State of California

California State Transportation Agency

Department of Transportation

Changeable Message Sign (CMS) Guidelines

Prepared by the Division of Traffic Operations

April 2021

This 2021 edition of the Changeable Message Sign Guidelines is available on the California Department of Transportation Website at:

http://www.dot.ca.gov/hq/traffops/systemops/tim_tmt/cms/

TABLE OF CONTENTS

PREFACE

This document provides policy and guidance for the use of changeable message signs (CMS). The California Department of Transportation (Caltrans) personnel shall use this document when making decisions on when, where, and how to install, as well as what to display on CMS. In this document, unless otherwise noted, CMS refers to both fixed changeable message signs (FCMS) and portable changeable message signs (PCMS).

All standards cited in these guidelines are required by the current Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) and the *California Manual on Uniform Traffic Control Devices* (CA MUTCD). Exceptions or deviations from these guidelines should be discussed with Caltrans' District Traffic Managers (DTMs), Transportation Management Center (TMC) Manager, or the Headquarters CMS Coordinator. See "CMS OPERATIONS POLICIES" section for more information.

For additional information or if there are any questions regarding the CMS policy, contact the Headquarters CMS Coordinator.

CMS OPERATIONS POLICIES

A Changeable Message Sign (CMS) is described as a traffic control device that is capable of displaying one or more alternative messages (CA MUTCD and MUTCD)]. With certain exceptions, a CMS shall display only traffic operational, regulatory, warning and guidance information. A CMS should remain blank when conditions do not warrant the display of a message as described above.

Whenever a message is displayed on a CMS, drivers will know that it will likely affect them. Thus, Signs should be activated only when drivers within the signs area need to be alerted.

As used in the CA MUTCD, the words "shall," "should," and "may" have the following standard meanings:

SHALL - A mandatory condition. Requirements having "shall" stipulations are mandatory. No discretion in following them is allowed. Items marked as "shall" are typically included as a STANDARD in the CA MUTCD.

SHOULD - An advisory condition. Where "should" is used, the suggestion is recommended, and normally is to be followed, but is not mandatory. Deviation from such provision is permissible if, and to the extent that, there is justifiable cause to do so. Decision to deviate shall be determined by the District Traffic Manager (DTM) or the Headquarters CMS Coordinator. The reasons for any deviation should be documented and filed for future reference.

MAY - A permissive condition. No requirement for design or application is intended. Items marked as "may" are typically included as an OPTION in the CA MUTCD.

<u>CMS shall:</u>

Display only information that is associated with:

- unexpected conditions, nonrecurring congestion, incidents, adverse weather conditions, travel times, current and future road closure information;
- America's Missing Broadcast Emergency Response (AMBER) Alerts and Blue Alerts that have been approved and requested by the California Highway Patrol (CHP) Emergency Notification and Tactical Alert Center (ENTAC);
- Caltrans Headquarters approved safety messages; emergency and homeland security messages.

- Comply with Caltrans Standard Specifications and Standard Special Provisions.

- Adhere to Caltrans policy when used to display messages for other states or agencies (i.e. AMBER Alerts, Blue Alerts, emergency and homeland security messages, etc.).
- Display messages that consist of no more than two phases, with each phase consisting of no more than three lines of text that shall be understood by itself regardless of the sequence in which it is read (CA MUTCD, Section 2L.05.04).
- When displaying two-phase messages, the display time for each message should be long enough to allow the motorist time to read the entire message at least twice at the posted speed limit. (CA MUTCD Section 2L.05.08).
- Use only graphics and colors that are approved for use in the CA MUTCD (CA MUTCD paragraph 2L.04.14 through 2L.04.18 and Table 2A-5). Have messages updated for accuracy as conditions change.

The DTM, TMC Manager, or the Headquarters CMS Coordinator shall be consulted before using a CMS for purposes not described in this CMS Guidelines.

PCMS shall:

- Comply with Caltrans' Standard Specifications and Standard Special Provisions.
- Be raised to a minimum height of seven feet from the ground in urban areas and five feet from the ground in rural areas. The top of the sign shall be no more than 14.5 feet above the ground.
- Be turned off, removed and stored outside of the clear recovery zone or behind a protective barrier when not being used.

CMS should:

- Have a minimum of 1,000 feet of separation between CMS when multiple CMS are used.
- Display consistent messages along a roadway corridor or adjacent corridors when the objective is to display messages related to a specific situation.
- Be monitored for malfunctioning display. At least 95 percent of the CMS characters should be functioning properly before displaying the message.
- Display the traffic problem and location statements as the minimum information that needs to be contained in a message. An action or effect statement should be included if deemed relevant.
- Use standard abbreviations when creating a message (Appendix C).
- Display one-phase messages whenever possible. The CMS operator should attempt to limit the units of information displayed to a one-phase message.
- Be placed one to two miles in advance of a major decision point whenever possible.

CMS shall not:

- Display advertising messages or public service messages that could be considered as advertising messages on CMS, its supports or other equipment.
- Detour motorists to arbitrary routes. Prior to displaying a detour route, the CMS operator should know the current route constraints and traffic conditions.
- Display fading, flashing, exploding, dissolving, or moving messages.
- Display any type of graphics. Exceptions include graphics on full matrix signs displaying:
    - An exact duplicate of a standard sign or other sign legend using standard symbols, the Standard Alphabets and letter forms, route shields, and other typical sign legend elements in the appropriate color combinations and with no apparent loss of resolution.
    - Images of vehicles as part of AMBER Alert messages.
    - A flashing flagger symbol on a PCMS in lieu of a live flagger for advanced flagger.
- Provide information that is already obvious to the motorist.
- Display any safety or transportation-related message if doing so would adversely affect the public's respect for the sign.

CMS may:

- Use two-phase messages only when it is determined that a motorist has enough time to read the entire message at posted speeds.
- Occasionally display local safety campaign messages when it is used as part of larger multi-organizational and multi-media safety campaign. These messages must be approved by the Headquarters CMS Coordinator.
- Display images of vehicles as part of AMBER Alert messages

Chapter 1 – USE

CMS should be used to give motorists real-time traffic safety and guidance information about events and incidents that significantly impact traffic or travel on the State Highway System

CMS use for events includes advance notice of upcoming roadwork or special events that will affect travel, and to notify the travelling public of work zones ahead (See Appendix G). Advance notification should not be displayed more than seven days prior to the event or upcoming roadwork. When possible, days of the week (Monday-Friday) should be displayed instead of calendar dates (May 11-May 15).

CMS is used to display statewide safety campaign messages approved by Headquarters CMS Coordinator and distributed to the districts. These safety campaign messages could be part of the annual statewide CMS safety campaign calendar or for specific reasons. Occasionally, CMS may be used to display local safety campaign messages, when it is used as part of larger multi-organizational and multi-media safety campaign. These messages must be approved by the Headquarters CMS Coordinator. Additional guidance regarding the use of CMS to display safety related messages on the State Highway System will be disseminated to the TMC Managers and appropriate staff via e-mail as necessary.

Tables 1.1 through 1.3 provide examples of typical applications for CMS.

TABLE 1.1 - CMS MESSAGE TYPES AND USES	
MESSAGE TYPE	**USES - INFORMATION RELATED TO**
Early Warning	**Traffic Safety/End-of-Queue Protection** • Unexpected Traffic • Managed Lane Operation • Slow Traffic • Stopped Traffic
Advisory	**Guidance** • Post-Event Congestion • Adverse Roadway Conditions • Advance Notice • Lanes Blocked (Temporary Duration) • Major Closure • Lanes Closed (Long Duration) • Major Special Event • Freeway/Highway/Ramp/Connector Closed • Emergency and Homeland Security Messages • Chain Control Conditions • Managed Lane Operation **Congestion** • Estimated Travel Times • Expected Delays • Adjacent and parallel transit alternatives **Alerts requested by CHP's ENTAC:** • AMBER Alert • Blue Alert
Alternative Route	**Guidance** • Soft Detour (Optional Detour) • Hard Detour (Required Detour)

PROPER AND IMPROPER CMS USE

A CMS should be used to inform motorists of unexpected conditions but should not be used until such conditions warrant their use. The benefits of a CMS to manage traffic and inform motorists are maintained only if used properly. Improper use can adversely affect travel and effectiveness of CMS. In areas where both FCMS and PCMS are used, it is important that conflicting messages are not displayed. CMS should be used as a supplement for conventional traffic control devices and not as a substitute.

An important consideration in successfully operating a CMS is to maintain credibility with motorists. Motorists expect the CMS to provide useful and accurate information. The CMS message should not provide information that is already obvious to the motorist (such as **HEAVY RAIN**, **ROAD WET** AND **SLIPPERY**). The decision on when to use a CMS is determined by the operator and is based on field conditions and the message being displayed.

Statewide safety campaign messages should be limited to the messages and dates listed on the annual statewide CMS safety campaign calendar distributed by the Headquarters CMS Coordinator or occasionally, local multi-agency and multi-media safety campaign.

All law enforcement requests for alerts on the CMS must be approved by the CHP's ENTAC and be in compliance with the CMS Guidelines. CHP may request messages regarding fog, gusty wind and other weather- related conditions. These are regular requests that do not require ENTAC approval. The district should decide on approving these message requests.

TABLE 1.2 - CMS USE FOR EVENTS IMPACTING TRAFFIC	
EVENT	**EXAMPLES**
Construction Activity	Lane Closures Detours Change in Lane Pattern Special Speed Control Measures
Maintenance Activity	Lane Closures Moving Closures
Permit Activity	Utility Work Encroachment Work Special Event Filming Transportation Loads
Special Event	Sporting Events Concerts Festivals Parades
Operational Feature	High-Occupancy Vehicle Reversible, Exclusive or Contraflow Lanes Ramp Meters
Design Feature	Drawbridges Tunnels Ferry Service
Safety Campaigns	Seat belts Phone use DUI

TABLE 1.3 - CMS USE FOR INCIDENTS IMPACTING TRAFFIC	
INCIDENT	**EXAMPLES**
Collision	Jackknife Fatal Overturn Spilled Load
Hazardous Material (HAZMAT) Spill/Release	Chemical Spill Oil Spill Toxic Cloud Refinery Fire
Natural Disaster	Flood Slide Fire Earthquake Tornado
Law Enforcement Activity*	Bomb Threat Terrorist Attack Hostage/Kidnapping Situation Suicide Attempt
Severe Weather	Fog, Dust, Wind Snow, Ice, Heat

*A CMS may be used for law enforcement activity that directly impacts the motorist or traveled way.

Requests to display traffic/travel information from other states or local agencies shall be evaluated by the appropriate district traffic manager and should adhere to these guidelines. Requests received by other Caltrans' units to display messages that are not consistent with these guidelines shall be denied.

