



TRAFFIC AND SAFETY MANUAL

Chapter 2 - Signing

2F –Permanent Changeable Message Signs

Operating Fundamentals

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The fundamental operating statements with regard to responsibilities are based on the premise that there is no Traffic Management Center operating in a given area. If there were operational traffic management centers, some of the responsibilities would be more clearly assigned to personnel in the TMCs. Regardless of whether there is a traffic management center, the signs should be operated within the context of the incident management plan for the area.

Introduction

The operation of CMSs involves six basic considerations presented in logical order:

1. Determine the purpose for using a CMS.
2. Determine which CMS(s) is (are) appropriate to use.
3. Determine what to display on the CMS.
4. Determine how long to display the message (s).
5. Resolve any message signing conflicts that exist.
6. Display and verify CMS message.

Within each of these, several factors and issues need to be addressed. It is important to realize that these factors often change over the duration of an incident or other event. These changes require those responsible to revisit the situation and possibly modify how the CMS is being used.

Determine the Purpose for Using A CMS

CMSs should always be used with a specific purpose or objective in mind. To determine this purpose, those responsible must fully understand six things:

1. What is the problem I am trying to address?
2. What verified information do I have?
3. Who is the audience that I am trying to reach with the CMS message?
4. What type of motorist response is required?
5. Where should the response take place?
6. What degree of response is required?

What Is the Problem I Am Trying to Address?

Those responsible must consider not only the basic type of problem (i.e., crash, work zone lane closure, etc.) that exists, but also the following:

- Location of problem (position within the roadway right-of-way as well as its relation to other freeways and major traffic generators).
- Scope (number and types of agencies that will likely need to be involved, whether police officers will be required to direct traffic at the scene or on a detour, whether a major incident response team will be activated).
- Potential duration of the situation.
- Extent of impacts (number of lanes affected, location where lanes are affected, nearby ramps that are blocked or constrained by the traffic queue, etc.).

What Verified Information Do I Have?

Credibility is very important in CMS operations; therefore, those responsible must determine the information that is available about the:

- Incident,
- Conditions on the primary route, and
- Conditions on the diversion route.

Although it is desirable to design and select messages based on complete and perfect information, situations often occur where those responsible for operating the CMSs have only limited information about a problem (particularly early on in the timeline of an event). Furthermore, the information that is available may be from an unknown or untrained source (e.g., a motorist), or may conflict with other information that has been received. As a result, it must be decided what information can be used, and how it can be best used to operate the CMS.

Verified information is that which is obtained directly via closed circuit television or other visual means, or is provided by approved personnel of selected agencies. Law enforcement officers, emergency response personnel, or transportation agency courtesy patrol personnel are examples of individuals who can generally provide verified information.

Unverified information, on the other hand, is not obtained directly or received from the sources above. Most common examples of unverified information are calls received from motorists about incidents that they have encountered. Unconfirmed commercial radio reports are another source of unverified information.

Only verified information should be used to operate CMSs. Motorists and other sources of unverified information will often provide inaccuracies about locations and effects that, if presented to the public and found to be false, degrade the credibility of the CMS system and the operating agency. *However, unverified information can be useful in identifying information items that may need to be explored further.* For example, calls from one or more motorists that an incident has cleared may be a prompt to check a closed circuit television (CCTV) camera or contact the appropriate enforcement agency to verify that the incident has indeed cleared.

If recommendations are to be made on a CMS about a specific diversion route to use around a problem, information must be available about current conditions on that route. If such information is not available, the CMS should not recommend a specific route. The only exception to this is when the freeway has been completely closed and police officers or traffic control personnel are directing traffic along a designated detour route.

Who Is the Audience for the CMS Message?

A component of establishing an objective for a CMS message is to decide who the audience will be for the message. The audience is the group of motorists that are expected to respond to the message in some manner. In some cases, this may be all of the motorists who pass by the CMS. In other cases, the message is intended for only some of the motorists (e.g., those who are traveling all

the way into downtown). Depending on the situation, it may be necessary to identify the intended audience as part of the CMS message itself. In other situations, the intended audience is implied.

What Type of Motorist Response Is Required?

Messages will be most effective when they encourage some type of response from the motorist, such as to:

- Reduce speed;
- Move out of a blocked or closed lane; or
- Take an alternative route.

Where Should the Response Take Place?

The location where responses are desired will depend on

- Type of response desired,
- Layout of the roadway system,
- Type and severity of problem being addressed, and
- Availability of existing guide signs or those installed by the DOT in response to a major incident.

