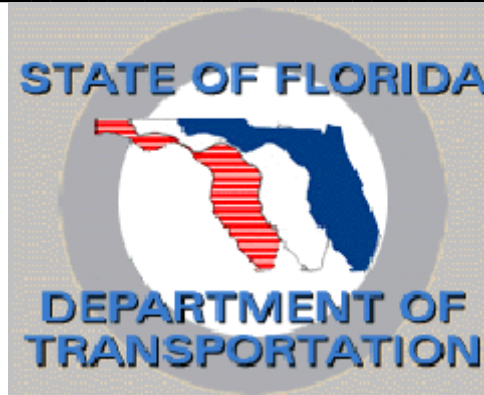


Appendix E

Draft Minimum Specifications for Permanent Mount Dynamic Message Signs (DMS)

TECHNICAL RESEARCH SUMMARY REPORT



Permanent Mount Dynamic Message Signs Specifications

October 2000



— Traffic Engineering Research Laboratory —
Tallahassee, Florida

**STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION**

**Permanent Mount
Dynamic Message Signs
Specifications
October 2000**



**Addendum to the
Minimum Specifications for Traffic
Control Signal Devices**

**STATE TRAFFIC ENGINEERING OFFICE
TALLAHASSEE, FLORIDA
<http://www.dot.state.fl.us/trafficengineering>**

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Permanent Mount Dynamic Message Signs

9802-1 Scope

This specification establishes the minimum requirements that Permanent Mount Dynamic Message Signs (DMS) must meet for design and operational acceptance to be used in the state of Florida.

Dynamic Message Signs (DMS) are programmable traffic control devices that display messages composed of letters, symbols or both. They are used to provide information about changing conditions in order to improve operations, reduce accidents, and inform travelers. They may ask drivers to change travel speed, change lanes, divert to a different route, or simply to be aware of a change in current or future traffic conditions.

9802-2 Terminology

Due to the varying definitions used in DMS technology, this section defines specific terms as they apply to this special provision.

Sign: The sign housing and its contents.

Local Sign Controller: Located in a sign, the local sign controller specifies the message to be displayed on the sign. The message can be selected either remotely from the master system controller, locally from a laptop computer or from the front panel of the local sign controller.

Master System Controller: The computer system and related software that operates a sign or a group of signs.

Laptop Computer: This computer can operate both as a remote terminal to the master system controller or a maintenance terminal to the local sign controller. In its maintenance terminal operation, an operator can connect the laptop computer to the local sign controller and run diagnostic tests on the sign or select and program messages for that sign. In its remote terminal operation, an operator can dial in to the master system controller and gain full access to all functions of the master system controller.

Pixel: Any of the small discrete elements that, when arranged in a 5 by 7 matrix, create a character.

Pitch: Distance measured from center to center of adjacent pixels within a character. This distance can be measured both horizontally and vertically.

Message: The information-bearing text shown on the sign. Standard message format consisting of approved message content and information.

Display: The message seen by the motorist. A display may include more than one page of text (an alternating display). Any character or set of characters of a display may be flashed at an operator-specified rate (a flashing display).

Scenario: A preset plan that assigns specific displays to a specific sign or a group of signs at specific intervals.

TERL: Florida DOT Traffic Engineering Research Laboratory

Display Rate: The rate and content of the message displayed for driver perception and understanding.

Vendor: The manufacturer/designer of DMS.

Default State: This refers to the condition when the sign is blank or a predefined message is displayed.

WYSIWYG: An acronym stands for what you see is what you get.

Ground Control Cabinet: A cabinet installed outside the sign housing offers local access to the local sign controller on the ground.

Electronic Control Cabinet: A cabinet installed inside the sign housing contains interface circuits for the local sign controller and display modules, LED display of the sign operation, and connector for a maintenance laptop computer.

Dynamic Message Sign (DMS) System: A complete system consists of one or more signs and the associated controllers that operate the entire system.

9802-3 Sign Configuration

A sign shall consist of the following as a minimum:

- * a display panel
- * a housing
- * a local sign controller
- * a communication device
- * an electrical system
- * a ventilation system
- * a dimming system

The total weight of a sign (added to the sign support structure) shall not exceed 2182 kilograms (4800 pounds).

9802-3.1 General - Display Panel

The DMS message display shall utilize Light Emitting Diodes, Flip-Disk, Flip-Disk/Hybrid or Shuttered Fiber-Optic. Any illumination technology may be submitted for approval as long as the requirements of this specification are met.

The display panel of a DMS can be either line matrix or full matrix.

The display panel of the DMS shall be capable of displaying any message of three (3) lines with at least fifteen (15) characters per line. All three lines of characters shall be of the same height and with a minimum height of 45.7 centimeters (18.0 inches).

There shall be proper spacing between lines and characters so that the message is legible from a distance of 274.3 meters (900 feet).

The message matrix shall be assembled with identical display modules. There shall be at least 21 modules per line.

A display module shall consist of thirty-five (35) pixels arranged into a five (5, horizontal) by seven (7, vertical) matrix.

A display module shall be capable of displaying a character of at least 45.7 centimeters (18.0 inches) in height and minimum of 9 inches in width.

All display modules shall be fully interchangeable and shall not require any address switches or adjustment when interchanged or placed in service. Module addressing, where required, shall be accomplished in the connector.

Replacement of a complete display module shall be possible without the use of any tools. Interconnection of modules shall be through connectors only. All connectors shall be keyed to preclude improper hookups.

9802-3.1.1 LED Display Modules

An LED display module shall consist of an LED circuit board, a connector for power, and a connector for controls and data.

The LED display modules shall be 1.59 to 2.22 centimeters (5/8 to 7/8 inch) behind the lens panel assembly.

The LED circuit board shall be a single printed circuit board with a minimum thickness of 1.57 millimeters (0.062 inch). The LED board shall also hold the supporting control electronics and have an extruded aluminum frame.

The LED board shall contain thirty-five (35) LED pixels arranged into a 5 by 7 matrix. The board shall contain the solid state electronics necessary to control pixel data and read pixel status.

9802-3.1.1.1 Pixels and LEDs

All pixels in a display module shall be of the same construction. Each pixel shall be a maximum of 3.5 centimeters (1 and 3/8 inches) in diameter. There shall be a minimum of 20 LEDs in each pixel. Each pixel shall have a minimum on-axis intensity of 60 candelas.

The LEDs in a pixel shall be arranged in at least two interlaced strings with equal number of LEDs. The LEDs in a string shall be connected in series. The pixel strings shall be connected in parallel and be powered from a regulated DC power source. The LED current shall be maintained at 25 +/- 3 milli-amperes (mA) per string to maximize the life of the pixel. The failure of a single LED in one string within a pixel shall not affect the operation of any other strings of the pixel. Pixel power drawn from the DC supplies shall not exceed 1.5 watts (W) per pixel, including the driving circuitry.

The LEDs shall be AlInGaP, Precision Optical Performance HLMP-DL17, T - 1 3/4 diodes, manufactured by Hewlett-Packard Company (Toshiba TOSBRIGHT InGaAlP LED lamp series is considered an equivalent). The diodes shall have a minimum of fifteen (15) degrees viewing angle and display an amber color with a dominant wavelength range from 588 to 592 nanometers (nm) and a peak wavelength of 590 nm. Other LEDs may be used if approved as equal by TERL.

The LEDs shall be individually mounted directly to a printed circuit board and be easily replaceable and individually removable using conventional electronics repair methods.

Epoxy encapsulation of the LEDs is not permitted.

9802-3.1.1.2 LED DC Power

The voltage to the LED boards and associated electronics shall not exceed 25 volts (V) DC.

