TRAFFIC AND SAFETY MANUAL

Chapter 2 – Signing
2E – Portable Changeable Message Signs

Guidelines for Portable CMS

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Description

A portable Changeable Message Sign (CMS) is a traffic control device with the flexibility to display a variety of messages to fit the changing needs of highway authorities. Each message consists of one or more displays. They are used most frequently on high-density, urban freeways, but have applications on all types of highways where alignment, traffic routing problems or other conditions require advance warning and information. The components of a CMS include the message sign panel, control systems, power source and mounting and transporting equipment. The sign panel is typically capable of displaying three lines of eight characters per line. It should be visible for one-half mile under ideal day and night conditions. Each message should be legible from all lanes for a minimum of 650 feet. The message panel should have adjustable flash rates, so that the entire message can be read at least twice at the prevailing speed.

Training

The type of training needed is dependant on each person's involvement with the use of portable CMS. Those who are responsible for message design and application must be familiar with the provisions of this document. District Traffic Technicians and others are available to conduct training in appropriate forums such as district construction or maintenance staff meetings.

When new units are purchased the successful vendor must provide training. The training is to include operation, service and upkeep. Those who will operate and maintain the new units should

attend this training. A manual that explains operation, service and upkeep is also to be provided by the vendor.

When a CMS is transferred from one location to another, the manual should accompany the unit and its operation should be explained to the appropriate people in the new location. Technical training is available from the Office of Maintenance, Repair Shop.

Operation

Changeable Message Signs are traffic control devices that have unique capabilities for communicating with drivers. As a result, they create high levels of expectations on the part of the motorist. It is critical that every effort be made to meet those expectations by ensuring that any message displayed:

- Fulfills an essential need.
- Commands the attention of the road user.
- Conveys a clear and simple message.
- Commands the respect of the road user.
- Gives adequate time for proper response.
- Provides timely information consistent with current conditions.
- Does not tell the drivers something they already know.

A CMS should only be operated when a message is needed for informational purposes. Routine long-time operation with a static message displayed will reduce the effectiveness of CMS units since a static message can be effectively displayed on a permanent post-mounted sign. A CMS is intended to be used to display messages that are timely and responsive to actual field conditions that are not readily apparent to drivers. When these conditions are no longer met the message should be removed.

CMS units should be located beyond the outside shoulder whenever practical and should be installed level so that displayed messages can be easily read. Leveling jacks are located on the four corners of the trailer to level the unit. The bottom of the message panel shall be a minimum of 7 feet above the surface of the roadway in urban areas and 5 feet above the roadway in rural areas when it is in operation. The message panel should be turned towards the roadway approximately 3 degrees from perpendicular to the edge of pavement as shown in Figure 1. This angle reduces glare from reflected sunlight, vehicle headlights, or the internal sign illumination itself.

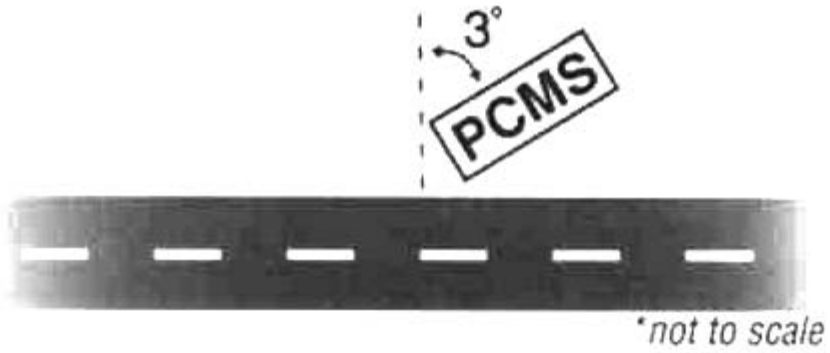


Figure 1

CMS units should never be located directly opposite each other on both sides of the highway, since the oncoming motorist will be unsure of which unit to read and may then miss an important message completely. When two separate units are needed for a particular situation, they should be

placed at least 500 feet apart on a two-lane rural road or 1,500 feet apart on the same side of the roadway on an expressway or freeway, so that one message can be understood before the next message is observed. For expressways and freeways, signs may be placed on both sides of the highway, separated longitudinally by at least 1,000 feet and displaying the same messages. The first one is to be placed on the right and the second one on the left.

Messages must be readily understood by motorists to allow them adequate time to react. Messages should be designed as described in the Message Design and Selection section. Changeable Message Signs are used primarily for temporary traffic control zones, traffic management for special events, incident management and extreme environmental conditions.

Temporary Traffic Control Zones

The primary purpose of portable changeable message signs in temporary traffic control zones is to advise the motorist of unexpected traffic delays or diversions ahead. Repeat motorists (i.e. familiar drivers) can become accustomed to a static message after a period of time and will begin to ignore the stale message. When a static message is later changed to describe a newer existing condition on the construction project, these repeat motorists may not read the new message. Prolonged operation of a CMS displaying a static message will reduce its effectiveness. They should not be used where a standard construction sign will suffice. Incorrect use of CMS units include: advertising special events; showing regulatory speed limits; as a replacement for an advance arrow panel; or happy messages, such as "Have A Good Day" or "Drive Safely".