It is important to realize that the desired motorist response to a particular problem may differ depending on where in the roadway system the motorists are at that particular time. For example, the desired response for a motorist traveling immediately upstream of a full freeway closure might be to follow the designated traffic control devices to leave the freeway, travel along the designated alternative route, and return back to the freeway. For motorists approaching an intersecting freeway farther upstream of the closure, however, the desired response might simply be to not exit onto the closed freeway, and find their own alternative route to their ultimate destination. In general, the more severe the problem and the longer it is expected to last, the farther upstream messages should be displayed on CMSs.

What Degree of Motorist Response is Required?

Traffic conditions and motorist response to the CMS messages must be monitored. Suggested alternative routes must provide improved travel to motorists as compared to remaining on the freeway. The messages on the CMS's should be changed or turned off when conditions on the alternative route(s) are no longer better than the freeway.

Determine Which CMSs Are Appropriate To Use

When signing for a current incident or work zone lane closure, care must be taken to make sure that the CMSs selected will reach the appropriate audience for the message to be displayed.

Proximity of CMSs to Problem

Three simple questions should be asked when determining which CMS should be activated:

- Is the incident close enough to the CMS so that the distance does not exceed the written CMS operations guidelines?
- Is the expected duration of the incident or lane closure longer than the expected travel time from that CMS to the incident or lane closure?
- Are there a significant number of motorists traveling past the CMS who are destined for the incident or lane closure location?

If the answer to any of these questions is “no,” the CMS is not appropriate to activate for that situation. For advance notice of future lane closures and special events, the messages being displayed are typically of an informational nature and so can be displayed on CMSs over a fairly wide area.

Characteristics of the CMS Hardware

The maximum length of CMS message that should be displayed will be dictated by the characteristics of the sign. These include the type of sign (LED, fiberoptic, etc.), the number of lines available, and the number of characters on each line. Each of these characteristics can have an effect on how far away the CMS can be read and, consequently, how much information can be presented to motorists.

In locations where permanent CMS have not been installed or in situations where the amount of information that needs to be presented exceeds the motorists’ processing capabilities from a single sign, it may be necessary to deploy portable CMSs to provide the necessary information to motorists. The time needed to deploy these devices must be considered in determining whether they are appropriate for a given situation. These CMSs should also be deployed far enough away from other CMSs, existing static signing, and complex roadway geometrics such as weaving areas to ensure that motorists are not overloaded with information.

Roadway, Traffic, and Environmental Characteristics in the Vicinity of the CMS

The actual site characteristics in the vicinity of the CMS must be known. These characteristics dictate the amount of information that can be displayed. Among the items of interest are the following:

- The operating speed of traffic on the roadway.
- The presence and design characteristics of any vertical curves affecting sight distance.
- The presence of horizontal curves and obstructions such as trees, bridge abutments, or construction vehicles that constrain sight distance to the CMS around the curve.
- The location of the CMS relative to the position of the sun (for daytime conditions).
- The presence, number, and information on static guide signs in the vicinity.
- Whether or not rain or fog is present to degrade visibility to the sign.

Determine What to Display on the CMS

CMSs are a transportation agency’s direct link to the motoring public. Displaying well-designed messages on CMSs is key to effectively managing traffic and to maintaining credibility with motorists. [Section 2F-4](#), Message Design, is devoted to proper design of CMS messages.

Basic Information Needs

Proper design begins with understanding the basic information needs of motorists. Motorists need several different types of information in order to make their driving decisions. For lane closure incidents and roadwork, these elements include the following:

- The type of problem (incident or road work descriptor).
- Location of the problem.
- The lanes that are affected (closure description).
- Location of the lane closure.
- The effect on travel.
- The audience for the message.

- Proper response or driving action by motorists.
- A reason to follow the recommended driving action.

Unfortunately, motorists are not equipped to perceive, process, and remember a large amount of information at one time. Consequently, decisions must be made about what information is most important, and how to present that information on a CMS in a way that maximizes motorist understanding and encourages them to take appropriate actions.

Diversion Routes

Motorists must not arbitrarily be diverted to other routes. It is important that the suggested diversion route result in a significant saving of time in comparison to remaining on the primary freeway. In addition, it must be a route that contains adequate static guide signs or emergency route trail blazers so that motorists can travel without getting lost. It must be an acceptable pre-established alternative route according to the CMS operations policy or incident management plan. Before a recommended diversion route is displayed on a CMS, it must be determined that the route is acceptable according to policy regarding current traffic capacity restraints and current traffic conditions.