All LED module power supply voltages shall be continuously measured and monitored by the local sign controller. The local sign controller shall provide these voltage readings to the master system controller or a maintenance laptop computer upon command. When a voltage drops below 80 % of the rated value, an error message shall be generated and transmitted to the master system controller or a maintenance laptop computer.

9802-3.1.1.3 Display Module Characteristics

The LED board in a display module shall receive control signals and display data from the local sign controller via a standard ribbon cable. The display module shall contain the control and memory elements and provide the signals to switch the LED pixels.

Pixel status and diagnostics returned from the board shall include string failure, pixel failure and failed pixel location (line, module, row and column numbers).

The display modules shall connect to a single control ribbon cable common to each line of display modules.

There shall be a power distribution system that connects each display module to all power supplies and minimizes the voltage drop over the face of the sign. The voltage measured at the display modules shall not vary more than 50 milli-volts (mV) over all the display modules in the sign with 17 pixels on at 100 % intensity in each and every display module.

Hoods, louvers, cylinders or visors, that would impede the free flow of air over any surface of each individual LED, shall not be used. The LEDs shall be protected from the outside environmental conditions, including moisture, snow, ice, wind, dust, dirt and UV rays.

Pixel brightness shall be controlled by pulse width modulation of the DC current. The pixel current waveform shall have a frequency of 100 +/- 5 Hz at nighttime brightness levels and 2400 +/- 120 Hz at daytime brightness levels with an adjustable duty cycle of 0.5 to 99.5 % in 0.5 % or finer increments.

The operational status of the LEDs in each pixel shall be regularly tested by the local sign controller and then transmitted to the sign control system. A list of defective pixels shall be provided, listing pixel status, line number, module number, column number and row number for each defective pixel.

A defective pixel is a pixel, which has one or more defective strings of LEDs.

All LED boards shall be conformal coated except at the pixels.

All printed circuit boards, including the LED circuit board, shall have a solder mask and a component identifier silk screen.

9802-3.1.2 Fiber Optic/Reflective Disk (or Shuttered) Display Modules

9802-3.1.2.1 Fiber Optic/Reflective Disk (or Shuttered) Pixels

Each fiber/reflective (F/R) pixel shall consist of at least one light point made up of a fiber optic bundle with its end fitted with a lens, closed or opened by a shuttering device using electromagnetic flip disk technology. The shutters shall be controlled by electromagnetic pulses and the disks shall remain in their state after the pulse is removed. In a stable position, power consumption of the electromagnetic shutters shall be zero.

The lighting source for the F/R pixels shall consist of two 50-watt quartz halogen lamps consisting of a primary lamp and a "backup" lamp per module group. The maximum lamp voltage shall not exceed 13V RMS.

The average service life of the lamps shall be 8,000 hours. The lamp and reflector shall be a single unit. It shall be possible to service the lamps from the inside of the sign and without the use of any special tools or removal of the shuttering devices. For each display module, only one lamp shall be in use. Switching from the "primary" lamp to the "secondary" lamp, and vice versa, shall be automatic when one of the lamps malfunctions. Circuitry shall be provided to "soft-start" the lamps to extend filament life. Light output from each pixel shall be at least 33 candela. The color of the emitted light out of the sign shall be amber.

Only high quality step index glass optical fiber shall be used. Each fiber optic harness shall contain spare bundles equal to 5 percent of the total bundles used per module. Each optical fiber light guide end shall be fitted with a lens which shall produce an emission controlled angle equal to 15 degrees centered around the optical axis.

The shuttering device shall consist of a disk activated by electromagnetic technology. (For the purposes of this section, "disk" shall mean disk, vane, or other light-blocking object.) The disk shall operate as to effectively block light from the fiber optic bundle when closed, and allow the passage of light when open. Flip-Disk devices shall be reflective on one side (the "on" side), so as to enhance the readability of the sign, and flat black on the other. The shutter/flip-disk device shall contain an aperture located approximately on the centerline of the pixel through which the fiber optic light is transmitted for the "on" position. Each disk shall be activated by a reversible magnetic stator which contains a remnant magnetic field to latch the disk securely against vibration.

The reflectivity of the flip disk shall enhance the target value of the display by more than 10 candela in direct sunlight and shall enlarge the viewing angle up to 80 degrees centered around the optical axis for both daytime and nighttime viewing.

When the disk is in the "off" or reset position, the gap between the disk surface and the lens shall be less than 2.03 millimeters (0.08 inch). The narrow gap is essential to minimize the possible scatter effect from the individual fiber optic pixel.

The shuttering device shall be rated for a minimum of 100 million operations. All materials used in the fabrication of the pixel display modules shall not be damaged by direct exposure to sunlight.

Each DMS pixel shuttering device shall be commanded to "exercise" on an automatic, periodic basis and such that the exercising action is imperceptible to a sign observer. The exercising shall have no perceptible effect on the message being displayed at the time of exercising. The exercising shall be controlled locally and shall occur regardless of the control state or commands from the central control center.

There shall be equal horizontal and vertical pixel spacing (minimum 1.27 centimeters (0.5 inch), center to center and gap between pixels).

9802-3.1.3 Module Mounts

Module mounts are parts of the internal structural of the sign housing. They shall help retain the display modules in a manner to facilitate easy and rapid removal of each display module without disturbing adjacent display modules.

9802-3.2 Housing

9802-3.2.1 Construction

The sign housing shall be designed and constructed so as to present a clean and neat appearance. The equipment within the sign housing shall be protected from moisture, dust, dirt and corrosion. The sign housing shall be constructed of aluminum alloy 3003-H14 or an approved equal which shall not be less than 0.318 centimeter (1/8 inch) thick. Framing structural members shall be made of aluminum alloy 6061-T6, or 6063-T6, or an approved equal. Seams shall be continuously welded through an inert gas process or other approved process.

The sign housing shall be designed for a continuous usage of at least 20 years.

The sign enclosures shall be capable of withstanding wind loading of 177 km/h (110 mph, the highest wind speed of a Category 2 hurricane) without permanent deformation. The bottom panel of the sign housing shall have a minimum of four drain holes with water drain filter inserts in each section formed by internal structural members. Water drain filter inserts shall be replaceable with regular hand tools.

9802-3.2.2 Walk-in Housing

The walk-in housing dimension shall not exceed 3.10 meters (10 feet and 2 inches) tall, 7.32 meters (24 feet) wide, and 1.96 meters (6 feet and 5 inches) deep.

9802-3.2.3 Exterior Housing Panel

The exterior housing, door and end panels shall be made of 3003-H14 aluminum alloy sheets or approved equals with minimum sheet thickness of 3.18 millimeter (1/8 inch).

The number of seams in the top housing panel shall be kept to a minimum.

All exterior seams and joints shall be continuously welded through an inert gas process or other approved process.

The exterior housing panel material shall be stitch welded to the internal structural members to form a united structure.

9802-3.2.4 Housing Face

The housing face shall be of a three-part construction, consisting of internal structural members, external fascia panels and lens panel assemblies. No exposed fasteners will be allowed on the housing face.

The internal structural members shall be extruded aluminum and shall accommodate both display-module mounting and air distribution. They shall retain the display modules in a manner to facilitate easy and rapid removal of each display module without disturbing adjacent display modules.

The external fascia panels shall be extruded aluminum and shall be designed to keep heat conduction to a minimum between the exterior surfaces and the interior components. They shall incorporate provisions for retaining and sealing the modular lens panels and have a gasket track for a closed cell resilient gasket. They shall be finished with a matte black factory applied polyvinylidene fluoride (PVDF) resin coating, KYNAR 500, or an approved equal suitable for unfavorable chemical and physical environments. Individual panels shall be removable for cleaning or replacement from within the sign housing. The external fascia perimeter panels shall be a minimum of 30.5 centimeters (12 inches) wide. The external fascia interline panels shall be a minimum of 22.7 centimeters (9 inches) wide. The external fascia panels shall be thermally isolated from the rest of the sign housing. There shall be a minimum amount of metal contact between the external fascia panels and the rest of the sign housing.

