20.3.1 Design Process

In the DMS design process, the designer must follow several steps to ensure successful implementation and proper operational capabilities. Many of these steps, such as power and communication requirements, must be addressed early in the design process.

1. Collect preliminary data required for the proposed dynamic message sign location
2. Determine DMS type
3. Determine corridor placement for DMS implementation
4. Collect site-specific data required for the proposed DMS location
5. Select the DMS site required for design
6. Determine cabinet placement for the DMS
7. Perform underground infrastructure
8. Determine the communications medium used for the proposed location
9. Revisit steps 4 through 8 until final design is complete
10. Begin the process to establish electrical service for the proposed location with the local power company. This should be done early in the design process to establish an acceptable electrical service location.
11. Determine the construction details needed for the proposed design, details that need to be modified, and new details, which need to be created to provide a complete construction plan.
12. Determine the special provisions needed for the proposed design, special provisions that need to be modified, and new special provisions, which need to be created to provide a complete construction plan.
13. Determine the standard specification bid items and procurement items that will need to be included in the estimate and miscellaneous quantities to provide a complete construction plan.

20.3.2 Sign Placement

Using data and information collected during the previous step, site selection is now possible. If possible, signs should be placed so that nearby CCTV cameras can view the DMS message. The following demonstrates how that information is utilized when selecting sites for possible deployment.

20.3.2.1 Alternate Route Diversion Points

In an urban roadway network, DMS should be located in advance of alternate route access points on the network to allow motorists to take action in response to the message on the sign. In an urban setting there are typically many other signs that compete for motorists' attention, and DMS should be placed for maximum visibility and impact. On an arterial roadway segment, the distance may vary based on issues such as speed limit, local factors, and right of way constraints. The designer should review each site individually and utilize proper engineering principles to determine locations.

20.3.2.2 Existing Horizontal Alignment Data

To insure proper viewing of the DMS message sites must be located on tangent roadway sections. The introduction of even minor curves along the roadway can impact visibility. Current DMS technology used limits a pixel's cone of visibility to only a few degrees. Because of this, minor changes in the roadways horizontal alignment may make the message unreadable. The designer should look for sites that are located on tangents and allow a motorist at least 900 to 1000 feet to view the sign while traveling 55 mph or faster. If the motorist is traveling between 30-45 mph, the minimum distance needed should be 500 feet. If no site is available on a desirable tangent section, overhead DMS may be placed on gradual horizontal curves; however, the structure design must be modified to focus the sign to a point on the roadway 900 to 1000 feet upstream of the sign to enhance its legibility.

20.3.2.3 Existing Vertical Alignment Data

Vertical alignment along the roadway also impacts the visibility of the DMS. The cone of visibility (discussed previously) limits the visibility of the DMS in these areas. If there are a limited number of potential locations available, an upward grade is desirable. Ideal site locations on roadway segments are where the grade is 1% or less. DMS should not be placed along grades exceeding 4 percent.

20.3.2.4 Existing Sign and Traffic Control Inventory

DMS should not compete with other existing signs or interfere with traffic control devices. The designer must take inventory of all signs and traffic control along a roadway segment to properly place the DMS. Based on this inventory, existing signs may need to be relocated to accommodate proper DMS placement. On the freeway, the minimum distance between Type I guide signs and a DMS is 800 feet. On arterial streets the distance allowed between Type I signs and a DMS is approximately 400 feet. Since the DMS signs are typically installed in elevated positions care should be taken by the designer to also identify possible conflicts with the DMS blocking other existing traffic control devices. Care should also be taken that existing trees do not block the view within the 800 or 400 feet viewing distance.

20.3.2.5 Location of Power Along Roadway Segment

Locating existing power along a roadway segment helps a designer understand how difficult it might be to power a potential DMS site. It is desirable to locate the cabinet and electrical service as close together as possible. All power service locations will require approval from the utility company prior to installation.