When motorists are advised by the CMS message to divert and take a specific highway or route, it is essential that the destination names and routes used in the message are the same as those displayed on the existing guide signs. Inconsistency between the CMS message and the existing guide signs will lead to motorist confusion and cause some to take incorrect routes. Therefore, if a new message is being composed, it must be done with full knowledge of the wording and route markers on the existing guide signs or emergency route trail blazers.

CMS Operator Message Options

The design of a safe, effective CMS message requires consideration of a number of different factors and the interactions between factors. This design process is complex, and can take a significant amount of time to utilize properly. Fortunately, many situations require a message or group of messages that are identical to those used in past situations or that have been developed in advance for a particular event. In other situations, a CMS message or message group can utilize a general template and modify an item or two prior to display on the CMS(s). Finally, an extremely complicated or unusual situation may necessitate following the complete design process in order to determine the best CMS message to display. Basic considerations under each of these approaches are discussed below.

Selecting a Message From a Message Library

In the simplest case, a CMS operator will be able to select a proper message from an existing message library on the CMS operating system as requested by an authorized person. The District will have a predefined scenario prepared (following the proper message design process) for a given type of problem, location, severity (such as how many and which lanes are blocked or closed), and time of day. If a problem develops that fits the scenario, the CMS operator can simply call up a message from the library and display it on the appropriate sign(s). This approach only requires that all of the information to be displayed on the CMS is correct (which lane or lanes are blocked, the location of the problem, etc.).

Modifying a Message From a Message Library

Another type of CMS message that may be included in message libraries is one that requires some modification by the operator prior to displaying it on a sign. The modification may be needed to display the correct location of a problem to motorists, the lane(s) that are affected, the action that should be taken, etc.

Modified messages present special challenges in CMS operations. They require CMS operators or other authorized persons to make sometimes complex decisions about message elements

that need to be changed, whether a change in overall message format is required (e.g., if the location name is fairly long), the proper term to use for a location, etc. Consequently, the potential for errors to creep into modified messages can increase during periods of high workload. CMS operators need to pay special attention to ensure that they review such messages prior to posting on a CMS.

Creating a New Message

If a message in the library does not properly address the particular situation of interest or cannot be modified to address the situation, a new message must be created. Principles and procedures listed below and addressed in detail in [Section 2F-4](#), Message Design should be followed to formulate the message.

1. Messages should be as brief as possible and no more than two displays should be used for any message cycle.
2. Message length is limited by reading time. A good rule of thumb is that a driver will need at least one second per short word (up to eight characters) not counting prepositions, or two seconds per unit of information to read and recall a well-designed message. A unit of information is a data item that a motorist could use to make a decision. It is typically one to three words.
3. No more than four units of information should be in a CMS message when the operating speeds are 35 mph or more. In addition, no more than three units of information should be displayed on a single message frame. Normally, only one unit of information appears on each line of the CMS. However, a unit of information may be displayed on more than one line. A sign line should not contain more than two units of information.
4. Message formatting is the arrangement of informational units to form a total message. Compatibility must be maintained between words within a line and between message units on the CMS. The information must be arranged in the expected order to allow motorists to easily read and interpret the information and make rational decisions based on that information. The problem, location, effect, attention and action statements are normally shown in that order. If a problem statement is not used the effect statement is shown first.
5. There are several word and phrase meanings to be considered in message design. The word *USE* is selected to indicate a route that will carry the motorist to a destination. The word *TAKE* should be selected to identify the route or ramp that should be used to exit the freeway. The word *FOLLOW* carries the additional connotation that the motorist will be guided by other signs along the way and should not be used when guidance is not available. The word *GO* is not used in CMS messages for route guidance.

The word *ROADWORK* may be used rather than *CONSTRUCTION*, a longer and more complex word that takes longer to read. The word *EXIT* should be used rather than the word *RAMP* when referring to an off ramp. A hyphen may be substituted for the term *THRU* to indicate a set of inclusive days. A space should be inserted on both sides of the hyphen. The term *NITE* may be substituted for the word *NIGHT* if needed for space restraints. The term *FOR 1 WEEK* should not be used because it is too ambiguous. The term *WEEKEND* may be used if needed due to space restraints, but only if the work begins on Saturday morning and ends on Sunday with no Friday or Monday work.

6. Abbreviations are acceptable, with a maximum of two per display and preferably with only one per display. Refer to Section 2F-4 for use of abbreviations. Table 11 shows acceptable abbreviations from the MUTCD list for a number of words that might sometimes be used in CMS messages. Table 12 shows acceptable abbreviations from the MUTCD list that might be appropriate for use in CMS messages when used with the indicated prompt word. Table 13 shows the MUTCD list of unacceptable abbreviations.