Regardless of who requests it, the following types of messages shall not be displayed – advertisements, public service announcements, messages not directly impacting motorists (with certain exceptions) (See Table 1.4). If there are questions on messaging, district should contact the Headquarters CMS Coordinator for guidance.

Districts that are planning to use a CMS for pilot programs or other purposes not described in these guidelines, shall consult with the Headquarters CMS Coordinator for concurrence before displaying these messages. At a minimum, the District should perform an effectiveness evaluation of the pilot. Messages that have negative traffic impact or result in additional congestion should not be displayed.

TABLE 1.4 - IMPROPER CMS USE

APPLICATION	EXAMPLES
Commercial Logo Advertising	"NIKE RACE" "GOOD GUYS CAR SHOW"
Local Identifier Advertising	"RALEY FIELD" "ORACLE PARK"
Normal Recurrent Congestion	"HEAVY CONGESTION"
Public Service Announcement	"SUPPORT RED CROSS"
Political Message	"VOTE FOR JOE"
Not directly related to travel on the roadway	"ALL FOREST LAND CLOSED"

RESPONSIBILITIES FOR USE

Use of the CMS for traffic management on the State Highway System is the joint responsibility of TMC personnel, Traffic Management Team (TMT) members and field personnel, resident and permit engineers and the CHP as designated below. Personnel should always review the message composition and location of the CMS, and if needed, request assistance from Traffic Operations personnel. In addition, the CMS should be monitored to assure that it is on or off at correct times; there is no legibility or safety problems; and the sign is effective for traffic management.

- TMC personnel compose and display messages for FCMS based on information gathered from field personnel, CHP Computer Aided Dispatch (CAD), and Transportation Management System (TMS) field elements such as Closed-Circuit Television (CCTV) cameras and Vehicle Detector Systems.

- TMT and field personnel compose messages and deploy the PCMS. Field personnel are responsible for coordinating with the TMC to request FCMS support. Field personnel can provide information on Estimated Time of Opening (ETO), travel times, delays, and the status of the detour route.

- The Headquarters CMS Coordinator is responsible for providing guidance to all Caltrans personnel on when, where and how to use a CMS.

- Resident Engineers and Permit Engineers are responsible for providing guidance to the contractor on when, where and how to use their PCMS.

Note: PCMS used in work zones shall comply with Caltrans' Standard Specifications and Standard Special Provisions.

- CHP should refer to the Joint Operational Policy Statements and Caltrans CMS Guidelines when requesting CMS use.

CA MUTCD LIMITATIONS - USE OF CMS CAPABILITIES

- When a CMS is used to display a safety, emergency and homeland security, AMBER Alert or transportation-related message, the display format shall not include advertising, animation, rapid flashing, dissolving, exploding, scrolling, or other dynamic elements or be of a type that could be considered as advertising messages.

- CMS shall display only traffic operational, regulatory, warning, guidance information and AMBER Alert messages. Advertising messages shall not be displayed on CMS or its supports or other equipment.

- When a CMS is used to display a safety or transportation related message, the message should be simple, brief, legible, and clear. A CMS should not be used to display a safety or transportation-related message if doing so would adversely impact the effectiveness of the CMS.

- "**CONGESTION AHEAD**" or other overly simplistic or vague messages should not be displayed alone. These messages should be supplemented with a message on the location or distance to the congestion or incident, estimated delay time, travel time, alternative route, or other similar messages.

USE OF PCMS BY OTHER PUBLIC AND PRIVATE ENTITIES IN STATE HIGHWAY RIGHT-OF-WAY

From time to time, other State agencies, local agencies and even private entities will approach Caltrans to request permission to place and display messages on PCMS. Since these entities are furnishing the PCMS they might believe that they could display messages of their choice. When a PCMS is placed along a highway it becomes a traffic control device and has to conform to the requirements of the CA MUTCD. The PCMS shall not be used for public service announcements or for advertising messages. The message to be displayed on the PCMS on State highway right-of-way shall be approved by Caltrans. The proposed messages should be included with the permit application.

Chapter 2 - LOCATION

INSTALLATION AND PLACEMENT

Caltrans Divisions of Traffic Operations, Maintenance, and Design should work closely to determine the appropriate location of each FCMS before it is designed and installed. Proper placement of a PCMS should be determined in real-time by field personnel.

The most appropriate locations for installing or placing a CMS is in advance of major decision points, such as interchanges or intersections where motorists can respond to specific information displayed on the CMS. A CMS should be located as close to the edge of traveled way (ETW) as possible to maximize visibility.

- **A CMS should be located so that motorists can:**
  - Notice the sign.
  - Read and understand the sign.
  - Make appropriate decisions based on the information gained from the message.

A CMS too close to a decision point will not provide motorists adequate time to react to the message and will reduce the opportunity to respond. A CMS too far in advance of a decision point may reduce the overall impact or recall of the message. The recommended placement of a CMS is one to two miles in advance of a major decision point.

- **FCMS Locations**

  The recommended locations for installation or placement of the FCMS are upstream of:

  - Major special event facilities (stadiums and convention centers).
  - Locations which may experience severe weather conditions (fog, dust, wind, ice or snow).
  - Locations where information regarding travel times and delays are appropriate (for example construction zones and airports).

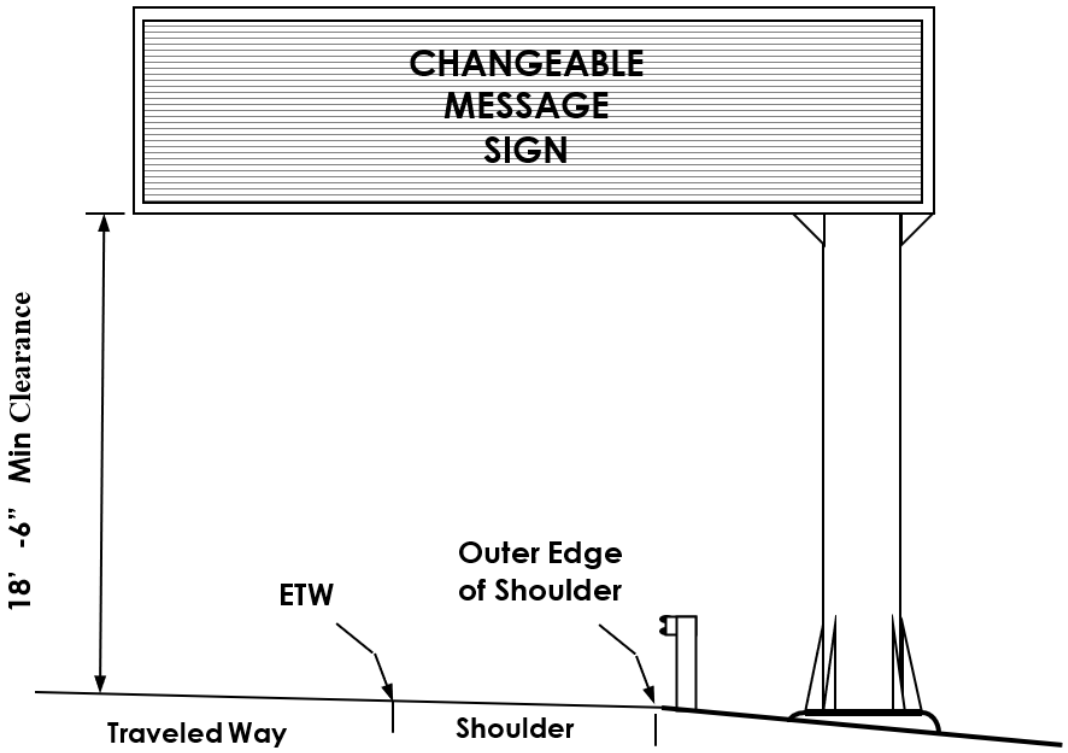


FIGURE 2.1
FCMS TYPICAL INSTALLATION

- **PCMS Locations**

When practical, PCMS should be placed:

- On the right and/or left shoulder of the highway.
- Upstream of bottlenecks and the resulting queues.
- On the same side of the highway if multiple PCMS are needed to give additional information. The distance between PCMS should be based on speed, terrain and visibility. A minimum of 1,000 feet separation should be provided between PCMS.
- Behind an existing barrier, such as metal beam guardrail or concrete barrier provided the message is not obstructed.
- To be Located on vertical roadway curve to provide maximum visibility.
- Adjacent to work zones.
- Placed upstream of an event or condition to give adequate time for motorists to react.

VISIBILITY

Visibility is the distance at which a motorist can first notice a CMS on the roadway. The components of visibility for a CMS are as follows:

- The ease with which a CMS can be detected and how well it attracts the driver's attention (target value).
- The ease with which the message can be seen (brightness).
- The ease with which the message can be read (legibility).
- The ease with which the message can be read from the side (cone of visibility).

➢ The target value is the distance from which the CMS is first noticed by the motorist. It is dependent on the CMS unit being more visible than the rest of the highway features. The early recognition that a CMS is present plays a key role in the motorists' ability to react to the message. The proper placement of a CMS should ensure that structures, curves, roadside signs and landscaping do not obscure visibility of the CMS (Figure 2.2).

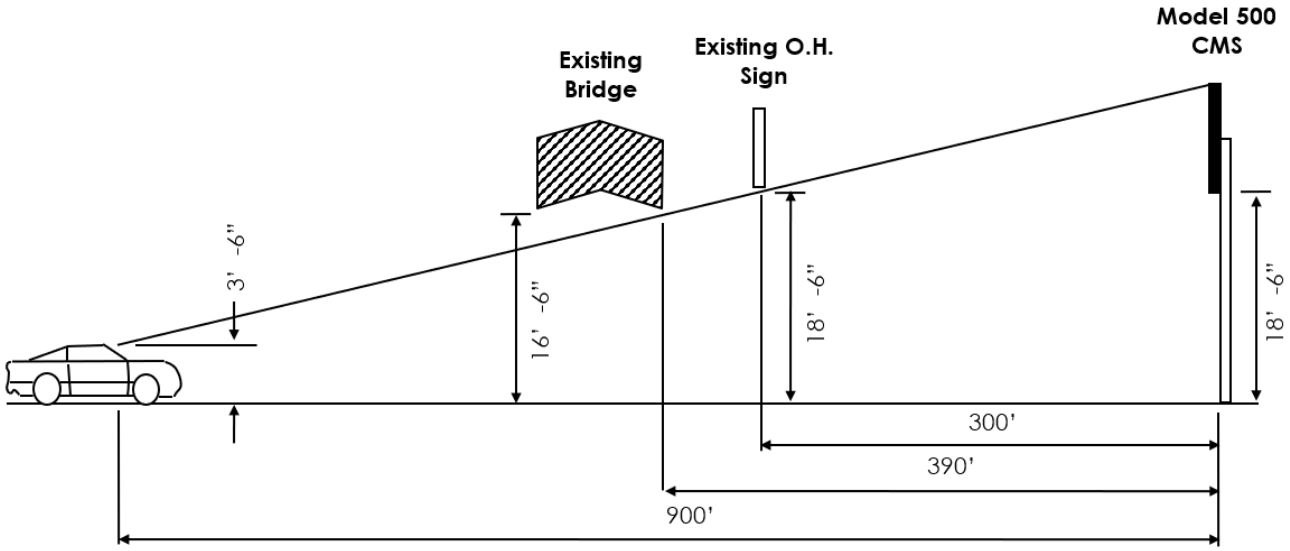


FIGURE 2.2*
FCMS OVERHEAD OBSTRUCTIONS

* Refer to Caltrans Highway design manual and standard plans for latest standards on fixed changeable message sign minimum height.