The lens panel assembly shall consist of a PVDF resin coated aluminum mask over a clear glazing. The lens panel assembly shall be modular in design, interchangeable without misalignment of the lens panel and the LED pixels and removable from within the main sign housing.

The aluminum mask of the lens panel shall be at least 1.02 millimeters (0.040 inch) in thickness and finished with a matte black factory-applied PVDF resin. The mask shall be perforated to provide an aperture for each pixel on the display modules. Each aperture shall be as small as possible, without blocking the LED light output at the required viewing angle.

The lens panel clear glazing shall be 90 percent UV opaque, non-breakable, polycarbonate-LEXAN XL, 6.35 millimeters (1/4 inch) minimum in thickness,

and clear in color. It shall be laminated to the inside surface of the lens panel aluminum mask using an acrylic foam tape joining system, 3M Scotch VHB or an approved equal, to form the lens panel assembly.

9802-3.2.5 Internal Walkway

The sign housing shall have a continuous walkway, of at least 45.7 centimeters (18 inches) wide extending the full length of the sign. There shall be a and with a clearance of at least 183 centimeters (6 feet) above the walkway. The walkway shall be made of 3.18 millimeters (0.125 inch) diamond tread 6061-T6 aluminum or an approved equal. All edges of the walkway grating shall be finished to eliminate sharp edges or protrusions.

9802-3.2.6 Grounding

The sign housing shall be properly grounded according to Section 620 of the FDOT Minimum Specifications.

9802-3.3 Electrical System

9802-3.3.1 Main Power Supply and Energy Distribution

The sign and its internal electrical parts shall be designed for use on a single-phase AC power line, rated 60 Hz, 120/240 V, and 40 A per leg. The system shall operate within a voltage range of 95 to 135 V and a line frequency range of 57 to 63 Hz.

Under normal operation, the drop in voltage between no load and full load of the sign and its internal electrical parts shall not exceed 10% of the rated voltage.

The system shall be protected with transient suppression devices.

Power protection shall be provided by a thermal magnetic circuit breaker equipped with a 5 mA ground fault circuit interruption (GFI) device. A GFI device shall protect all service outlets.

The sign shall have a 120/240 V AC, 200 A, two-pole load center with a capacity of 12 circuits. The load center shall be located near the housing entry point. Each circuit in the sign shall be powered through a separate thermal magnetic circuit breaker. All wiring shall be located in conduit, pull boxes, raceways or control cabinets. No wiring shall be exposed to the inside or the outside of the sign housing. The sign housing shall not be considered as a raceway or control cabinet.

The power cables shall be type XEM and sized as required by the NEC for acceptable voltage drop to supply AC power to the sign.

The total power required for the full sign operation (including internal lighting, fans, heaters, local sign controller, communication equipment and all pixels illuminated at 100 % brightness) shall be no more than 7000 watts.

9802-3.3.2 Internal Lighting and Electrical Outlets

The sign housing shall be furnished with four 40-watt fluorescent lights inside. The lights shall be spaced evenly above the walkway and shall be fitted with protective guards. The internal lights shall be controlled by an adjustable timer which is capable of turning off the lights after the set time has expired. The light timer/switch shall be located near the door.

The sign housing shall be equipped with at least three 15 A, 120V (+/- 10 %) grounded GFI protected duplex electrical receptacles to accommodate inspection and maintenance requirements. One receptacle shall be located at each end of the sign housing and one at the center of the sign housing. The duplex outlets shall be spaced evenly on the back wall no more than 91 centimeters (3 feet) above the walkway.

9802-3.4 Ventilation System

The sign housing shall be equipped with the necessary vents, filters, and forced air ventilation to provide ventilation for equipment and maintenance personnel inside the housing.

All fans or other forced air devices for equipment shall be thermo-statically controlled and shall use standard-sized, easy-removable dust filters. The equipment ventilation system shall have a minimum rating of 34 cubic meters per minute (1200 cubic feet per minute) and shall be controlled by a thermostat inside the sign housing. The thermostat shall have a minimum adjustable temperature range of 25° C to 50° C (77° F to 122° F). All intake and exhaust vents shall be rain-tight.

Fans or other forced air devices for maintenance personnel shall be in accordance with OSHA and all other applicable regulations. The ventilation devices for maintenance personnel shall be controlled with an adjustable timer that is capable of turning off the fans after the set time has expired. The adjustable timer shall be adjustable to at least 4 hours and shall be located within easy reach of the housing door. The maintenance personnel ventilation system shall use standard-sized, easy-removable dust filter.

All motors of the ventilation system shall be of self-lubricating industrial type and shall be equipped with ball bearing supported shafts or approved equals.

The interior temperature of the housing shall be continuously measured and monitored by the local sign controller. A temperature reading greater than a user selected critical temperature shall cause the sign message to go to blank and an error

message shall be sent to the master system controller. The temperature sensor shall have an accuracy of +/- 1° C and a range from -40° C to +70° C.

The master system controller and a laptop computer for sign maintenance shall be able to gather all temperature readings from a local sign controller.

9802-3.5 Dimming System

Each sign shall be provided with a system which shall sense the background ambient light level and provide a minimum of seven field-adjustable intensities (dimming). The lowest settings shall be for night use. The highest settings shall be for over-bright control. The middle settings shall be for normal daytime use allowing for variable light levels.

The dimming system shall contain three commercially available photo-electric sensors installed in water-tight metal enclosures on the DMS housing. The photo-electric sensors shall be capable of being continually exposed to direct sunlight without impairment of performance. The photo-electric sensors shall be placed so that they view the front, rear, and top of each sign.

The dimming system circuitry shall select one of seven levels from either the sensed ambient light when operating in local mode or from commands sent from the DMS control system when operating in remote mode. The dimming system shall be capable of sending readings from all three photocells to the DMS control system. The dimming system shall direct the local controller to modify the intensity of the light produced by the pixel elements.

All dimming adjustments shall be easily accessible at the local controller cabinet(s).

The dimming circuit and DMS power system shall have electrical devices installed to minimize RFI noise generated by the DMS both on the power line and radiated by sign circuitry.

The local controller circuitry shall determine the operating mode (local or remote) and select the appropriate method of implementing dimming.

9802-4 DMS Control System

The DMS control system shall consist of one master system controller (a central computer system), a local sign controller for each sign, and all the computer software and communications equipment necessary for the operation of the DMS system.

9802-4.1 National Transportation Communications for ITS Protocol Requirements

All controllers shall comply with the National Transportation Communications for ITS Protocol (NTCIP).

Software shall comply with NEMA TS 3.2 1996, the Simple Management Framework (STMF), and shall conform to Compliance Level 1.

Software shall conform to NEMA TS 3.3 1996, Class B Profile and the Class D Profile as required in Section IV E.10. All serial ports on the device shall support communications according to these standards. Each port shall support an assignable 1-byte Data Link layer address.

Software shall implement all mandatory objects of all mandatory conformance groups as defined in NEMA TS 3.4 1996, Global Object Definitions, and the NTCIP Joint Standards Committee Recommended Standard for Object Definitions for Dynamic Message Signs dated April 1997 or as approved by the Engineer.

Software shall also implement all mandatory objects of the following optional conformance groups as defined in NEMA TS 3.4 1996, Global Object Definitions, and the NTCIP Joint Standards Committee Recommended Standard for Object Definitions for Dynamic Message Signs dated April 1997 or as approved by the Engineer.

