changes take place at the appropriate times, and that the correct message is displayed on each sign.

Dulles Rail – Phase 2
DMS 30-Day Operational Tests

DMS Site #/Location: _____

Date & Time at Start / Restart of Test:_____

Date & Time at End / Suspension of Test: _____

Lead Technician: _____ **Witness:** _____

Witness: (Print & Sign Name)_____

PART 4 – 30-DAY OPERATIONAL TESTS AT INDIVIDUAL SIGNS

4. **30-Day Operational Test at Each Sign**
   This 30-day operational Test will operate the pixels of the sign for an extended time period to identify any components of the sign that might be failure prone, and assess the color uniformity after the burn in period.
   a. Operate each LED for 8 hours each day for a 30 day period to identify any defective LEDs. One possible procedure to accomplish this is to operate a horizontal band of all three pixels at full power over one-third of the sign and then a second band for the next 8 hours, etc. A message reading "SIGN TEST" should be displayed simultaneously on a portion of the display that is not being tested at that time. Alternative tests developed by the manufacturer may also be used if they have been approved in advance by MWAA.
   b. During each test period MWAA or its representative may initiate the display of additional test messages manually or through the use of the control software's scheduling capabilities. MWAA's representative will verify that these test messages are properly displayed, and that they begin and end at the proper times.
   c. At the conclusion of the 30-day period Test for correct display and color uniformity by repeat the display of the Test Patterns identified in Appendix A3 – DMS Field Tests, Section 4.5, Part 5.
   d. Identify any failure during the operational test below, the reasons for the failure, and actions taken to return the sign to operation and resume the test.

System Failures, Reasons, Corrective Actions and Restarts:

Dulles Rail – Phase 2

Fiber-Optic Cable Test Plan

1.0 Introduction

This document identifies the Optical Time Domain Reflectometer (OTDR) tests and inspections that are to be accomplished for the Communication Network to demonstrate that all hardware, cables, and connections furnished and installed by the Contractor operate correctly and that all functions are in conformance with project requirements.

A six strand single mode fiber-optic cable will be installed between the communication cabinet at each of the five DMS units and a splice enclosure in manhole 4163.[1] At this splice enclosure all six strands of the five fiber-optic cables will be fusion spliced into one 48 strand single mode fiber-optic cable. This 48 strand cable will be routed to the Communications Room on the 3rd floor of Building 8 at Dulles International Airport. For purposes of this document the rack for the LAN Interface Units (LIU) in this Communications Room is the designated Tie-in point.

All fibers at all five DMS communications cabinets and the Tie-in point will be terminated in factory assembled Fan-outs with ST Connectors. All spare fibers at the splice enclosure at manhole 4163 will be terminated with factory assembled Fan-out kits with ST connectors or factory assembled pigtails with ST connectors. Caps will be provided for all ST connectors. As indicated in the Splice Plan Notes all ST connectors at the DMS communications cabinets, and the splice enclosure at manhole 4163 may be joined together in pairs[2] with ST/ST couplers to facilitate testing from the Tie-in point.

1.1 Exclusions

1. The Contractor is not responsible for BER (Bit Error Rate) performance of the network as a function of the network equipment. MWAA will perform network design and will configure and operate all Administration equipment.
2. The Contractor will purchase the network switches and modules that will be installed in the DMS Cabinets, and provide these units to MWAA's Network Communications Group for initial testing and configuration. Acceptance of these units will be determined by MWAA. After they have been accepted and configured MWAA will return the units to the Contractor for installation in the DMS cabinets. Any issues with the operation of these units will be investigated and corrected by MWAA.
3. The Contractor will not be responsible for the performance of the fiber-optic network and splices installed by others.

2.0 Sign Locations

The Communications Network of the fiber-optic cables on the DTR and DIAAH extends from the west at the Tie-in point to the DMS units. The locations of these DMS units are identified in the following list. (The stationing provided in this list is roadway construction stationing.)

---

[1] Manhole 4163 is located near a group of above ground electrical cabinets near the gore of the eastbound DIAAH collector-distributor road at exit ramp leading to southbound Route 28.

[2] Pairs will be comprised of adjacent fibers (fibers #1 & #2, fibers #3 & #4, etc.)