Looking at Figure 2.2, a vehicle traveling at 65 mph will have approximately 9.5 seconds to read the sign:

$$\text{Time} = \frac{900 \text{ ft}}{(65 \text{ mi/hr})(1\text{hr}/3600 \text{ sec})(5280 \text{ ft/mi})}$$

$$= 9.5 \text{ sec}$$

It takes a motorist at least one second to read each unit of information (see Chapter 3). If a sign will frequently be displaying longer messages, relocation of existing highway and/or construction signs may be necessary in order to install a FCMS and allow the motorist time to read the messages.

Vertical and horizontal curves on freeways may influence the visibility of a CMS.

Care should be taken to prevent objects from being located too close to the PCMS since they are more likely to impact the visibility of the sign. A motorist in the lane closest to the CMS may not be able to see around the object and fully read the message.

Obstructions such as trees, bridge abutments, overhead signs, or construction vehicles may impact the legibility of a CMS.

Semi-trucks in the traffic stream can be a major cause of sight obstruction to the PCMS. Motorists in vehicles traveling closely behind or adjacent to a truck may have limited time to read a PCMS. In cases where this is prevalent, using multiple PCMS on the same side of the highway will provide an additional opportunity for motorists to comprehend the message.

For maximum visibility a PCMS should be raised to a minimum height of seven feet from the ground in urban areas and five feet from the ground in rural areas.

Brightness or luminance of a CMS is the amount of light that is coming from the CMS. Weather conditions such as fog, dust, snow, or rain, and other conditions such as heat or cold can affect the visibility of messages. Rain, fog and snow can scatter and block light rays from a CMS as that light travels through the atmosphere and reduce the contrast between the CMS and its background. If the contrast becomes too low, motorists cannot read the message. Most CMS are equipped with an automatic dimmer mechanism that will account for these conditions.

Legibility is the maximum distance at which a motorist can first correctly identify letters and words on a CMS. A short message with a large font has greater legibility than a long message with a small font.

Current CA MUTCD and Caltrans' Standard Specifications (Sec. 12-3.12) require the following minimum distances for visibility and legibility:

Visibility = 1,500 feet

Legibility = 750 feet

A CMS should be routinely monitored for malfunctioning disks, lamps or panels. At least 95 percent of the CMS characters should be functioning, and the message should also remain legible to motorists.

The legibility distance of a CMS may be significantly reduced if the sun is shining directly on the CMS or into the eyes of the motorist.

The Cone of Visibility identifies how many degrees from the CMS center axis the message remains legible. Care should be taken not to place a PCMS so far off the roadway that the PCMS is not in the motorist's cone of vision long enough to read the message. The exposure time to read a message increases as the cone of visibility increases. The PCMS should also be slightly tilted toward the traveled way to reduce glare.

SAFETY

Along with considering the traffic management and visibility aspects of a CMS, safety of staff that will be maintaining the CMS and the motorists should also be considered when proposing CMS locations.

FCMS installed to the right of the traveled way is preferred because it allows maintenance personnel to use shoulder closures during inspection or repair. Providing a parking area or pullout for maintenance (Figure 2.3) shall be considered in the design. If the FCMS is installed behind a sound wall, fence, gate, or access door should be provided at a safe location.

FCMS installed in a median or on an existing over-crossing provide high visibility. However, they are also difficult for maintenance personnel to access and may impact the vertical limits for transporting tall loads.

The controller cabinet should be located at least 40-60 feet upstream from the FCMS to allow good visibility for testing. Security from theft and vandalism should be considered.

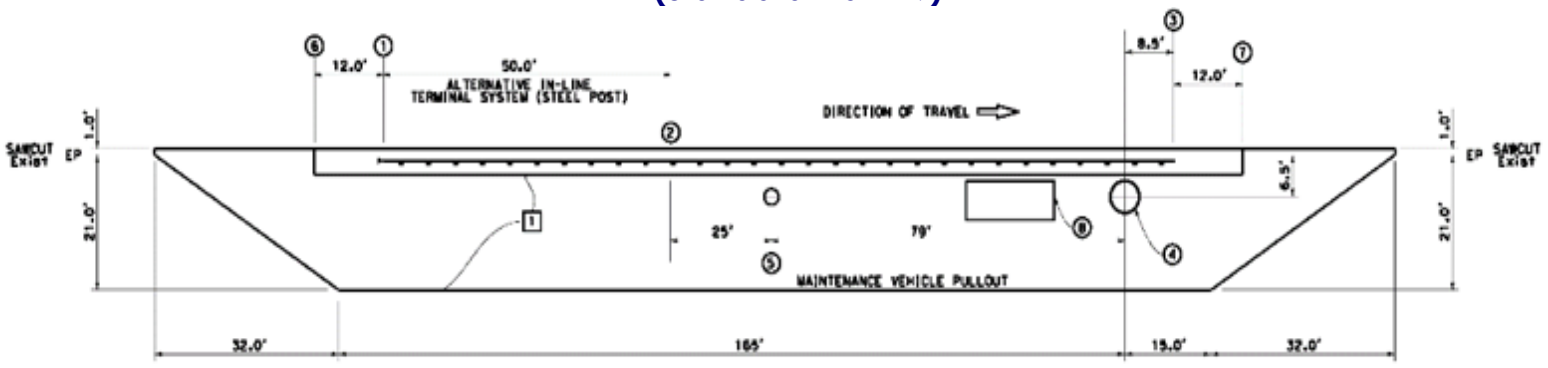
Whenever possible a CCTV camera should be installed in front of the FCMS on a separate pole. A camera in front of the FCMS has the benefit of visually verifying the FCMS message without a maintenance call-out. Fewer calls reduce worker exposure and improve safety.

PCMS should be located as close to the roadway as possible, making the message visible to motorists. If the PCMS is located within 15 feet of the edge of traveled way, it should be delineated with a taper consisting of 9 cones placed at a spacing of 15 feet apart (CA MUTCD, Section 6F.55).

- For freeways and expressways – 30 feet from traveled way.
- For conventional highways (no curb) – 20 feet from traveled way.
- For conventional highways (with curb) – 1.5 feet from face of curb.

Whenever a PCMS is not being used, it shall be turned off, placed or stored outside of the clear recovery zone or behind a protective barrier.

FIGURE 2.3*
FIXED CHANGEABLE MESSAGE SIGN
MAINTENANCE VEHICLE PULLOUT
(Standard Plan H9)



* Refer to Caltrans standard plan for latest standards on fixed changeable message sign and maintenance vehicle pullouts.

Chapter 3 – MESSAGES

CMS messages provide motorists accurate and real-time information and, in some cases, a suggested course of action.

Motorists have difficulty perceiving, processing, and remembering a large amount of traffic information at one time. Consequently, the CMS operator is responsible for deciding what information is most important and how to present that information to motorists. Messages should encourage motorists to make appropriate driving decisions.

A CMS is a traffic control device that must conform to the requirements of the CA MUTCD. According to the CA MUTCD and MUTCD, "All word messages shall use standard wording and letters as shown in this Manual and in the "Standard Highway Sign and Markings" book." As such, we do not post messages or signs (traffic control devices) in languages other than English. Additionally, any changes to traffic control devices will require Federal Highway Administration's approval and consultation with the California Traffic Control Devices Committee (CTCDC).

This chapter will assist CMS operators in creating message displays that avoid confusion on the roadway, improve traffic flow, and enhance safety.

MESSAGE ANATOMY

CMS messages are divided into information components that when read separately or collectively, convey a complete thought or message to motorists (Table 3.1).

- A unit of information is typically one to three words of text and usually occupies one line on a CMS phase (Table 3.2). Each unit answers a question that a motorist might ask about an event or incident and provides information to assist the motorist in making a decision. Units of information should be arranged in a logical order that effectively conveys the message to motorists. Generally, this order is, "The Problem, Location and Effect statement".

- It is important to remember that it takes a motorist at least one second to read each unit of information. A motorist traveling at freeway speeds of 65 miles per hour (mph) on average has 4 to 7 seconds to read a CMS message under ideal conditions. Unless a motorist is in a queue or traveling at a low rate of speed, the operator should limit the units of information displayed to a one-phase message and under no circumstances more than two phases.

TABLE 3.1 - MESSAGE ANATOMY EXAMPLE

PHASE 1			
UNITS OF INFO.	**INFORMATION**	**MOTORIST QUESTION**	**CMS ANSWER**
1 1 1	Problem Location Effect	• What happened? • Where? • What is the effect on traffic?	**COLLISION AT HOWE AVE TRAFFIC JAMMED**

PHASE 2			
UNITS OF INFO.	**INFORMATION**	**MOTORIST QUESTION**	**CMS ANSWER**
1 1	Audience Action	• Who is message for? • What is advised?	**STOCKTON TRAFFIC USE HWY 99**

TABLE 3.2 - UNITS OF INFORMATION BREAKDOWN

UNITS OF INFO.	INFORMATION	MOTORIST QUESTION	CMS ANSWERS (examples)
1	Problem/ Descriptor	What happened?	COLLISION HIGH WINDS FLOODING
1	Location	Where?	AT LONG BEACH BL 15 MILES AHEAD EXIT 12
1	Lane Closed (blocked)	What is Closed (blocked)?	2 RT LANES CLSD FREEWAY CLOSED SINGLE LANE ONLY
1	Effect	What is the Effect on Traffic?	TRAFFIC JAMMED 25 MIN DELAY
1	Audience	Who is the Message for?	COLLISEUM STOCKTON TRAFFIC
1	Action	What is Advised?	USE HWY 99 PREPARE TO STOP USE EXIT 24

A few key points regarding units of information:

- Limit each line of the CMS to one unit of information whenever possible. No more than two units of information on a line.
- It is acceptable (when space is needed) to convey a unit of information over multiple lines.
- No more than **three units** of information on a **single message phase**.
- No more than **four units** of information in the entire message (two-phase) when traffic operating speeds are **35 mph or more**.
- No more than **five units** of information in the entire message (two-phase) when traffic operating speeds are **less than 35 mph**.
- Only one unit of information on a single line. Finish one unit of information before starting another.
- Compatible units of information should be displayed on the same message phase.
- A single unit of information should not be split among two phases.