NEMA TS 3.4 – 1997, NTCIP – Global Object Definitions:

- * Time management
- * Timebase Event Schedule
- * Report
- * STMF
- * PMPP

NTCIP Joint Committee Recommended Standard – 1997, NTCIP – DMS Object Definitions:

- * DMS Sign Configuration
- * Font Configuration
- * Multi Configuration
- * Default Message Control
- * Pixel Service Control
- * Illumination/Brightness Control
- * Scheduling
- * Auxiliary I/O
- * Sign Status
- * Pixel Error Status
- * Fan Error Status

Software shall also implement the following optional objects as defined in NEMA TS 3.4 1996, Global Object Definitions, and the NTCIP Joint Standards Committee Recommended Standard for Object Definitions for Dynamic Message signs dated March 1997 or otherwise approved by the Engineer.

- * dmsSWReset

- * dmsMessage-Time-Remaining
- * dmsMemoryMgmt
- * dmsShortPowerRecoveryMessage
- * dmsLongPowerRecoveryMessage
- * dmsShortPowerLossTime
- * dmsResetMessage
- * dmsCommunicationsLossMessage
- * dmsTimeCommLoss
- * dmsPowerLossMessage
- * dmsEndDurationMessage
- * dmsMulti-Other-Error-Description
- * dmsIllumLightOutputStatus
- * watchdog-Failure-Count
- * dmsStat-Door-Open
- * fanFailures
- * fanTest-Activation
- * lineVolts

All objects required by these specifications shall support all values within its standardized range. The standardized range is defined by a size, range, or enumerated listing indicated in the object SYNTAX field and/or through descriptive text in the object's description field of the relevant standard.

The following provides the current listing of known variances for DMS projects.

Object	Minimum Project Requirements
TS 3.4-1996	
Max Time Base Schedule Entries	7
Max Day Plans	7
Max Day Plan Events	7
Max Event Log Configurations	50
Event Configuration Mode	2, 3, and 4
Max Event Log Size	200
Max Event Classes	7
Max Group Address	1

Object	Minimum Project Requirements
TS 3.6 Pending -1997	
Number Fonts	2
Max Font Characters	255
Default Background Color	0
Default Background Color	2, 7, 8, or 9
Default Justification Line	2, 3, 4

Default Justification Page	2, 3, 4
DMS Number of Permanent Message	0
DMS Maximum Dynamic Message	0
DMS Maximum Volatile Message	21
Volatile Memory	5 KB
DMS Control Code	2, 4, and 5
Number Action Table Entries	15

The software shall implement the following tags (opening and closing where defined) of MULTI as defined in the NTCIP Joint Standards Committee Recommended Standard for Object Definitions for Dynamic Message Signs dated April 1997 or as approved by the Engineer.

- * Flash
- * Font
- * Justification Line
- * Justification Page
- * Moving Text
- * New Line
- * New Page
- * Page Time
- * Scrolling

Software shall be supplied with full documentation, including 3.5” floppy disk(s) and a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN. 1) format:

- * The relevant version of each official standard MIB Module referenced by the device functionality.
- * If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX field of the associate OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension “.man”.
- * A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- * A MIB containing any other objects supported by the device.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Florida Department of Transportation for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

9802-4.2 Local Sign Controller

9802-4.2.1 General

The local sign controller shall be a digital solid-state device mounted inside the sign housing.

The local sign controller shall consist, as a minimum, of the following:

- * Local control panel status indicators
- * Central processing unit (CPU) module
- * Memory module, including DRAM and PROM
- * Input/output circuits

The local control panel status shall include the following:

- * Power on/off
- * Master system controller communication status
- * Laptop maintenance computer communication status
- * Communication status with other electronic devices in the walk-in housing
- * Sign display power supply status
- * Pixel error status
- * Local controller address

The CPU of the local sign controller shall be equivalent to or more advanced than the Pentium microprocessor by the Intel Inc.

The local sign controller shall be programmed to receive sign control commands from the master system controller or a maintenance laptop computer, transmit responses as requested to the master controller or a maintenance laptop computer, and control the sign operation and message displays.

The local sign controller shall communicate with the master system controller through wired or wireless medium. The transmission speed between the local sign controller and the master system controller shall be no less than 36.6 kilobits per second (kbps).

Connections from the local sign controller to display modules shall be made through an electronic control cabinet via industry standard, keyed type connectors with a retaining mechanism.

9802-4.2.2 Display System Accessories

The sign shall be equipped, as a minimum, with the following accessories:

- * Modem or other communication equipment

- * Power supplies
- * A electronic control cabinet, with a flat top or a shelf for the operation of a maintenance laptop computer
- * An RS-232 cable, a minimum of 4 feet long to connect a maintenance laptop computer to the electronic control cabinet
- * Un-interruptible power supply
- * Transient voltage surge suppressors (TVSS)

All the display system accessories shall be mounted inside the walk-in housing

9802-4.2.3 Electronic Control Cabinet

The electronic control cabinet shall be made of 2.03 millimeters (0.080 inch) aluminum and shall have a double door with two quarter-turn latches.

The electronic control cabinet shall contain the following assemblies:

- * Display system interface circuits, consisting of data bus drivers and line address decoders, for the local sign controller and the display modules
- * Local/remote control switch and LED indicator
- * RS-232 plug-in connection for a maintenance laptop computer

The electronic control cabinet sub-assemblies shall be designed for continuous operation over an ambient temperature range of -34°C to $+74^{\circ}\text{C}$ (-30°F to $+165^{\circ}\text{F}$, NEMA defined range) without requiring fans or heaters.

9802-4.2.4 Ground Control Cabinet

The ground control box with a fold down shelf shall be mounted typically near the sign support structure pole and within direct sight of the sign face. The shelf shall have a minimum of 25 centimeters by 25 centimeters (10" by 10") work area and level when folded down. The shelf shall be used as a table for the laptop computer and shall be capable of sustaining a 9 kilograms (20 pounds) load.

The ground control cabinet shall comply with Section 676 of the FDOT Minimum Specifications.

The ground control cabinet shall contain the following assemblies:

- * Power-on indicator
- * Waterproof local/remote switch and LED indicator
- * Sign to ground voice communication RJ-11 jack
- * RS-232 connection for the portable laptop computer
- * RS-232 cable, a minimum of 4 feet long to connect the laptop computer
- * RJ-11 jack for connecting a dial-up phone line
- * GFI protected duplex outlet

Cables connecting the sign and the ground control box shall be provided for the operation of the sign.

A voice communication circuit from the sign to the ground control box shall be provided.

9802-4.2.5 Local Sign Controller Communication Interface.

The local sign controller shall include two separate EIA RS-232D serial interfaces for communication with the master system controller and the laptop computer.

One EIA RS-232D serial interface shall drive the communication devices for full duplex communication with the master system controller. Switching between local and remote operation shall not require local sign controller software or hardware modification.

9802-4.2.6. Local Sign Controller Functions

The local sign controller shall be controlled from the master system controller or a maintenance laptop computer, which shall specify the appropriate display. The local sign controller and its software shall perform the following functions:

- * Display messages
- * Report errors and failures
- * Monitor the message displayed and the status of the sign

The messages to be displayed shall include the following:

- * Static messages
- * Flashing messages
- * Alternating messages
- * Double brush stroke messages

It shall be possible to separately vary the flashing and alternating frequency. The flashing frequency shall vary between 0.5 and 5 seconds in 0.1-second increments. The alternating frequency shall vary between 0.5 and 5 seconds in 0.1-second increments. It shall be possible to flash any character or a set of characters in static or alternating messages. In the case of alternating message, the flashing period shall be a sub-multiple of the alternating on time it is associated with.