20.3.3 Geometric Considerations

Some of the geometric considerations will require some level of engineering judgment by the designer. In any case, all DMS site locations shall be approved by and coordinated with the STOC ITS Engineer. Placement of equipment for DMS sites involves the controller cabinet, sign structure, and electrical service.

20.3.3.1 DMS Supports/Location

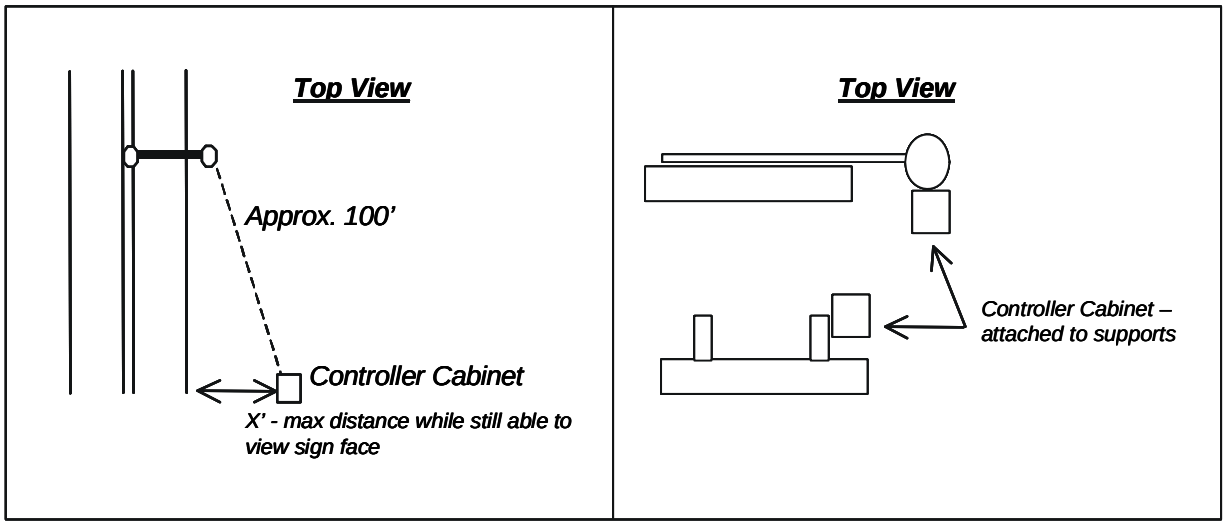
Design the sign bridges and sign structures per the FDM, Standard Specifications, and Structures Manual.

20.3.3.2 DMS Height Requirements

Per the MUTCD, the minimum distance from the roadway to the bottom of a freeway or arterial DMS shall be a minimum of 18 feet (19 feet maximum) above high point of road. Design the sign bridges and sign structures per the FDM, Standard Specifications, and Structures Manual.

20.3.3.3 Cabinet Location

Locating controller cabinets at DMS sites is done differently for freeway and arterial deployments. Due to right of way constraints, arterial DMS controller cabinets are typically located in close proximity to the sign or mounted directly on the support structure. The freeway DMS controller cabinets, however, should be located at a distance of 100 feet from the front of the sign at a location at which an individual can view the sign from the cabinet and provide a safe location outside the clear zone. The 100 feet is a typical deployment distance that is favorable to most DMS manufacturers. Figure 20.3-1 provides graphical representation of controller cabinet locations for various types of DMS deployment.