7. The minimum information required is a statement of the problem or effect and the action required. The driver needs to know what to do and one reason for doing it. Ideally, each message would consist of the following information:
 - A problem statement (accident, maintenance, construction, etc.)
 - A location statement (where the problem is)
 - An effect statement (delay, heavy congestion, etc)
 - An attention statement (addressing a certain group or audience)
 - An action statement (what to do)

Great care must be taken to ensure that messages are properly designed. Displaying messages that are too long for motorists to read and comprehend at prevailing speeds or that are too complex or inappropriately designed can lead to motorist confusion, and adversely affect both traffic flow and the agencies credibility.

The State Traffic Engineer will provide assistance with message design at the request of the District Office.

Determine How Long to Display the Message

After messages have been selected and conflicts resolved, it must be decided how long to display the message on the sign. For advance warning of upcoming work activity or special events, the message can be shown for several hours or even days prior to the event during off-peak hours. However, it is more difficult to determine an appropriate duration for incidents. It is the responsibility of the authorized person making the request for activation of the CMS to estimate the expected duration of the incident and ask the operator to set the message display time to that duration. That person is also responsible to inform the operator if the message is to be changed, terminated sooner or extended as needed. The operator should monitor the message to ensure that it is still valid.

Failure to change or deactivate messages that are no longer relevant can degrade the agency's credibility with the motoring public.

Resolve Any Message Conflicts

There are two levels of message display priorities that must be established. These are,

1. Priorities of message types, and
2. Priorities when two or more similar events occur on the freeway.

Priorities of Message Types

There are a variety of message types (incident, construction, weather, test messages, etc.) that may be displayed on CMSs. In general, certain types have priority over other types but the over-riding factor in the decision is judgment based on circumstances. The authorized person making a request for activation of a CMS must consider the consequences of the request. Rerouting traffic to other segments of the freeway system may not always be the best solution i.e., during periods of rush hour traffic, major construction projects, etc. The alternative route should result in a significant savings in time for the diverted motorists. The priorities of message types are based on the criticality of the message as listed below:

1. Non-recurrent incidents
 - a. An event that causes total closure of the freeway in both directions.
 - b. An event that causes total closure of the freeway in one direction.

- c. An event that causes a reduction in the number of available lanes.
- d. An event that impedes the flow of traffic in either or both directions.
- e. An event that causes the closure of an exit ramp.
- f. An event on an intersecting freeway or street.

An event is defined as any situation that impedes normal traffic flow. Examples are hazardous materials incidents, roadway collapse or failure, motor vehicle crashes or fires, lost loads, roadway construction or repair projects and special event traffic congestion.

2. AMBER Alert (America's Missing: Broadcast Emergency Response) Plan messages.
3. Advance Notice Messages
 - a. Advance notice of road work
 - b. Advance notice of special events
4. Adverse Weather Conditions
 - a. National Weather Service Warnings
 - b. Specific location weather and roadway conditions
5. Public Service Announcements
6. Test Messages

Priorities When Two or More Events Occur on the Freeway

Sometimes there are competing message needs when two or more similar events take place on the freeway at the same time. For example, the CMS may contain a message about a downstream crash when a second crash occurs on the freeway. It must then be decided which of the two crashes should be presented on the CMS because it is neither possible nor advisable to display information about two crashes on the CMS.

Basic Message Priorities

There are a number of different combinations of similar events that can take place on the primary freeway and on intersecting freeways. In general the following priority principles should apply but the over-riding factor in the decision is judgment based on circumstances.

- Messages about downstream events on the primary freeway should receive priority over similar events on downstream intersecting freeways.
- When two similar events occur concurrently on the primary freeway the one nearest the sign should generally receive priority.
- When two similar events occur concurrently on an intersecting freeway the one likely to have the most effect on traffic on the primary freeway should receive priority.

For example, a major incident on an intersecting freeway may possibly have an adverse affect on motorists who will turn off the primary freeway onto the intersecting freeway. However, if the major incident is far downstream (e.g., 10 miles) of the interchange, then the likelihood that the incident would affect motorists turning onto the intersecting freeway would greatly diminish.

Display and Verify The Message

When the accuracy of the information available is confirmed, the information in the message is established and the message formatted, the selected message can be displayed. After the CMS message is activated, it is important to validate that the correct message is displayed on the CMSs. The operator should not rely solely upon electronic validation from the software/computer system.

Terminate The Message

It is the responsibility of the authorized person making the request for activation of the CMS to inform the operator that the message should be terminated or changed. The operator should also monitor the message to ensure that it is still valid while it is being displayed.