The errors and failures to be reported shall include the following:

- * Data transmission error
- * Receipt of invalid data
- * Communications failure recovery
- * AC power failure
- * Power recovery

- * Pixel status
- * Fan status
- * Temperature status
- * Power supply status

The local sign controller shall transmit a return message to the master system controller whenever the local sign controller receives a valid request for status. The return message shall contain the following:

- * Address of the local sign controller
- * Actual message visibly displayed on the sign on an individual pixel basis
- * Current sign illumination level
- * Local control panel switch position (master or local)
- * Error and failure reports
- * Temperature readings
- * Power supply voltage levels
- * Origin of display message transmission (laptop, manual, master, etc)
- * Un-interruptible power supply status

9802-4.3 Master System Controller

9802-4.3.1 Hardware Requirements

The master system controller shall meet the following minimum specifications:

- * One CPU, equivalent to or more advanced than the Pentium microprocessor by Intel and with a clock frequency no less than 233 MHz.
- * One motherboard with at least four 32-bit, two 16-bit and two 8-bit expansion slots and in compliance with non-proprietary industry standards.
- * A set of dynamic RAM, at least sixty-four megabytes (MB).
- * One CD-drive, with a maximum transfer rate of no less than 2 Mbps.
- * One 3.5" format, 1.44 MB, high-density floppy drive.
- * One half-height hard drive with at least 4 gigabytes (GB) in capacity and an average access time no more than 12 ms.
- * Eight EIA RS-232D asynchronous communication ports, forming eight channels for external communication with the signs, laptop computer and remote terminals.
- * One parallel port for communications with a printer.
- * Two non-expanded serial ports for communications with serial peripherals.
- * One PS/2 style mouse port.
- * One 32-bit video graphics adapter with at least 4 MB onboard Video RAM (VRAM), capable of resolutions up to 1280 by 1024 with at least 256 colors at 1280 by 1024 resolution, and with a refresh rate at least 72 Hz.
- * One 17-inch monitor with a flicker-free non-glare display and a tilt/swivel base, non-interlaced, Super VGA (SVGA), flat-screen, color, low-emission,

capable of resolutions up to 1280 by 1024 with a maximum 0.28 millimeter dot pitch, capable of accepting a refresh rate of at least 72 Hz.

- * An internal back-up unit, with sufficient capacity to back-up the entire hard drive.

- * One two-button mouse.

- * One plain-paper Laser printer, with a minimum resolution of 600 by 600 dpi, a minimum printing speed of eight pages per minutes (ppm), at least 5 MB memory, a minimum of 13 scaleable typefaces and 14 bitmapped fonts, support for third-party typeface-scaling solutions, noise level no more than 47 dB, capable of accepting both 8.5" by 11" and 8.5" by 14" print media from separate paper trays, capable of manual and automatic feed of cut paper, capable of Post Script and Printer Control Language-5 printing.

All devices shall be tested and approved by Underwriter's Laboratories.

9802-4.3.2 Software Requirements

The software of the master system controller shall be built for true 32-bit or more advanced applications.

Assembly language, if used for speed, may be used for drivers and/or I/O management.

The software shall be designed to be user-friendly and multi-user, multi-tasking, and networking capable. The software shall have full mouse support and utilize window-driven color screens.

Automatic logging to the printer, of activities or events, shall be user selectable.

The software shall be capable of controlling a minimum of 64 dynamic message signs. The master system controller shall be capable of controlling at least eight dynamic message signs per channel. All signs shall be referenced by 19 character minimum text names. Sign numbers or cryptic abbreviations will not be allowed.

Communication with the signs shall be asynchronous through the EIA RS-232D ports.

Communications data rate shall be user selectable.

The master system controller software shall be capable of driving signs of various messages up to four lines of characters each, with a maximum of 30 characters per line.

The master system controller software shall check each message entered against the functionality of the sign. If the message size exceeds the limit for the sign, the master system controller shall not accept the message for storage or display. An error message shall be displayed on the master system controller CRT and logged in the log file for permanent record. If the operator has font access privileges, the software shall offer the option of compressed fonts or reduced character spacing before canceling the request and recording an error.

The master system controller software shall poll each connected sign for status retrieval at user specified time intervals.

Signs that fail the normal poll shall be re-pollled, but the rest of the normal polling shall occur first. If a sign should fail to properly respond to a poll, it shall be added to a re-poll list. After the computer has finished polling all the signs, the signs on the re-poll list shall be polled again. If this re-poll is successful the sign shall be removed from the re-pollled list. If the re-poll is unsuccessful it will be tried once more before being removed from the list.

If a poll fails, the sign status shall be flagged and displayed on the master system controller CRT.

Polling and time of day commands shall be done in a manner that does not interfere with the operators' use of the system.

The master system controller software shall poll the local sign controllers for the status of the LED power supply voltages. When a low voltage message is received, an error message shall be displayed on the master system controller CRT and logged in the log file for permanent record.

The master system controller software shall include a function to view the status and current display of all the signs as retrieved at the last polling.

The master system controller software shall include a pixel test to view the operational status of each pixel and display the status as a function of the pixel's location for each individual sign. On the master system controller CRT, the operational pixel status shall be displayed in a graphical, pixelated, "WYSIWYG" format of the sign face showing each and every pixel and its associated status by showing each pixel state in a different color. The pixel test shall be initiated once a day and on command. A list of defective pixels shall be logged in the log file for permanent record and printed on command, listing pixel status, sign number, module number, column number and pixel number.

The master system controller software shall include a function to view the operational status of the fans and display each individual fan number and the corresponding fan status for each sign in the system. A fan test shall be initiated

on command and once a day. Failure of a sign fan shall generate an error message to be displayed on the master system controller CRT and logged in the log file for permanent record.

The master system controller software shall poll the local sign controllers for the temperature readings from all the temperature sensors in each individual sign. A temperature reading greater than a programmable level shall cause a blanking message to be sent to the sign, an error message to be displayed on the master system controller CRT and logged in the log file for permanent record.

The master system controller software shall poll the local sign controller for errors and failures, including:

- * Data transmission error
- * Communications failure recovery
- * Power recovery
- * Pixel status
- * Fan status
- * Temperature status
- * Power supply status

The master system controller software shall poll the local sign controller for the following information:

- * Actual message that is visibly displayed on the sign on an individual pixel basis
- * Current sign illumination level
- * Local Control Panel switch position (master or local)
- * Error and failure reports
- * Temperature readings
- * Power supply voltage levels
- * Un-interruptible power supply status

The master system controller shall receive calls from all local sign controllers for any of the following conditions at each sign:

- * AC power failure
- * AC power recovery

Any malfunction of a connected sign shall be recorded in the log file and a printout made.

The master system controller software shall be easily programmable to support any type of printer.

The master system controller software shall permit access by a minimum of 16 users. Each user shall be identified by a name, a password, and access privilege.

To gain access to the system, each user shall enter his/her name and password. Each log-in shall be recorded by name in the log file.

Access privileges shall be fully programmable by levels for each user and shall entitle the user to access only those functions which the user is cleared to access.

Each event, including log on attempts by non-authorized users, shall be recorded in a log file. In addition, if a printer is connected, the event shall be printed. The record shall include: the event number, date/time, sign name/user name, and event description.

The master system controller software shall automatically start a new log file at the beginning of each month. The previous log files shall automatically be saved on hard disk.

The master system controller software shall display and print any log file on the system sorted by users login, sign event, date/time, sign name or any combination of the above.

The master system controller shall create, modify and store sign libraries consisting of 640 messages on hard disk. All messages shall be stored by 12 character minimum text names. Message numbers or cryptic abbreviations will no be allowed.

Messages shall be logically grouped into libraries, allowing the software to control signs of different sizes and types. The master system controller shall be capable of assigning messages to multiple libraries to minimize program set-up time and repetitive data entry.

The master system controller shall show all messages in a graphical, pixelated, "WYSIWYG" format of what will actually be displayed on the sign face before a message is manually downloaded to the local sign controller. New messages and editing of messages shall also be performed in this graphical "WYSIWYG" format.