Location statement information will be useful whether motorists are familiar or unfamiliar with the area. If exit numbers are posted, the operator should use them in the location statement. The location can also be referenced by distance or prominent landmarks.

Note: Location Statement - If the incident is on the same highway as the CMS, there is no need to display the route number or name because motorists will assume the event is on the same highway.

- **Message Phase**

A phase is one frame of a message, which includes the units of information and the display time. Each phase of a message should be independently understood by motorists, whether it is read before or after an adjoining phase.

Single-phase messages should be used whenever possible.

Two-phase messages should be used only when it is determined that motorists have enough time to read the entire message at prevailing speeds.

If a two-phase message is needed, the Problem and Location units of information should appear together on one phase. An example of a two-phase message showing units of information is shown in Figure 3.1.

Note: A message of this length (five units of information) should only be used in prevailing speeds less than 35 mph to assure adequate time for motorists to read and comprehend the message.

FIGURE 3.1
For prevailing speeds less than 35 mph <35 mph

Phase 1

COLLISION AT HOWE AVE 45 MIN DELAY

Phase 2

STOCKTON TRAFFIC USE HWY 99

Note: **Three-phase messages are prohibited.**

A message consists of all the text or characters being displayed on a CMS. The minimum information that needs to be contained in a message is the traffic Problem and Location. The Effect or Action information should be included, if relevant. Messages should be brief and clear but enough for the motorists to make an informed decision. When used, abbreviations should be easily understood (see Appendix C).

- **Display Time**

  A display time should be selected for multi-phase messages which will allow the motorist time to read the message at the posted speed.

  The display time for a FCMS is generally three seconds per phase. However, two phases with a three second display time for each is not adequate for traffic moving at 60 mph. Therefore, a single-phase three-line message is preferred. Keep in mind that for motorists to read a two-phase message with three second display times, they would need to be in a queue for 12 seconds to read both parts of the message twice.

A PCMS displays less text and fewer units of information per phase. Therefore, a shorter display time may be used. When a motorist can read the message twice at posted speeds, the operator knows the CMS has a proper display time. his should be the intended outcome for all messages; however, it may be difficult to achieve under less than ideal conditions.

Two examples of FCMS and PCMS messages for a highway closure are shown in Figure 3.2 and 3.3. Figures 3.2A and 3.3A show two-phase messages when the posted speeds are less than 55 mph (four units of information). Figures 3.2B and 3.3B show a single-phase when the posted speeds are greater than 55 mph (3 units of information).

- **Message Length**

Messages should provide motorists with enough information to make a timely decision. CMS operators should resist the urge to lengthen a message simply because there is space available on the CMS. A driver has a limited amount of time to read a message. A message that is too long to read while traveling at posted speeds could cause traffic slowing especially since motorists cannot devote their full attention to reading the CMS while driving. CMS Operators should look for ways to reduce the message length without losing the intent of the message. This can be achieved by deleting unimportant and redundant information.

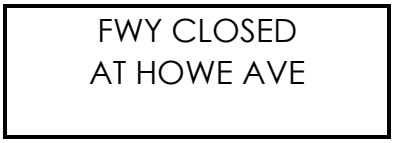
Empty spaces in a CMS message may be used for visual clarity.

Abbreviations may be utilized when creating or editing a CMS message. The example message shown in Figure 3.2B was shortened by displaying USE S-99 in lieu of USE SOUTH 99. Use of appropriate abbreviations is very important.

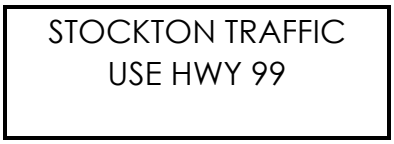
FIGURE 3.2
FIXED CHANGEABLE MESSAGE SIGN

A. (<55 MPH)

Phase 1



Phase 2



B. (>55 MPH)

Single Phase

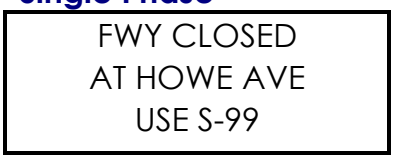
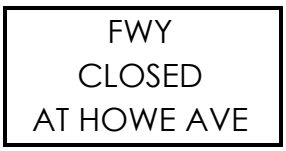


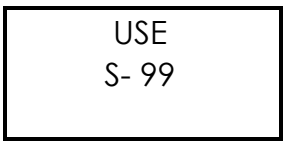
FIGURE 3.3
PORTABLE CHANGEABLE MESSAGE SIGN

A. (<55 MPH)

Phase 1

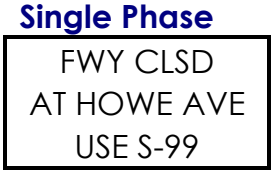


Phase 2



B. (>55 MPH)

Single Phase



Certain words or abbreviations are evident to the driver. For instance, the use of "Street," "Avenue" or "Boulevard" following a familiar arterial name is not required and could be omitted. There is no need to use the phrase "east bound" to describe a direction. The direction is already described in the term east or "E" if using an abbreviation. When used in conjunction with a prompt word, the motorist understands most commonly used words and abbreviations (see Appendix C).

Abbreviations are useful to help reduce the message length and to make the message fit within the limited CMS line capacity. In order to facilitate ease of comprehension, keep the following in mind when using abbreviations:

- Avoid two consecutive abbreviations if possible.
- Do not use three or more consecutive abbreviations.

➢ **Standardized Messages**

CMS operators statewide should follow the same messaging as described in these guidelines. Message familiarity reduces motorist reading and comprehension time, thereby enhancing delivery. In general, motorists need more time to read unfamiliar messages.

The information below should be understood before composing a CMS message.

- When referring to an off ramp, the word **EXIT** is preferred.
- The verb **USE** should be selected to indicate a route that will carry the motorist to a destination.
- The term **BLOCKED** may be used when an unexpected event is blocking lanes and no formal closure is in place.
- The term **CLOSED** is recommended after traffic control is in place.
- When using the word **AHEAD** (without referencing miles) to describe a location, the CMS should not be over one mile upstream of the event/incident location. Also, the CMS should be on the same route as the event/incident location.
- The verb **FOLLOW** carries the inferred meaning that motorists will be guided by other signs along the route. **FOLLOW** should not be used unless detour signs are in place.

- In areas where both FCMS and PCMS are used, it is important that conflicting messages are not displayed simultaneously.

➢ **Message Type**

Early warning messages give motorists advance notice of unexpected, slow or stopped traffic and queueing due to an event or an incident. Early warning messages are effective in reducing secondary collisions. Examples of early warning messages are shown in Figure 3.4.

Note: CMS displaying early warning messages should be blanked if the queue builds beyond the sign.

FIGURE 3.4
EARLY WARNING MESSAGES

FIXED CHANGEABLE MESSAGE SIGN

➢ **Incident less than a mile ahead**

Problem: Location: Effect:	SLOW TRAFFIC AHEAD EXPECT DELAY

Problem: Action:	ONE LANE AHEAD PREPARE TO STOP

➢ **Incident more than a mile ahead**

Problem: Location:	STOPPED TRAFFIC 2 MILES AHEAD

Problem: Location: Action:	COLLISION 2 MILES AHEAD PREPARE TO STOP

PORTABLE CHANGEABLE MESSAGE SIGN

Phase 1	Phase 2
SLOW	PREPARE TO STOP

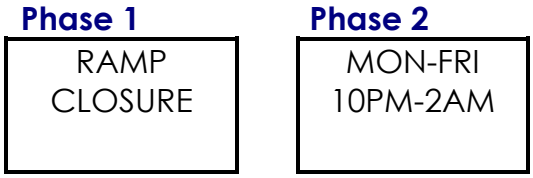
- **Advisory Messages**

Advisory Messages provide motorists with real-time information about a specific problem along their route. Advisory messages can be used to provide guidance, congestion notification and future closures. The message should use days of the week and not dates (for example Mon, Tues - not 12/15 to 12/17). Examples of Advisory Messages for a ramp closure are shown in Figure 3.5.

FIGURE 3.5
ADVISORY MESSAGES

FIXED CHANGEABLE MESSAGE SIGN

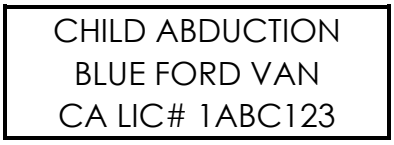
PORTABLE CHANGEABLE MESSAGE SIGN



- **AMBER Alert Messages**

AMBER Alert messages are typically a one-phase, three-line message that provides information to motorists on the abduction of a child. The message should display a vehicle description and license plate number (or partial number). The use of AMBER Alert is detailed in the CA MUTCD sections 2L.02.08 through 2L.02.19. An example of an AMBER Alert message is shown in Figure 3.6.

FIGURE 3.6
AMBER ALERT MESSAGES



Care should be used to compose the second line of an AMBER Alert message. The second line of an AMBER Alert message is the most important component of the message. It defines the message, and either makes or breaks the effort to convey information to the motorist. Oftentimes, the information provided from ENTAC on the vehicle description is more than what will fit on a single line. The CMS operator may need to omit some information and display only what is most helpful for the public. In general, motorists are less familiar with the vehicle year as compared to the vehicle color. For example, it is more effective to display: ***WHITE FORD WAGON*** rather than ***1986 FORD WAGON.***

- **Blue Alert Messages**

Blue Alert messages consist of a one- phase, three-line message that provides information on a suspect's vehicle to motorists following an attack on a law enforcement officer. The message should display a vehicle description and license plate number (or partial number). An example of a Blue Alert message is shown in Figure 3.7.

FIGURE 3.7
BLUE ALERT MESSAGES

CALL 911
BLUE FORD VAN
CA LIC# 1ABC123

As with the AMBER Alerts, care should be used to compose the second line of the message. The information provided by ENTAC on the vehicle description may be more than what will fit on a single line. The CMS operator may need to omit some information and display only what is most helpful for the public.

- **Travel Time Messages**

Travel Time Messages give motorists the estimated travel time from a FCMS to a specific downstream destination. Travel time information is especially useful for the daily commuter since the destination(s) listed on the FCMS will remain the same from day to day.