1. Departure Zone Sign 1 DMS – STA 553+25 WB
2. Departure Zone Sign 2 DMS – STA 565+25 WB
3. Departure Zone Sign 3 DMS – STA 577+25 WB
4. Departure Zone Sign 1 DMS – STA 589+00 WB
5. Parking Information DMS – STA 616+00 WB

3.0 Test Equipment

The following test equipment or equivalent equipment shall be provided for the Communications Network OTDR testing.

- Laptop Computer
- Fiber-optic Test Set: Noyes OPM6/OLS6 or equivalent
- OTDR: AFL-OFL-200 or equivalent
- Network Cable Tester: Fluke LinkRunner or equivalent

4.0 Inspection/Test Procedures

A general description of the OTDR testing procedures for the fiber-optic communication network is provided in the following sections.

4.1 Fiber-Optic Cable Testing

Testing of the fiber-optic cable system will verify the acceptable performance of the fiber-optic cable system. The general nature of these tests is to compare the results of actual OTDR tests with a maximum loss based on the worst case assumptions of the losses associated with the internal losses on the fiber, splices and connectors. The test is conducted at both 1300 NM and 1550 NM and is "passed" if the actual average losses at both frequencies are less than the theoretical losses.

Two types of tests will be made: Fiber-optic cable "Reel Tests" and tests of the Installed Fiber-optic Cable. These tests will be conducted using the fiber-optic test procedure described in the BICSI "Telecommunications Distribution Methods Manual" (TDMM) 11th Edition or newer.

The tests of the fiber-optic cable system will be based on the attenuation of the fiber as indicated below.

	Wavelength (nm)	Worst-Case Attenuation Coefficient
Fiber-optic Cable Strands	1310 1550	0.5 (dB/km) 0.5 (dB/km)
Connectors	Average of 1310 &1550	1.0 (dB) per PAIR
Splice Attenuation	Average of 1310 &1550	0.3 (dB) per SPLICE

4.1.1 Fiber-Optic Cable Reel Tests

Fiber-optic cable "reel tests" of the six-strand and 48 strand fiber-optic cables will be made on all of the cables purchased by the contractor prior to their installation to verify that the losses in each of the strands are acceptable.

The results of these tests will be reported as indicated in Section 5.0.

After the results of these tests have been reviewed and Accepted by MWAA the Contractor can proceed with the installation of the cables.

4.1.2 Tests of the Installed Fiber-Optic Cable

If all of the fibers at the communications cabinets and the spare fibers at the splice enclosure at manhole 4163 have been linked into pairs with ST/ST Couplers, the tests of the installed fiber-optic cable may all be conducted from the Tie-in point. All of the strands in the network will be tested twice by testing all 48 strands at the Tie-in point. At each frequency the average OTDR readings on the two paired fibers is derived from readings taken with the OTDR input on the first fiber in the pair (the A-B reading), and the reading taken with the OTDR input on the second fiber in the pair (the B-A reading).

If the ST connectors are not linked by couplers the readings on each fiber at each frequency will be taken at the Tie-in point (the A-B reading for all 48 fibers), the splice enclosure at manhole 4163 (the B-A reading for the 18 spare fibers at this enclosure), and at all five communications cabinets (the B-A reading for the 30 fibers that terminate in the five communications cabinets).

Alternate testing procedures will be considered but shall be approved prior to their use.

5.0 Test Data Reporting

The Contractor shall provide a brief narrative and suitable spreadsheets tabulating the results of the tests for each fiber. The narrative should include a measure of reflectance and an interpretation of any events shown on the OTDR traces. End to end power readings should also be provided. The OTDR test results will be documented on paper as an Appendix.

The Contractor shall also provide computer readable media with the OTDR outputs. A separate file shall be provided for each reading indicating the DMS communication cabinet, fiber, strand(s), date, and time that the readings were made.

The reports and associated computer readable data for the Fiber-optic Cable Reel Tests and the Tests of the Installed Fiber-optic cable shall be submitted for review and approval as indicated in Section 3.1 of the "ITS Acceptance Test Plan for DMS and Fiber-Optic Cable."