Master system controller software shall include a display window that accurately reflects the message, in graphical pixelated "WYSIWYG" format, as it is visibly displayed on the sign, including different colors for various pixel status. This graphical, pixelated, "WYSIWYG" format shall also include flashing and alternating displays.

The master system controller shall normally display single stroke (5 by 7) characters with double column spacing between characters on each sign. The master system controller shall also be able to display compressed (4 by 7), expanded (6 by 7) or double-stroke (7 by 7) character fonts or change the default spacing between characters on each sign. The spacing options shall be one, two or three pixel columns. Each font shall be fully customizable, and the master system controller shall be capable of downloading any modifications to the local sign controller at any time without any software or hardware modifications.

The master system controller shall be capable of displaying a different font and character spacing on each line of a sign.

The master system controller shall be capable of displaying a self-updating time, temperature and/or date display on the signs.

The master system controller software shall include a window which can modify any character of any font by using the mouse to turn on and off pixels of a graphical, pixelated, "WYSIWYG" character. The master system controller shall then download the revised font to a local sign controller.

The master system controller software shall include a window that shows all characters of various fonts in a graphical pixelated "WYSIWYG" format.

The master system controller shall have time of day schedules for any or all signs in the system.

The time of day mode shall have both a weekly and yearly schedule. In the weekly schedule, the day of week and time of day shall be entered. In the yearly schedule, the month, day, year and time of day shall be entered.

More than one time of day file may be run at a time. The operator shall ensure that the time of day files will not adversely interact.

The time of day file may be edited while being used. The new edits will take effect only after closing the edit session.

The master system controller shall create or modify 32 scenarios. A scenario shall consist of display definitions attached to signs. The displays shall be started on their respective signs either manually from the keyboard or as part of the time of day schedule. The display definitions may include messages, blanks, static, alternating, or flashing messages.

More than one scenario may be run at a time. The operator shall ensure that the scenarios will not adversely interact.

The master system controller software shall provide a function to automatically change the time on the master system controller and in each local sign controller due to changes for daylight savings time. The software shall then automatically advance the clock by one hour and set back the clock by one hour when the exact time to start and end daylight savings time is reached, respectively. The function shall also adjust automatically for leap years.

The master system controller software shall be Year 2000 compliant.

The master system controller software shall include a window to easily customize the brightness table of any local sign controller and download this new table into the non-volatile memory of the local sign controller.

The master system controller software shall allow a remote terminal to communicate with the DMS system via the remote access feature of the operating system. Communication with the master system controller shall be through dedicated or dial-up lines.

Remote log-ins shall be recorded in the log as "Remote log-in" as distinguished from a login at the server's console that shall be recorded as "Log-in". The user name shall accompany both types of log-ins. Clear sign commands shall be considered an event and therefore shall be logged. When a custom message is down loaded to a sign the text of the custom message shall be logged.

The master system controller software shall check each message entered for spelling errors. Any misspelled words shall be prompted to the attention of the user for editing and confirmation. In addition to spelling, the software shall check the message against an approved/disapproved words list. The operator shall be notified of disapproved words found and the disapproved message shall be recorded in the log. Messages containing disapproved words shall not be displayed on the signs.

The master system controller software shall automatically log off any operator after a user-specified time of keyboard inactivity.

Each function of the master system controller shall have a contact sensitive help screen.

To avoid burning the phosphor screen, the CRT shall be automatically blanked after a user-defined interval of keyboard inactivity. Any keyboard activity shall restore the screen.

The master system controller software shall be capable of controlling flashing beacons.

The master system controller shall be able to utilize any RS-232 port for any function, including remote terminal communications, and shall support simultaneous communication with at least three remote terminals on dial-up and/or dedicated lines.

9802-4.3.3 Message Display Time

For each message, the master system controller shall be capable of defining either a display time in hours and minutes (maximum 99 hours and 59 minutes) or an unlimited display time.

The master system controller shall be capable of displaying static, flashing, or alternating messages on a sign. It shall be possible to separately vary the flashing and alternating frequencies.

The master system controller shall be capable of adjusting the timing of a flashing message as follows:

- * Message time on from 0.5 to 5.0 seconds in 0.1-second increments.
- * Message time off from 0.5 to 5.0 seconds in 0.1-second increments.

It shall be possible to flash any character or a set of characters in a message.

The master system controller shall be capable of adjusting the timing of an alternating message as follows:

- * Primary message time on from 0.5 to 5.0 seconds in 0.1-second increments.
- * Primary message time off from 0 to 5.0 seconds in 0.1-second increments.
- * Alternate message time on from 0.5 to 5.0 seconds in 0.1-second increments.
- * Alternate message time off from 0 to 5.0 seconds in 0.1-second increments.

It shall be possible to flash any character or set of characters in an alternating message at the adjustable frequencies listed above for flashing messages. In this case the flashing period shall be a sub-multiple of the alternating on time it is associated with.

9802-4.4 Laptop Computer for Maintenance and Remote Access

The laptop computer shall provide on-site processing of all commands that a local sign controller has been programmed for. The laptop computer shall have the capability of functioning as both a remote terminal and a maintenance device. The following minimum requirements shall apply to the laptop computer:

9802-4.4.1 Hardware Requirements

A laptop computer shall be provided for local control or maintenance in the event of communication link failure of the master system controller and for remote operation.

The laptop computer shall be furnished with all necessary batteries, cabling, hardware, software and accessories required for maintenance and diagnostics, as well as minimum remote terminal operations.

The laptop computer shall not weigh more than 4.5 kilograms (10 pounds) including the battery, cable and modem, and shall be no greater than 2950 cubic centimeters (180 cubic inches) in volume. It shall be equipped with the following:

- * One CPU, equivalent to or more advanced than the Pentium microprocessor by Intel and with a clock frequency no less than 233 MHz.
- * An SVGA active matrix color display.
- * A set of RAM, at least 16 MB.
- * One hard disk drive, at least 1.0 GB in capacity.
- * One 3.5", 1.44 MB floppy disk drive.
- * One CD-drive, with a maximum transfer rate of no less than 2 Mbps.
- * One internal modem, at least 33.6 kbps in speed.
- * Two RS-232C serial ports with DB25 or DB9 connectors.
- * One parallel port with DB25 connector.

The laptop computer shall have built-in provisions for running on 120 V AC from a standard duplex outlet. The laptop computer shall run on a Nickel Hydride battery for a minimum of 5 hours in power saving mode and 2.5 hours on full power. A suspend/resume button and function shall be fully supported. A battery and a charger shall be included. A 12 V DC automobile adapter for plugging into a cigarette lighter to run and simultaneously charge the laptop shall be provided.

9802-4.4.2 Software Requirements

The laptop computer shall provide the following capabilities as a minimum:

- * Sign startup.
- * On-site maintenance package, including complete diagnostic of the sign and with screens and commands identical to the master system controller software.
- * Display any message stored in the PROM of the local sign controller.
- * Create a new message to display on the sign.
- * Start a "test pattern" display to check and verify each individual LED string in the sign.
- * Create a non-volatile activity log, for later transfer to the master system controller, in order to maintain a complete historical record if the master system controller is unable to do so.
- * Dial-in to the master system controller and provide remote access to all master system controller functions via the remote access feature of the operating system.

9802-5 Qualification for the DMS Manufacturer

9802-5.1 Pre-Qualification

A vendor who intends to bid for a DMS contract shall undergo the Design Data Review and DMS Prototype Demonstration/Testing in Tallahassee, FL, for pre-qualification.

9802-5.1.1 Design Data Review

The vendor shall conduct a brief (2 to 4 hours) system design review presentation, to be held at TERL, or another Department-approved site. The system design review presentation shall be presented to Department staff, TERL staff and/or any other involved persons.