FCMS selected to display travel times are at locations that are decision points for commuters. FCMS display travel times during the morning and evening commute hours.

Travel time messages should only be used in corridors that experience recurring congestion where traffic conditions are dynamic enough that they are not viewed as static messages.

The format of the message will differ slightly depending on the number of destinations shown in the message but should be limited to one phase. The recommended formats are shown in Figure 3.8.

Travel times are automatically calculated based on data from TMS field elements and posted on the FCMS. Like any CMS message, accuracy is key to maintaining credibility. The difference in posted and actual travel times should not differ significantly.

FIGURE 3.8
TRAVEL TIME MESSAGES

Single Destination

MINUTES TO:	
DOWNTOWN	35

Two Destinations

MINUTES TO:	
BEACH BL	11
WESTMINSTER	19

Three Destinations

SFO ARPT	11 MIN
RTE 92	19 MIN
DALY CITY	7 MIN

Alternate Routes

MINUTES TO RTE 57:	
VIA RTE 10	14
VIA RTE 210	20

- **Alternative Route/Detour Messages**

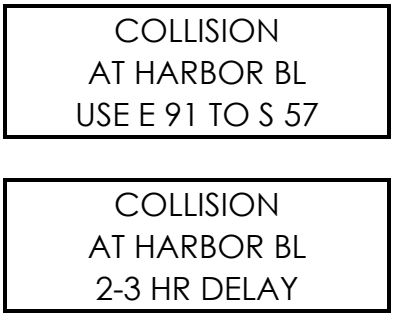
Alternative route/detour messages are used when an incident blocks or closes an exit or freeway interchange. This situation requires motorists to use

or take another route than originally intended. Motorists should not be detoured to arbitrary routes. The suggested detour route should be a route that contains adequate road signs so motorists can travel without getting lost. Before a recommended detour route is displayed on a CMS, the CMS Operator should know the current traffic conditions and current constraints on that route. The CMS Operator should also consult with the DTM to identify if alternate routes are available to detour motorists.

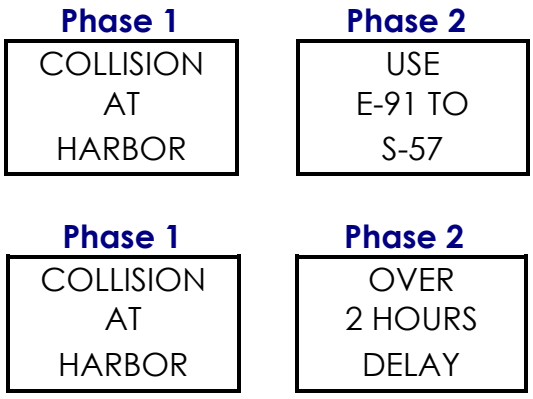
A simple message is needed to allow motorists a quick return to their original route. Examples of alternate route messages are shown in Figure 3.9.

FIGURE 3.9
ALTERNATIVE ROUTE MESSAGES

FIXED CHANGEABLE MESSAGE SIGN



PORTABLE CHANGEABLE MESSAGE SIGN



Alternate route messages are divided into two categories: Soft Detours and Hard Detours. A Soft Detour is an optional detour, for example **USE OTHER ROUTES**. A Hard Detour is a required detour, for example **USE NEXT EXIT / USE HIGHWAY 99**.

- **Use of CMS for Work Zones**

Whenever there are workers working on a highway, CMS may be used to inform motorists they are approaching a work zone. Using these signs will improve communication to the public and encourage them to slow down and be vigilant when they approach active work zones. Both FCMS and PCMS may be used.

FCMS located in advance of Caltrans work zones should display the following message:

FIXED CHANGEABLE MESSAGE SIGN

WORK ZONE AHEAD WATCH FOR HIGHWAY WORKERS

FCMS should only be activated for Caltrans work zones when workers will be working at a location longer than an hour, less than a day, and only when workers are present. Field staff are responsible for notifying the TMC as to when to activate and deactivate FCMS. PCMS should be used for longer duration work zones.

Use of FCMS for Caltrans work zones should be considered only when the FCMS is located five miles or less in advance of an active work zone.

Consider using additional PCMS at a decision point upstream of a work zone to indicate slow traffic ahead and suggest detours. These additional PCMS can help reduce the volume of motorists passing through the work zone.

PCMS, when used, should be placed within one mile of the work area with the following two-phase message:

PORTABLE CHANGEABLE MESSAGE SIGN

Phase 1	**Phase 2**
WORK ZONE AHEAD	WATCH FOR WORKERS

- **Statewide Safety Campaigns**

Caltrans is an active participant in safety campaigns and displays traffic/travel related safety messages on CMS in conjunction with nationwide or statewide safety campaigns as well as around holidays. A calendar of the messages to be displayed is developed every year by Caltrans in consultation with an advisory committee comprised of representatives from the other departments under the California State Transportation Agency that have significant traffic safety interests - CHP, Office of Traffic Safety and the Department of Motor Vehicles.

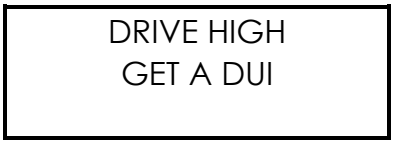
Regional/local safety campaigns can be implemented by the districts if the dates do not coincide with a statewide campaign and is done in conjunction with other regional safety efforts. The messages shall comply with the requirements of the CA MUTCD and these guidelines. Messages for regional/local campaigns need to be submitted for review and concurrence to the Headquarters CMS Coordinator. Proposed messages should be submitted at least two weeks in advance of the campaign to provide enough time for review.

Statewide or regional/local safety campaigns must be a coordinated effort with other agencies and using multiple media to clearly and effectively convey the travel/traffic related safety message.

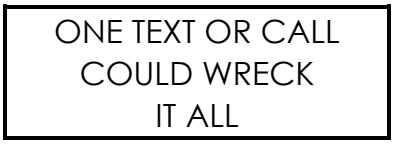
Examples of statewide safety campaign messages are shown in Figure 3.10.

FIGURE 3.10
SAFETY CAMPAIGN MESSAGES

Impaired Driving



Text



Motorcyclists

SHARE THE ROAD LOOK TWICE FOR MOTORCYCLISTS

Slow/Move Over

MOVE OVER OR SLOW FOR WORKERS IT'S THE LAW

Handheld Law

HANDHELD CELL AGAINST THE LAW AND DANGEROUS

Seatbelts

DO IT FOR YOUR FAMILY BUCKLE UP

Speeding

SLOW DOWN AND SAVE A LIFE

- **Emergency and Homeland Security Messages**

  Emergency and Homeland Security Messages originate in the Director's office at the request of the Secretary of the Office of Emergency Management under the authority granted in California Government Code 8587(a) (see below). Requests for these messages should come to the TMC via the Director's office or the Headquarters Division of Traffic Operations. Questions about the message priority of Emergency or Homeland Security Messages should be directed to the Headquarters CMS Coordinator. The priority of Emergency or Homeland Security Messages will vary depending on other events occurring at the time.

California Government Code 8587(a):

During a state of war emergency, a state of emergency, or a local emergency, the Secretary shall coordinate the emergency activities of all state agencies in connection with that emergency, and every State agency and officer shall cooperate with the secretary in rendering all possible assistance in carrying out the provisions of this chapter.

- **Message Priority**

  Message priority will be determined by the staff within the TMC and should comply with these guidelines.

  Safety is Caltrans' number one priority and any message related to an unforeseen traffic condition downstream of a CMS should be given priority on that CMS.

In cases where multiple CMS are available along a route or corridor, travel times may be displayed in conjunction with AMBER and Blue Alerts, but in the immediate vicinity of a kidnapping/assault, or along a corridor or route that has been identified as a most likely route for the vehicle of interest, priority should be given to the AMBER and Blue Alert messages.

The list below serves as a guideline, and it is understood that a mixture of signs may be used on any given corridor in order to best serve the traveling public (see Table 3.3 for an example of possible sign combinations along a route).

1. Incident Ahead
2. Lane Closures/Work Zones
3. Weather Related
4. Special Events
5. AMBER Alert
6. Blue Alert
7. Future Lane/Ramp Closures/Events
8. Travel Times
9. Safety Campaigns
10. Emergency or Homeland Security Message*****

***** The priority of Emergency or Homeland Security Messages will vary depending on other events occurring at the time.

The priority list primarily applies to FCMS, but it would also apply to remotely operated PCMS that function in the capacity of a FCMS.

TABLE 3.3
MESSAGE PRIORITY EXAMPLE

(Vehicle in area, no other information)

CO	RTE	PM	DIR	MESSAGE
LA	5	21.8	NB	Travel Time
LA	5	37.4	NB	AMBER Alert
LA	5	44.4	NB	Travel Time
LA	5	54.6	NB	Collision Ahead
LA	5	78.1	NB	AMBER Alert

(Vehicle last seen NB on I-5)

CO	RTE	PM	DIR	MESSAGE
LA	5	21.8	NB	AMBER Alert
LA	5	37.4	NB	AMBER Alert
LA	5	44.4	NB	AMBER Alert
LA	5	54.6	NB	Collision Ahead
LA	5	78.1	NB	AMBER Alert

Chapter 4 - EQUIPMENT

TYPICAL MODELS

When installed or placed, the CMS becomes a part of the total motorist traffic control system, acting in conjunction with existing roadway signs. Roadway signs display an unchanging message to motorists; therefore, the need for a CMS is prevalent for situations requiring time sensitive information. For this reason, both FCMS and PCMS are utilized. FCMS are placed in the median, shoulder or on over-crossings. PCMS can be temporarily placed in desired locations.

Here are some specifications for FCMS and PCMS. These models change over time and this is provided for information only.

FCMS Model 500

- Size 306" x 79.5"
- 3 lines of text
- 16 characters per line
- 18" characters
- Full Matrix Display
- Installed on freeways, expressways, and conventional highways

AMBER Alert on Model 500 FCMS

FCMS Model 510

- Size 230" x 53.75"
- 3 lines of text
- 16 characters per line
- 12" characters
- Full Matrix Display
- Installed on freeways, expressways, and conventional highways

Safety Message on Model 510 FCMS

FCMS Model 520

- Size 84" x 43.75"
- 3 lines of text
- 8 characters per line
- 12" characters
- Full Matrix Display
- Installed on conventional and rural highways

Message on Model 520 FCMS

Full Color FCMS Models 700, 710 and 720

- Size 300" x 86" (Model 710)
- 3 lines of text
- 16 characters per line
- 18" characters (Model 700)
- 12" characters (Models 710 and 720)
- Full Matrix Display
- Installed on freeways, expressways, and conventional highways

Color on MODEL 700 FCMS

PCMS Trailer-Mounted

Characteristics vary

- Sizes W80"x H56" or W115"x H80"
- 3 lines (based on 12" characters)
- 8 characters per line
- Full Matrix Display
- Can be left at location for duration of event

Advisory on PCMS

PCMS Truck-Mounted
Characteristics vary
- Size W80"x H56"
- 2-3 lines
- 8 characters per line
- Full Matrix Display
- Can be constantly repositioned, providing end of queue control

Incident Warning on Truck-Mounted PCMS

CMS TECHNOLOGY

There are several types of technology currently available for CMS. One of the technologies used by Caltrans is Light-Emitting Diode (LED).