Freeway DMS Controller Cabinet – Overhead Sign Bridge Structure

Arterial DMS Controller Cabinet Cantilever and Shoulder Mounted

Figure 20.3-1: DMS Controller Cabinet Locations

20.3.3.4 Underground Infrastructure

When the controller cabinet, electrical service and DMS have been placed, the underground conduit infrastructure can be designed. Issues to keep in mind when designing the conduit infrastructure include:

- Pull Box Spacing - Pull boxes should be spaced within 200 feet.
- Terrain - Conduit infrastructure should be designed on relatively flat (4:1 slope or flatter) terrain. For steeper sloped terrain (3:1 or greater) , conduit may be run perpendicular to (i.e., up or down) the slope to locations where the terrain is more suitable for conduit installation.
- Conduit Size - 4-Inch conduit is typically used for detector station raceways. 2-inch conduit must be used when entering electrical service (meter) pedestals.
- Conduit Fill - The size and number of conduits along a run is dependent on percentage of fill as established by the National Electric Code (NEC). For new conduit installation, the percent fill must not exceed 31%. For installation of cable in existing conduit, 40% of the available area may be used.
- Conduit in Concrete Base – Two 4-inch conduits, and one 2-inch conduit or three 2-inch conduits should be placed in the concrete foundation. This will allow one conduit for electrical wire, one conduit for communication wire, and one conduit for other cables needed.

20.3.3.5 Electrical service

The power distribution wires running between the electrical service and the controller cabinet consist of stranded copper single conductors, cross-linked polyethylene (XLP), USE rated. Section 655 of the standard specifications provides guidance on additional requirements. The bid items for Electrical Wire Traffic Signals (gauge #) AWG or Electrical Wire Lighting (gauge #) AWG will meet the requirements. The gauge of conductors must be calculated per the requirements of the National Electrical Code.

Consistent with the design practice recommended in the National Electric Code, the power distribution system should be designed for a maximum of a 3% voltage drop between the electrical service location, which may be a utility connection point or a dedicated circuit in an adjacent installation such as a lighting distribution cabinet, and the DMS or other field cabinet. When calculating the voltage drop, it is important that the ultimate potential power draw is considered. The sum of the size of the circuit breakers within the cabinet should be used as the potential draw. This will mean a 50-Amp power draw should be used as most ITS cabinets come with 2-25-Amp circuit breakers.

Depending on the availability and location of electrical service locations, these requirements may dictate the use of step-down voltage transformers adjacent to field cabinets. Refer to the SDD and specification for use of step-down voltage transformers.

20.3.3.6 Electrical Wire Routing

The conduit system for DMS sites needs to be bonded together, due to the fact that power cables are running within the system. Bonding all metallic components of the system together assures that there will be no difference in voltage potential across two points in that system. In addition, grounded conductor needs to be run with current-carrying cables (such as traffic signal conductors, power distribution wires, etc.), which returns the circuit's current at zero voltage. The bonding/grounding wires in system typically use Electrical Wire Traffic Signals 10 AWG (Item 655.0515) in the State's Standard Specifications. The gauge of grounded conductor must be calculated per the requirements of the National Electric Code.

The pull boxes do not require grounding if the total voltage encountered in the pull box is 50 volts or less. In some Districts, a policy has been made to bond and ground all conduit systems, since equipment is frequently added to various locations in the future. For assistance in bonding and grounding of underground systems, consult the State Electrical Engineer.

20.3.3.7 Cable Routing

Cable routing for dynamic message signs typically involves the connection of communication and power to the controller cabinet from the sign and from the cabinet to the power and communication resources. Communication cable from the cabinet to the DMS is typically proprietary to the DMS manufacturer. Outside of the DMS Communication cable the current standardized cables are utilized. The power distribution wires running between the controller cabinet and the electrical service should be in a separate conduit. Power and communication cables should not be mixed together. In addition, the power and communication cables for the dynamic message sign should also be kept in separate raceways.

20.3.3.8 Safety Considerations

A site must be designed to allow for safe maintenance and operation of the DMS and its controller cabinet. To address safety issues the following questions should be asked:

Does the site allow safe and easy access to the sign for maintenance vehicles?

How exposed will maintenance vehicles and personnel be to live traffic while at the site?

Can personnel access the controller cabinet without having to use the roadway shoulder?

Answering these questions the designer may choose to make additional site modifications. Safety considerations should always be considered in the site's design.