The vendor shall submit to the Department a complete set of drawings, specifications and other design data for review. Comments and/or approval of the information will be provided to the vendor within 60 calendar days after receipt.

9802-5.1.2 DMS Prototype Demonstration/Testing

The vendor shall submit to the TERL a DMS prototype assembly consisting of at least three display modules and necessary software/hardware, to demonstrate the feasibility of the system design. The DMS prototype assembly will then be tested at TERL, or another Department-approved site. Test results will be furnished to the vendor within 60 calendar days after the demonstration.

9802-5.1.3 DMS Module Certification

The display module assemblies as submitted for evaluation will be certified and placed on the Department's Approved Product's List (APL). The module shall have a model configuration number assigned and shall be the only type of module that may be used in the construction of DMS assembly for use in the state of Florida. Any model or redesign of the module will require notification to the Department and evaluation and re-certification may be required.

9802-5.2 References

A pre-qualified DMS system manufacturer chosen by a contractor as a supplier shall submit to the Department three references. These references are preferred to be other State Departments of Transportation, successfully operating a multi-unit, multi-lane State or Interstate Highway, permanently-mounted, overhead dynamic message sign system supplied by the manufacturer under the current corporate name, for a period of no less than **five years**. Reference data shall include current name and address of organization, and the current name and telephone number of an individual from the organization who can be contacted to verify system operation, as well as the date of system installation. This information shall be provided prior to the bidding of the contract. Failure to furnish the above references will be sufficient reason for rejection of the contractor's bid.

9802-6 Test and Acceptance Requirements

The equipment covered by this Specification shall be subjected to following tests to determine conformance with all requirements of these specifications. The DMS vendor shall arrange for and conduct all tests in accordance with the testing requirements stated herein.

The result of each test shall be compared with the requirements specified herein. Failure to conform to the requirements of any test shall be counted as a defect, and the equipment shall be subject to rejection by the Project Engineer. Rejected equipment may be offered again for a re-test, provided that all areas in non-compliance have been corrected and re-tested by the DMS vendor and evidence thereof submitted to the Project Engineer.

The following tests shall be conducted after all design and drawing documentation has been reviewed and approved by the Project Engineer.

9802-6.1 Independent Environmental Lab Tests

The equipment shall meet all the environmental requirements outlined in Section 615 of the FDOT Standard Specification. The test report certified by an independent laboratory should be provided.

9802-6.2 System Design Tests

The DMS vendor shall be responsible for conducting the System Design Tests on all units. These tests shall be done at a vendor-chosen site. All tests shall be conducted in accordance with the pre-approved test procedures.

This test shall consist of the following:

- * Testing of display modules.
- * Testing of local sign controllers.
- * Testing of the master system controller.
- * Testing of a laptop computer.
- * Testing of the communications technology to be used.

The procedure for this test shall include the following:

- * Examination of the product -
Each piece of equipment shall be examined carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of these specifications.
- * Continuity tests -
The wiring shall be checked to determine conformance with the requirements of these specifications.

* Operational tests -

Each piece of equipment shall be operated long enough to permit equipment temperature stabilization, and to check and record an adequate number of performance characteristics to ensure compliance with the requirements of these specifications.

* Test failure -

If any unit fails to pass its test, the unit shall be corrected or another unit substituted in its place and the test successfully repeated. If a unit has been modified as a result of a test failure, a report shall be prepared and delivered to Project Engineer. The report shall describe the nature of the failure and the corrective action taken.

In addition, the DMS vendor shall provide the Project Engineer with a site license allowing the Project Engineer to use the terminal software and remote software on as many laptop computers as required for testing.

9802-6.3 Site- System Acceptance Tests

At least thirty 30 working days' notice shall be given prior to all tests to permit the Project Engineer or his representative to observe each test. All test results shall be documented by the DMS vendor for submission to the Project Engineer for approval and acceptance.

The DMS vendor shall conduct a pre-approved stand-alone test of the equipment installation at the field site. The test shall, as a minimum, exercise all stand-alone (non-system) functional operations of the field equipment with all of the equipment installed as per the plans. If any unit fails to pass its stand-alone test, the unit shall be corrected or another unit substituted in its place and the test successfully repeated.

The DMS vendor shall also conduct a pre-approved full-operation system test on the field equipment with the central equipment. The tests shall, as a minimum, exercise all remote control functions and display the return status codes from the controller for a minimum of 72 hours.

If any Site System Acceptance Tests fail because of any components in the subsystem, the particular components shall be corrected or substituted with other components and the tests shall be repeated. If a component has been modified as result of the system test failure, a report shall be prepared and delivered to the Project Engineer prior to the re-test. The report shall describe the nature of failure and the corrective action taken.

If a failure pattern develops, the Project Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or extension of the contract period.

9802-6.4 90-Day Test Period

After the installation of the DMS system is completed and the successful completion of the Site System Acceptance Tests, the DMS vendor shall conduct a 90-day continuous full-operating test. The procedures for the 90-day test shall be pre-approved by the Project Engineer and shall consist primarily of exercising all control, monitor and communications functions of the field equipment by the master equipment.

The 90-day test period shall commence on the first day after the successful completion of the approved 72-hour continuous full operating test period. Upon satisfactory completion of the 90-day full-operation test period, a notification of final acceptance will be issued by the Project Engineer.

9802-6.5 Test Procedures

The DMS vendor shall provide three (4) copies of the **System Design Test** and the **Site-System Acceptance Tests** procedures. These test procedures shall be submitted to the Project Engineer at least 60 days prior to the day the tests are to begin. The test procedures shall include the sequence in which the tests will be conducted.

The DMS vendor shall also furnish the Project Engineer with two (2) copies of all results/data taken during the above tests. All test results shall be approved by an authorized representative (company official) of the equipment manufacturer.

The DMS vendor shall be responsible for providing all test fixtures and test instruments for all tests.

9802-7 Submittal of Information

The Contractor shall submit the information described in this section to the Project Engineer within 45 days of award of the contract.

The Engineer will review the submitted information and provide comments and approval of the information to the Contractor within 45 calendar days after receipt.

Review of the submittal information by the Engineer shall not relieve the Contractor of contractors obligation to furnish and install the work in accordance with the contract documents. No time extensions will be granted to the Contractor as a result of the need to resubmit various items for review.

Shop drawings shall be submitted in accordance with the Standard Specifications and as specified in these special provisions.

Prior to purchase or fabrication of any equipment or material for use on this project, the Contractor shall submit appropriate catalog cut sheets and specifications for all standard,

off-the-shelf, items and shall submit shop drawings and other necessary data for all non-catalog or custom-made items.

The Contractor shall furnish five sets of submittal data directly to the Engineer. Two copies of this information, with appropriate notations, will be returned to the Contractor after the review.

If reprinted literature, such as catalog cut sheets, are used to satisfy the submittal data requirements, there shall be no statements on the literature which conflict with the requirements of the contract documents. Any such statements shall be crossed off and initialed by the Contractor. Explanation of how specifications shall be met pertaining to items changed from the literature shall be documented in writing and included with the submittal information.

All items shall be submitted together.

Each submittal shall contain sufficient information and details to permit full evaluation of each item and its interrelationship with other items. Submittals which, in the judgment of the Engineer, are insufficient to permit proper evaluation, will not be reviewed. The functional and technical interrelationships among the various items shall be carefully addressed.

The Contractor shall prepare and submit detailed shop drawings for each sign type indicating of materials proposed for each component of each sign, parts lists, assembly techniques, layout of all display elements, and wiring schematics. The shop drawings shall also illustrate in detail how the Contractor proposes to mount and connect the DMS sign case to the sign support structure (truss). The DMS sign case shall include any support mechanism necessary for the installation of the DMS sign case that is not included in the truss. These drawings shall be submitted to the Engineer for review and approval prior to fabrication of any sign. Parts lists shall include circuit and board designation, part type and class, power rating, component manufacturer, and mechanical part manufacturer.