LED Signs use a cluster of LED lamps to produce light. A bright amber LED currently produces the highest light output. The key advantage is the theoretical 100,000-hour life and solid-state design. Disadvantages include inconsistency of color, need for adequate ventilation and require screening from the sun. Currently, the entire fleet of PCMS at Caltrans is LED signs. Caltrans has decided to use LED signs for most applications.

USE OF GRAPHICS AND COLOR

- Graphics can be used on full-color CMS with pixel resolution that allows clear display of the graphics. Graphics should be limited to approved traffic control devices and symbols contained in the CA MUTCD and shall conform to the provisions of the CA MUTCD, including the use of borders and font cases. Images of vehicles may be used as part of AMBER alert messages.
- Graphics of traffic control devices and symbols can be displayed either in stand-alone fashion or as a supplement to text. Graphics may be used in place of text-only messages if the same meaning is conveyed to the motorist. When supplementing text, the graphic is be placed to the left of the text and vertically centered. Graphics may be used with one- or two-phase messages.
- Do not use graphics that have lettering smaller than 18". Any lettering smaller than that cannot be read at free flow speeds and will then be clutter on the sign. All the lettering shall conform to the CA MUTCD.

- If a black background is used, the color used for the legend on a CMS should match the background color that would be used on a standard sign for that type of legend, such as white for regulatory, yellow for warning, orange for temporary traffic control, red for stop or yield, fluorescent pink for incident management, and fluorescent yellow-green for bicycle, pedestrian, and school warning.
- If a green or blue background is used for a guide message or motorist services message respectively, the background color shall be provided by green or blue lighted pixels such that the entire CMS would be lighted, not just the text.
- Brightness or intensity of the message should be adjusted to the ambient light conditions. The use of background color in nighttime conditions should be limited. Full background color at night may cause a washout effect of the text or loss of resolution of the graphic. In addition, the sign could appear too bright to the driver in dark conditions.
- The use of color and graphics should be limited to those instances where they are expected to add benefit to the message being displayed. The overall message on the sign must adhere to the recommended units of information guidance to maximize understandability and reduce comprehension time.

CMS COORDINATION WITH OTHER FIELD ELEMENTS

A CMS can convey only a limited amount of information; therefore, when there is a need to provide extensive information to motorists, a CMS can be used in conjunction with other traveler information devices. These devices include, but is not limited to, the following:

- **Highway Advisory Radio (HAR)**

  HAR are used when there is a need to provide extensive roadway information to motorists, such as chain control or adverse weather conditions. HAR provides verbal recorded roadway information messages over radio signals that can be received when motorists tune to the designated radio stations in their vehicles.

- **Extinguishable Message Sign (EMS)**

  An EMS is used to display a fixed message such as **TUNE RADIO TO 1610 AM** or **ALL TRUCKS EXIT AT SCALES**. Another type of EMS is a roadside sign which displays fixed messages with flashing beacons to draw attention to the activated sign.

- **Flashing Beacon**

  Flashing beacon can be used in conjunction with the CMS, HAR, EMS or roadside signs to draw attention to the sign and its message.

- **Blank-Out Signs (BOS)**

  Blank-Out Signs display only a limited number of messages, but are much cheaper than CMS, consume much less energy and are very easy to operate. Blank-out signs that display only single-phase, predetermined electronic-display legends that are limited by their composition and arrangement of pixels or other illuminated forms in a fixed arrangement should comply with the provisions of the applicable Section in the CA MUTCD for the specific type of sign. Because such a sign is effectively an illuminated version of a static sign, the size of its legend elements, the overall size of the sign, and placement of the sign should comply with the applicable provisions for the static version of the sign.

Chapter 5 - DOCUMENTATION

Consistent documentation is used to evaluate CMS and its benefits to the motoring public.

TYPE OF INFORMATION

The following information should be recorded whenever a CMS is operated within the State right-of-way:

- Location/Route/Direction
- Messages displayed
- Date of usage
- Time on and off
- Reason for use, such as incident, event traffic guidance, traffic congestion, severe weather advisory, AMBER Alert, approved PSA, etc.
- Name of operator
- Name and Unit of person requesting the message or providing the information to use a CMS.

RETENTION OF DOCUMENTATION

A copy of all documentation should be kept on file by the District for the current calendar year plus three prior years.

Appendix A - ACRONYMS

AMBER..... . "America's Missing: Broadcast Emergency Response"
CAD..... Computer-Aided Dispatch
CHP..... California Highway Patrol
CMS..... Changeable Message Sign
CRZ..... Clear Recovery Zone
DOT..... Department of Transportation
DTM..... District Traffic Manager
EMS..... Extinguishable Message Sign
ENTAC..... Emergency Notification Tactical Alert Center
ETO..... Estimated Time of Opening
FAS..... Flashing Arrow Sign
FCMS..... Fixed Changeable Message Sign
FHWA..... Federal Highway Administration
FSP..... Freeway Service Patrol
JOPS..... Joint Operational Policy Statement
HAR..... Highway Advisory Radio
HazMat..... Hazardous Material
LED..... Light-Emitting Diode
MEP..... Maximum Enforcement Period (CHP)
MUTCD..... Manual on Uniform Traffic Control Devices
PCMS..... Portable Changeable Message Sign
RE..... Resident Engineer
TMC..... Transportation Management Center
TMP..... Traffic Management Plan
TMS..... Transportation Management System
TMT..... Traffic Management Team

Appendix B – GLOSSARY

AMBER Alert.....“The America’s Missing: Broadcast Emergency Response Alert” is a Plan through which emergency alerts are issued to notify the public about abductions of children.

Blocked (lanes).....Per FHWA, the term BLOCKED is recommended when an incident affects the lane and the police or traffic control personnel have not arrived to direct traffic around the incident. The term CLOSED is recommended after the police or traffic control personnel begin directing traffic out of the affected lane.

Blue Alert .....Blue Alerts are activated by CHP’s ENTAC, when a law enforcement officer has been assaulted and the suspect(s) are believed to be fleeing on a state highway.

Bottleneck .....A location where traffic demand wanting to use a section of roadway is greater than that section’s capacity

Clear Recovery Zone The unobstructed, relatively flat area beyond the edge of the traveled way which affords the drivers of errant vehicles the opportunity to regain control

Closed (lanes).....Per FHWA, the term CLOSED is recommended after the police or traffic control personnel begin directing traffic out of the affected lane. The term BLOCKED is recommended when an incident affects the lane and the police or traffic control personnel have not arrived to direct traffic around the incident.

Cone of Visibility .....The area inside which a CMS sign is visible, which is narrow near the sign and gradually increases in width as the distance from the sign increases, effectively creating a “cone”- shaped footprint on the pavement

Congestion.....A condition where a breakdown of traffic flow has occurred, and a queue begins to form because the amount of traffic approaching a section of highway exceeds the amount of traffic passing through it

Credibility .....Believability (credit, belief or trust; confidence)

Cycle ..... For multi-phase messages, the complete series of phases for a given message; the time within which a set of phases is complete

Appendix B – GLOSSARY (Con't)

Decision Point.....An interchange or intersection where a motorist must decide on a route

Display Time .....For multi-phase messages, the time in seconds that each phase will appear

Downstream .....Beyond or past a certain location, in the same direction of traffic

End-of-queue.....The upstream end of congestion

Extended Message....Multi-phase message

Frame.....A set of text displayed as one phase of an extended message

Full Matrix Display.....A bulb or LED array capable of displaying graphics, animation, and various sizes of text

Head of Queue .....The downstream most area of congestion

LED.....Light-emitting diode; a type of technology used for CMS luminance;

Legibility.....The ease in which a sign can be read or deciphered

Luminance.....A measure of the brightness of a luminous surface

Message .....All the text or characters being displayed, including all panels in multi-phase operation

Panel.....The physical part of a sign which displays the message; also used to reference a part of a message that is held by one panel, as in a multi-phase message

Phase .....The message displayed on a panel

Queue.....A waiting line (of vehicles); the area of congested traffic upstream of a bottleneck or incident scene

Recurrent.....Appearing or occurring again, or typically

Secondary Collision ..Collision which occurs in the queue of an initial collision, or as a result of an initial collision

Special Event….....A sporting event, concert, or other event likely to attract large numbers of attendees, potentially causing heavy traffic or congestion

Appendix B – GLOSSARY (Con't)

Taper ..... A section of cones laid out to divert vehicles out of a lane, shoulder, or away from an obstruction

Target Value ..... How well a CMS attracts the motorists' attention

Traveled Way ..... The portion of the roadway for the movement of vehicles, excluding shoulders

Upstream ..... In advance or prior to a certain location, in the direction of traffic

Appendix C – ABBREVIATIONS

ACCEPTABLE ABBREVIATIONS

***Note:* Where shown, prompt words should be used for clarification**

WORD	ABBREVIATION	POTENTIAL PROMPT WORD
Access	ACCS	ROAD
Afternoon/Evening	PM	
Ahead	AHD	ACCIDENT *
Alternate	ALT	ROUTE
Avenue	AVE, AV	
Bicycle	BIKE	
Blocked	BLKD, BLOCKD	LANE *
Boulevard	BLVD, BL	
Bridge	BRDG	(Name) *
Canyon	CYN	
Center	CNTR	
Chemical	CHEM	SPILL
Circle	CIR	
Closed	CLSD, CLOSD	LANE *
Condition	COND	TRAFFIC *
Congested	CONG	TRAFFIC *
Construction	CONST	AHEAD
Crossing (other than highway-rail)	XING	
Do Not	DONT	
Downtown	DWNTN	TRAFFIC
Drive	DR	
East	E	(Route #)

* These prompt words should precede the abbreviation

Appendix C – ABBREVIATIONS (Cont'd)