As part of the submittals for the DMS assembly, the Contractor shall submit an engineering drawing illustrating the DMS character set including 26 upper case letters, 10 numerals, a dash, a plus sign (+) and slash. The Contractor shall also submit complete technical information, shop drawings, photographs, graphs, circuit diagrams, instruction manuals, security provisions, and any other necessary documents to fully describe the DMS assembly and associated equipment.

9802-8 As-built Documentation

The Contractor shall provide to the Engineer the following documentation of the complete installed equipment prior to testing. Sufficient documentation shall be provided to reflect "as-built" conditions and to facilitate operation, maintenance, modification, and expansion of the system or any of its individual components. Manufacturer supplied

documentation which covers the intent of this requirement may be used, subject to the approval of the Engineer.

9802-8-1 Operator's Manuals.

A manual containing a general description and detailed operating and installation instructions shall be provided for each different type or model of equipment. Five copies of the manual shall be provided to the Engineer for each model of equipment. The manual shall include the following information:

- * A general description of the equipment including all information necessary to describe the basic use or function of the system components. This shall include a general block diagram presentation of the equipment. Where auxiliary equipment is required, tabular charts shall be included to list such equipment. These charts shall include the nomenclature physical and electrical characteristics, and functions of the auxiliary equipment unless such information is contained elsewhere in an associated manual. In the latter case, a reference shall be made to the location of the information pertaining to the auxiliary equipment.
- * The theory of operation of the system components in a clear, concise manner supported by simplified schematics, logic, data flow diagrams, one-function diagrams, etc. Timing and waveform diagrams, and voltage levels shall be shown as required. A logical development shall be used starting with a system block level and proceeding to a circuit analysis. Circuit analysis shall be detailed whenever circuits are not normally found in standard textbooks. The application of new theoretical concepts shall be fully described. Where the design allows operation in a number of different modes, an operational description of each mode shall be included.
- * In simple, clear language, the routine of operation, from necessary preparations for placing the equipment into operation, to securing the equipment after operation. This section shall contain appropriate illustrations, with the sequence of operations presented in tabular form wherever feasible. This section shall also contain a list of applicable test instruments, aids and tools required in the performance of necessary measurements and technique of each system component. In addition, set-up test, and calibration procedures shall be described.
- * The manufacturer's recommended procedures and checks necessary for preventive maintenance. This shall be specified for pre-operation, weekly, monthly, quarterly, semi-annual, annual, and "as required" checks as necessary to assure reliable equipment operation. Specification, including tolerances, for all electrical, mechanical, and other applicable measurement, adjustments, or both, shall be listed.
- * Data necessary for isolation and repair of failures or malfunctions, assuming the maintenance technicians to be capable of analytical reasoning using the information provided in above Article, 97035.05, Paragraph A (2). Accuracy, limits, and

tolerances for all electrical, physical or other applicable measurements shall be described. General instructions shall be included for disassembly, overhaul, and re-assembly, including shop specifications or performance requirements.

- * Detailed instructions shall be given only where failure to follow special procedures would result in damage to the equipment, improper operation, danger to operating or maintenance personnel, consumption of excessive person hours, etc. Such instructions and specifications shall be included only for such maintenance as may be accomplished by specialized technicians and engineers in a modern electromechanical shop. The instructions shall describe special test setup, component fabrication, use of special tools, jibs, and test equipment.
- * A detailed physical description of size, weight, special mounting requirements, electrical connections, and all other pertinent information necessary for proper installation and use of the equipment shall be provided.
- * The parts list shall contain all information required to describe the characteristics of the individual parts, as required for identification. It shall include a list of all equipment within a group and list of all assemblies, subassemblies, and replacement parts of units. The tabular arrangement shall be in alphanumerical order of the schematic reference symbols and shall give the associated description, manufacturer's name, and part number. A table of contents or some other convenient means, e.g., appropriate grouping, shall be provided for the purpose of identifying major components, assemblies, etc.
- * Schematic diagrams shall be complete and accurate as required to supplement the text material and to allow the books to be a self-contained technical information source. Maximum size of these diagrams should be limited to allow their use in close proximity of the equipment, in the classroom, etc., part reference symbols, test voltages, waveforms, and other aids to understanding of the circuit's function shall be included on the diagrams. Test voltages, waveforms, and other aids to understanding of the circuit's function may be shown on either the simplified schematics and other drawings (as required in the above sections) on theory of operation or maintenance or on the schematic diagrams required for this section. The overall scope of information shall not be less, however, than that stated for the schematic diagrams.

9802-8.2 Software Manuals

The DMS vendor shall provide manuals and data for the computer software system and components thereof. These shall include the following:

- * Computer programmer's manuals and computer user's manuals (5 copies of each). Include manuals for any CPU language used by the Contractor for this project. Include instructions for performing a backup of all software and message libraries.

- * Two (2) original copies of the computer's operating system manual and compiler and assembly language manuals and an instruction manual for translating source to object code.
- * Manufacturer's documentation (including schematics) for all plug in circuit cards used in the microcomputer chassis.
- * Computer program logic in flowchart forms (5 copies).
- * Narrative descriptions of programs and input/output formats (5 copies).
- * Two (2) copies of source programs, for master and sign controller software, shall be provided on 3-1/2 inch disk(s) or CD-ROM. An unrestricted license for software use by the Department shall be provided to the Engineer.
- * DMS vendor shall provide the communication protocol used between the DMS Master Controller and the DMS sign controller for use by the Department without any restrictions.
- * Documentation quantities required are summarized as follows:

Description	Quantity Required
Equipment Component Manuals	5 (May be used in training program)
Maps, Plans or Drawings	5 copies 1 Stable Base Reproducible Copy
Software Documentation	See Section Above

9802-8.3 Final Documentation

Final documentation shall reflect all field changes and software modifications and shall be provided before installation. Final documentation shall be approved prior to final system acceptance has begun. This documentation shall include drawings of conduit layouts, cable diagrams, wiring lists, cabinet layouts, wiring diagrams and schematics for all elements of the communications system. This shall also include detailed drawings identifying by cable type, color code and function, the routing of all conductors (pairs) in the communications system. Upon completion of the installation, the Contractor shall submit these plans, maps, and/or drawings to reflect an as-built condition, incorporating all changes made during installation, such as in pair identification and routing.

9802-9 Warranty

The equipment and parts furnished for the DMS system shall be new, of the latest model, and fabricated under high quality standards. Equipment and parts furnished for the permanent mount dynamic message sign system shall be warranted by the manufacturer to be free from defects in assembly, fabrication, and materials for a minimum of four years from the date of acceptance. The DMS signs shall be warranted for quality of work for one year from the date of final acceptance. If component manufacture's warranties are for a longer period, they shall apply. Any part or equipment found to be defective during the warranty period shall be replaced free of charge upon the concurrence of the defect by the manufacturer.

9802-10 References

1. "Special Provisions for Permanent Changeable Message Sign (CMS) System (Light Emitting Diode)," Linn County, Iowa, IMX-380-6(201)260--02-57, July 1997
2. "LED Changeable Message Sign System," Special Specification Item 6499, Texas DOT, Nov. 1996
3. "Changeable Message Signs," Special Provision 685S01, Ontario, Ministry of Transportation, March 1997
4. "Freeway Surveillance and Control System Phase I – Changeable Message Signs," Technical Special Provisions, State Project No. 72000-3401 & 78080-3436, FDOT, June 9, 1993
5. "Special Provisions for Variable Message Sign Central Software," Virginia DOT, June 1997