ACCEPTABLE ABBREVIATIONS

***Note:* Where shown, prompt words should be used for clarification**

WORD	ABBREVIATION	POTENTIAL PROMPT WORD
Emergency	EMER	
Entrance, Enter	ENT	
Exit	EX, EXT	NEXT *
Express	EXP	LANE
Expressway	EXPWY	
Feet	FT	
FM Radio	FM	
Freeway	FWY, FRWY	
Friday	FRI	
Frontage	FRNTG	ROAD
Hazardous	HAZ	CONDITIONS
Hazardous Material	HAZMAT	
Highway	HWY	
Hour(s)	HR	
Information	INFO	
Interstate	I-	(Route #)
Junction/Intersection	JCT	
Lane	LN	
Lanes	LNS	
Left	LFT **	LANE
Local	LOC	TRAFFIC
Lower	LWR	LEVEL

* These prompt words should precede the abbreviation

** LT for Left is not allowed per CA MUTCD Table 1A-3

Appendix C – ABBREVIATIONS (Cont'd)

ACCEPTABLE ABBREVIATIONS

***Note:* Where shown, prompt words should be used for clarification**

WORD	ABBREVIATION	POTENTIAL PROMPT WORD
Maintenance	MAINT	
Major	MAJ	ACCIDENT
Mile	MI	
Miles Per Hour	MPH	
Minor	MNR	ACCIDENT
Minute(s)	MIN	(Number) *
Monday	MON	
Morning/After Midnight	AM	
Nights	NITES	
Normal	NORM	
North	N	(Route #)
Oversized	OVRSZ	LOAD
Parking	PRKNG	
Parkway	PKWY	
Pavement	PVMT	ROUGH *
Pedestrian	PED	
Prepare	PREP	TO STOP
Required	REQ	CHAINS *
Right	RT	LANE
Road	RD	
Roadwork	RDWK	(Distance)
Route	RTE	(Route #)

* These prompt words should precede the abbreviation

Appendix C – ABBREVIATIONS (Cont'd)

ACCEPTABLE ABBREVIATIONS

***Note:* Where shown, prompt words should be used for clarification**

WORD	ABBREVIATION	POTENTIAL PROMPT WORD
Saturday	SAT	
Service	SERV	
Shoulder	SHLDR	
South	S	(Route #)
Speed	SPD	
Street	ST	
Sunday	SUN	
Telephone	PHONE	
Temporary	TEMP	
Thursday	THUR	
Traffic	TRAF	
Tuesday	TUE	
Two-Way Intersection	2-WAY	
Two-Wheeled Vehicles	CYCLES	
Upper	UPR	LEVEL
US Numbered Route	US	(Route #)
Vehicle(s)	VEH	ALL *
Visibility	VISB	REDUCED *
Warning	WARN	
Wednesday	WED	
West	W	(Route #)
Will Not	WONT	

* These prompt words should precede the abbreviation

Appendix C – ABBREVIATIONS (Cont'd)

ABBREVIATIONS TO BE AVOIDED

ABBREVIATION	INTENDED WORD	MISINTERPRETATIONS
ACC	Accident	Access (Road)
CLRS	Clears	Colors
EB	Eastbound (E)	
DLY	Delay	Daily
FDR	Feeder	Federal
I-5	Interstate 5	I S
L	Left	Lane (Merge)
LT*	Light (Traffic)	Left
NB	Northbound (N)	
PARK	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
SB	Southbound (S)	
SR	State Route	Senior
STAD	Stadium	Standard
WRNG	Warning	Wrong
WB	Westbound (W)	

* LT is not an acceptable abbreviation for the word Left. Use LITE as an abbreviation to indicate Lighting. Use LFT for the word Left, if necessary.

Appendix D – FIXED CMS MESSAGE EXAMPLES

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
Accident	COLLISION AHEAD		➢ Use the word **"COLLISION"** when signing for an accident. Only use the word "**AHEAD"** if the sign is less than a mile from the incident.
N, S, E, W Dashes or Slashes	E-60 AT AZUSA 2 RT LANES CLSD	2 RT LNS CLOSED EAST 60 AT AZUSA EB 60 AT AZUSA 2 RT LANES CLSD E/60 2 RT LANES CLSD AT AZUSA	➢ Use the letter designating direction **(N, S, E, W)** for the abbreviation. ➢ Don't use the abbreviation "EB", "WB", "NB", "SB" - this is an internal abbreviation and not familiar to all motorists. ➢ Using the dash is encouraged for connectivity. It is acceptable to leave it as a blank space. ➢ Avoid using slashes.
Order of Units of Information	E-60 AT AZUSA 2 RT LANES CLSD 3 RT LANES CLSD AT ARCHIBALD AVE W-10 AT CITRUS 2 RT LANES CLOSED	H2 RT LANES CLSD EAST 60 AT AZUSA W 10 2 RT LANES CLOSED AT CITRUS	➢ The general order of information is the Problem, Location, and **LANES CLOSED**/ Effect statement. ➢ State the Location before the **LANES CLOSED** information whenever possible. ➢ Separate the units of information (don't intermingle them) to make the message easier to comprehend. (such as keep the Location and **LANES CLOSED** information separate).

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
Closed vs. Blocked	COLLISION AHEAD LEFT LANES BLKD 2 RT LANES CLOSED AT MILLWOOD		➢ The term **"BLOCKED"** would be preferred for an accident, unless Maintenance had arrived and closed the lane with a formal closure. ➢ Use **"CLOSED"** when lanes are closed via a formal closure (such as cones, arrow boards, early warning signs, etc.)
Abbreviation	E-10 AT MILIKEN 3 RT LANES CLSD	E 10 AT MILIKEN 3 RT LNS CLSD	➢ A string of abbreviations makes it more difficult to comprehend. ➢ Avoid using consecutive abbreviations.
Use of ST, RD, and AVE	COLLISION AT GENESEE AV RT LANE BLOCKED COLLISION AT LOS CARNEROS SINGLE LANE ONLY 3 RT LANES CLOSD AT 8TH AVE TRAFFIC JAMMED	ACCIDENT LOS CARNEROS RD SINGLE LANE ONLY	➢ The modifiers of surface street names (such as, **ST, RD, AVE**) are not required and can be omitted. ➢ The modifiers should be omitted if doing so allows room for more important words. ➢ The modifiers are required if more than one street in the area have identical numeric names. In this case, there was an **8th ST** and an **8th AVE**.
Use of Numbers	COLLISION AT 17TH ST N-5 AT GENESEE 2 RT LANES CLOSED	ACCIDENT AT SEVENTEENTH ST N 5 AT GENESEE TWO RT LNS CLSD	Use numbers whenever possible.

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
"HWY", "FWY", "RTE", "I", or "SR"	COLLISION AT 5-FWY COLLISION AT HWY-57 COLLISION AT I-5	ACCIDENT AT SR-55	➢ Common Caltrans practice is to use **"HWY", "FWY" or "RTE"** to address the subject route. Be careful **"RTE"** doesn't get confused with **"RT"**. ➢ **"CA"** can also be used for state routes. ➢ **"SR"** is not considered a common abbreviation to the public and should not be used. ➢ **"I"** is still used to indicate "Interstate," especially when space is limited. A dash is encouraged to connect words (I-5).
Single-phase messages are preferred	3 RT LANES CLSD AT ROSEMEAD BL TRAFFIC JAMMED 3 RT LANES CLSD AT MICHILLINDA TRAFFIC JAMMED	3 RT LANES CLSD AT ROSEMEAD BL --- TRAFFIC JAMMED 3 RT LANES CLSD MICHILLINDA AVE --- TO BALDWIN AVE TRAFFIC JAMMED	➢ This information can be displayed on a single-phase 3 lines message, rather than a 2-phase message. ➢ The location of the beginning of the closure is useful to motorists. The lane closure limits are not as critical. In this case, forgoing the closure limits kept the message to a single phase.

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
Con-gestion after an incident is cleared from the roadway	TRAFFIC JAMMED CITRUS TO GRAND 30 MIN DELAY HEAVY TRAFFIC ROSEMEAD – GRAND TRAFFIC JAMMED TO ROSEMEAD SOUTH 880 JAMMED FRUITVALE TO HEGENBERGER RD		➢ Providing congestion limits is very effective and useful for motorists. ➢ When pressed for space, a dash can be used to replace the word **"TO"**, when conveying the limits between two points. ➢ Use **"TO"** instead of **"AT"** if the CMS is located in the traffic queue. ➢ Advising of congestion that is on a different freeway than the CMS.
CMS is on the same route as the incident	2 LFT LANES BLKD AT LAKE AVE	2 LEFT LANES AT LAKE BLOCKED	➢ No need to display the freeway route number. ➢ Problem stated on one line and Location stated on another.
Only one lane is open.	E-60 AT PECK RD SINGLE LANE ONLY SINGLE LANE ONLY AT GOVERNOR DR	E 60 AT PECK 3 RT LANES BLKD	**"SINGLE LANE ONLY"** has a great impact and provides a good description of the conditions to the motorists.

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
Off ramp or Freeway Con-nector closed	FAIRFAX EXIT CLOSED EAST 580 EXIT CLOSED	FAIRFAX OFF-RAMP CLOSED E 580 CONNECTOR CLOSED	The word **"EXIT"** is preferred when referring to an off ramp or freeway connector
Freeway Con-nector closed with recom-mended detour	W-10 EXIT CLOSED DETOUR USE VALLEY EXIT EAST 60 EXIT CLOSED USE EAST 10 TO SOUTH 710 SOUTH 5 EXIT CLOSED DETOUR USE W60 TO S 710	W 10 CONNECTOR CLOSED	If a detour is in place, the word **"EXIT"** is preferred when referring to a freeway connector.

EVENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
Freeway Connector (both directions) closed	RTE 10 EXITS CLOSED COLLISION HWY 101 EXITS BLOCKED		The word **"EXITS"** is preferred when referring to multiple locations of closures.
Off ramp partially blocked	COLLISION FAIRFAX EXIT BLOCKED		
Freeway Connector closed on another route	NORTH-710 TO WEST 105 EXIT CLOSED N-710 TO W-105 EXIT CLOSED N-710 TO W-105 EXIT CLOSED		Adding the dash in between the direction and route # is highly encouraged as it can improve the "aesthetics" and readability of the message.
Freeway Closed with recom-mended Detour	FREEWAY CLOSED AT CAPITOL AVE USE NEXT 2 EXITS FREEWAY CLOSED AT WESTLAKE BL --- DETOUR USE LINDERO CYN EXIT		

VENT/ SCENARIO	PREFERRED	AVOID	COMMENTS
More Example Messages	TRAFFIC INFO TUNE TO 1620 AM SLOW DENSE FOG AHEAD EXPRESS LANES CLOSED HONDA CENTER EXIT BALL RD		➢ ADDITIONAL INFORMATION ➢ The only desirable punctuation is a dash. Avoid periods, commas, quotes, etc. ➢ Make sure reference is a major cross street with signing on freeway. ➢ Never use the word ACCIDENT. Instead use COLLISION, CRASH, WRECK, or INCIDENT.
More Example Messages	CAUTION FLOODING AHEAD HIGH WINDS THRU TEJON PASS		➢ For off route incidents, use affected route and direction after the word **"CRASH"**. ➢ Only use the word **"AHEAD"** on signs one mile or less from an accident scene or event. ➢ Limit messages to two lines or one phase when possible.

Appendix E – PORTABLE CMS MESSAGE EXAMPLES

EVENT/ SCENARIO	PHASE 1	PHASE 2	COMMENTS
Accident	CRASH AHEAD	PREPARE TO STOP	One of the most commonly used PCMS messages to manage the end of queue. This message is generally used on TMT trucks.
N, S, E, W	S-133 EXPECT DELAY	MON – FRI 9AM - 3PM	Use the letter designating direction – use a dash or pace between the direction designation and the route number – do not use "NB", "SB", etc.
Advance Closure Notice	N-405 EXIT CLOSURE	FRI – 9 PM THRU MON – 5 AM	If a major ramp closure will have a significant impact on traffic, this advance notice is effective. Use days of the week (such as, MON, TUES) – avoid using calendar dates (such as, 3/14, SEPT 10).
Special Traffic Handling	ALL VEHICLES	CARPOOL LANE OK	
Special Traffic Handling	ALL VEHICLES	OK TO USE CARPOOL	

EVENT/ SCENARIO	PHASE 1	PHASE 2	COMMENTS
End Mixed HOV Lane	CARPOOL LANE	2 OR MORE PER VEHICLE	
Route Guidance	N – 5 DETOUR >>>>>>		
Route Guidance	NORTH 5 EXIT CLOSED	DETOUR USE TELEGRPH	
Route Guidance	N-101 EXIT CLOSED	DETOUR S-5 TO BROADWAY	
Advance notice	RAMP TO BE CLOSED	WED NIGHT 10 PM	
Advance notice	TRAFFIC INFO	TUNE TO 1620 AM	

EVENT/ SCENARIO	PHASE 1	PHASE 2	COMMENTS
Advance notice	CHAINS REQUIRED	SNOW TIRES 4 X 4 OK	
Advance notice	DENSE FOG AHEAD		
Advance notice	COLLISION EXIT 123 CLOSED		
Advance notice	TRAFFIC JAMMED	CITRUS TO GRAND	
Advance notice	EAST 60 AT PECK RD	SINGLE LANE ONLY	
Advance notice	LOCAL TRAFFIC ONLY		
Advance notice	HWY 123 CLSD AT LINCOLN	UNTIL 5 AM MONDAY	

EVENT/ SCENARIO	PHASE 1	PHASE 2	COMMENTS
Advance notice	HWY 123 CLSD AT LINCOLN	UNTIL 5 AM MONDAY	
Advance notice	HWY 123 TO BE CLOSED	NIGHTLY 8PM-5AM	
Advance notice	SLOW	RT LANE STOPPED AHEAD	
Advance notice	WORK ZONE AHEAD	WATCH FOR WORKERS	Per "Use of Changeable Message Signs for Work Zones" memorandum, dated August 5, 2011, portable CMS should be placed within one (1) mile of the work zone.

Appendix F – CALTRANS POLICY MEMORANDA

Joint Operational Policy Statement (JOPS): Blue Alert Activation JOPS states that the CMS can be used to display information regarding a suspect whose action has resulted in CHP officer suffering bodily injury or is an imminent threat to the general public and law enforcement officers. The CHP is responsible for issuing the Blue Alerts in order to help quickly and efficiently apprehend the suspect with the help of the general public.

Use of Changeable Message Signs for Work Zones (Caltrans, August 25, 2011)

Caltrans/CHP Blue Alert JOPS

DEPARTMENT OF TRANSPORTATION

AND

CALIFORNIA HIGHWAY PATROL

Joint Operational Policy Statement

Blue Alert Activation

GENERAL.

The California Department of Transportation (Caltrans) and the California Highway Patrol (CHP) have developed several special programs that increase safety and provide service to motorists. Safety is a primary concern for both agencies, and is central to the mission of each department. This policy statement discusses the use of the Changeable Message Signs (CMS) to support Blue Alerts and specifies the responsibilities of the two departments.

Section 8594.5 of the California Government Code requires the CHP to issue a Blue Alert upon the request of an authorized person at a law enforcement agency that is investigating an offense in which all of the following conditions are met:

1. A law enforcement officer has been killed, suffers serious bodily injury, or is assaulted with a deadly weapon, and the suspect has fled the scene of the offense.

2. A law enforcement agency investigating the offense has determined that the suspect poses an imminent threat to the public or other law enforcement personnel.

3. A detailed description of the suspect's vehicle or license plate is available for broadcast.

4. Public dissemination of available information may help avert further harm or accelerate apprehension of the suspect.

BLUE ALERT CMS ACTIVATIONS.

The CHP's Emergency Notification and Tactical Alert Center (ENTAC) has the responsibility for issuing Blue Alerts in order to solicit help from the public in the safe and swift apprehension of violent suspects who have killed or seriously

injured law enforcement officers and who continue to pose a threat to public safety. To assist in performing this duty, the CHP and Caltrans have agreed to activate the CMS in the area of the offense and in areas where the suspect vehicle is likely to be located.

Upon issuing a Blue Alert, ENTAC will contact the Transportation Management Center (TMC) in the district where the offense occurred and the TMCs in the districts they believe the suspect(s) may be fleeing towards and request activation of the CMS. The ENTAC will provide the TMC with the vehicle description, the license plate information, the location of the incident, and the direction the suspect(s) were last known to be heading.

The CHP and Caltrans have agreed on standard content and format for Blue Alert CMS messages. Any variation to the agreed format shall be jointly approved prior to Caltrans activating the CMS.

When the signs have been activated, Caltrans will notify ENTAC. The Blue Alert message may be preempted by Caltrans on specific signs when traffic conditions warrant posting of traffic management messages. Unless amplifying information is provided by ENTAC, Caltrans will discontinue the Blue Alert message on the CMS three hours after the message is first displayed. When ENTAC deactivates the Blue Alert, ENTAC personnel will immediately contact Caltrans and advise the message can be terminated

If Caltrans is contacted by a law enforcement agency other than the CHP for CMS activation, the call will be immediately forwarded to ENTAC for consideration.

For each Blue Alert in which a CMS is activated, the CHP will provide a copy of an after action report that contains at a minimum the statement that the suspect(s) were or were not apprehended due to a tip from a motorist who saw the CMS message.

MALCOLM DOUGHERTY, Acting Director
California Department
of Transportation

4/2/2012
Date

J. A. Farrow

JOSEPH A. FARROW, Commissioner
Department of California
Highway Patrol

4-19-12
Date

Use of CMS for Work Zones Memorandum

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: DISTRICT DIRECTORS
DEPUTY DISTRICT DIRECTOS

Date: **August** 25, 2011

From: RICHARD D. LAND
Acting Chief Deputy Director

Subject: **Use of Changeable Message Signs for Work Zones (Revised)**

Recent California Department of Transportation (Caltrans) highway worker fatalities have demonstrated the need for additional safety measures to help protect our employees. I want to emphasize that the use of changeable message signs (CMSs) to inform motorists they are approaching a Caltrans work zone can be invaluable. Using these signs will improve communication to the public and encourage them to slow down when they approach active work zones. This protocol does not apply to construction work zones. Construction has existing standards for CMS usage.

The following protocol should be used to display work zone messages on CMSs in advance of work zones:

1. Caltrans district staff should coordinate with their field staff and notify the Transportation Management Center (TMC) managers of estimated beginning and ending work times and locations where permanent CMSs should be activated (see attached TMC contact list).

2. Immediately prior to setting up a work zone, Caltrans field staff should notify the TMC that they are about to begin work to ensure that the CMSs are activated prior to the commencement of work.

3. TMC staff should consider using additional CMSs at decision points upstream of the work zone to indicate slow traffic ahead and suggest detours. These additional signs should help reduce the volume of travelers passing the work zone.

4. Permanent CMSs should only be activated for Caltrans work zones when Caltrans staff will be working at a location longer than one hour and only when workers are present.

5. Use of permanent CMSs for Caltrans work zones should be considered only when a sign is located five miles or less in advance of an active work zone.

6. Caltrans field staff should inform the TMC when work is completed, and workers have cleared the work zone in order to deactivate the CMSs in a timely manner.

7. **Permanent CMSs** posted in advance of Caltrans work zones should display the following message:

WORK ZONE AHEAD
WATCH FOR
HIGHWAY WORKERS

8. **Portable CMS** should be placed within one mile of the work area with the following two-phase message:

(Phase 1) WORK
ZONE
AHEAD

(Phase 2) WATCH
FOR
WORKERS

9. The worker safety message on permanent CMSs should be preempted when the signs are needed for emergency notifications, AMBER alerts, incidents, and major closures. Since Caltrans fieldwork normally is not scheduled during peak commute times, travel time usually will be placed on a CMS during those peak commute times. However, if urgent or emergency work requires land closures during peak commute times, the worker safety message should be placed on the CMS. When there are multiple demands for different messages on the CMS, the message priority should be discussed with the TMC Manager. TMC staff will do everything they can to display the safety message on the CMS in order to slow down drivers as they enter a work zone or to provide alternate route information so drivers can avoid the work zone.

This protocol will be incorporated into the appendices of the next revision of Caltrans *Changeable Message Sign Guidelines* expected to be published in the next six months.

The goal is to create a safer work environment for all highway workers that are in temporary work zones and are vulnerable to vehicles that drive past them.

For more information about using CMSs, please contact Diana Gomez, chief or the Office of System Management Operations in the Division of Traffic Operations, ad (916) 651-1255 or via Internal e-mail.

Thank you for your efforts to create the safe work environment our employees deserve.

Attachment

Appendix G– REFERENCES

California Manual on Uniform Traffic Control Devices – November 7, 2014
California: California Department of Transportation; Division of Traffic Operations, November 2014, as per Revision 5, March 29, 2020.

Federal Highway Administration Policy Memoranda.
http://www.fhwa.dot.gov/legsregs/directives/policy/index.htm

Federal Highway Administration TMC Pooled-Fund Study.
http://tmcpfs.ops.fhwa.dot.gov/index.cfm

Note: *Every attempt was made to cite reference sources used for this document. For questions, please contact the Headquarters CMS Coordinator.*

State of California
California State Transportation Agency
Department of Transportation