When a CMS is used within a temporary traffic control zone, motorists expect the sign to furnish reliable, accurate and current information. All possible precautions should be taken to ensure that these expectations are met. This requires some effort by project staff to ensure that appropriate messages are displayed. Motorists may develop negative attitudes towards the DMS and the message if:

1. The message is incorrect or inappropriate for the current highway conditions ahead,
2. The information displayed is not easily understood or read in ample time to make the appropriate maneuver, or
3. The message tells the motorists something they already know.

For Department construction projects, CMS units are supplied by the Contractor per Specification Article 2528.03.B. CMS units used for construction projects will generally have a specific placement location included in the Incident Management Plan. These locations may need to be modified due to field conditions.

Typically, four CMS units are used for a rural head-to-head construction project. Two units are located for each direction of traffic for the construction project. The two units closest to the project are used to display congestion relief and warning messages. The two units furthest from the project area are used to display diversion messages. These advance units should be placed prior to an interchange preceding the temporary traffic control zone to aid in traffic diversions. Some projects will require the use of more units due to the increased number of alternate routes, interchanges close to the project limits or more than one section of a project under construction at the same time.

Other projects where volume is expected to exceed capacity can also benefit from this system.

CMS units are placed in advance of project related traffic control signing and should not replace any other signing required by the contract documents. A CMS used in conjunction with any temporary traffic control zone should be visible for at least 1/2 mile under both daytime and nighttime conditions. Messages should be legible for a minimum of 650 feet.

Typical Messages

Typical messages for construction project use are divided into three categories: (1) Congestion Relief, (2) Warning and (3) Diversion. A sample message for Congestion Relief is:

RT LANE CLOSED 4 MILES	And	MERGE LEFT

This message is to help alleviate congestion occurring at the lane merge location by giving advance notice to the motorist that a lane is closed ahead. Hopefully, many motorists will merge into the appropriate lane well in advance of the actual merge area, resulting in increased capacity of the merge area. This message is not to be used unless traffic volume is near the normal merge capacity. It should normally not be used with less than an equivalent rate of 1300 vehicles per hour. It is important to turn the unit off when there is no longer a need to encourage early merging to improve capacity. When traffic starts to back up, the following sample Warning message may be used:

TRAFFIC DELAY AHEAD	And	PREPARE TO STOP

This message is to warn approaching motorists that congestion at the lane merge is starting to cause backups. The congestion is due to traffic volume exceeding the capacity of the merge from two lanes to one lane. Congestion and backups may be due to other causes such as a temporary road closure or crash. Motorists are being advised by this message to watch for stopped vehicles on the highway ahead. This message should not be used unless traffic is congested, or it is anticipated that congestion is imminent.

When capacity problems start to occur on the mainline, it is recommended that interchange on-ramps located in advance of or within the project be temporarily closed. Closure of on-ramps will eliminate a potential traffic conflict area, while also relieving traffic congestion. It is recommended to close on-ramps only when traffic congestion problems occur. After the congestion is relieved, the on-ramps should be reopened.

When an incident occurs and it is determined that its duration will warrant diversion, a sample Diversion message may be:

I-80 CLOSED AHEAD	And	TAKE EXIT 164

This message informs motorists that the highway is closed ahead and an alternate incident management route is to be used. State and local law enforcement are involved in relieving traffic congestion during diversions. They may have closed the highway and are forcing all motorists to exit and follow the previously trail-blazed route around the construction project.

Project inspection staff or contractor's surveillance staff should be used to activate the CMS units for Congestion Relief and Warning messages. Contractor surveillance staff may be allowed

to activate a CMS only after approval of the Resident Construction Engineer. Only maintenance staff should activate diversion messages, since diverting highway traffic includes local maintenance personnel helping direct traffic in conjunction with State and local law enforcement. Local maintenance personnel may be needed to quickly erect additional diversionary or trailblazing signs to smoothly redirect the diverted traffic.

Any project that is utilizing CMS units to display Congestion Relief, Warning, or Diversion messages needs to have close communication between construction and maintenance personnel. It is especially important for the Highway Maintenance Supervisor to be involved with all communications relating to project traffic control and incident handling.

The project incident management diversion route map and a list of pre-approved messages should be kept in a weatherproof folder secured inside the CMS. This folder should also include a brief step-by-step set of instructions detailing the remote start-up operation requirements of the CMS. Copies of the incident management diversion route and pre-approved messages should also be filed with the Project Inspector, Highway Maintenance Supervisor, District Maintenance Manager, Resident Construction Engineer, and Assistant District Engineer.

Traffic Management For Special Events

Changeable Message Signs can be of great value in managing special event traffic, but they should not replace fixed message signing which is to be furnished and placed by the sponsoring organization as required by Iowa Administrative Rule 761-131.6(321). The best use of the changeable message sign for special events is to assist with management of traffic in a way that static signing can-not. Static signing can be used to direct traffic but a CMS provides the flexibility to display warning messages or to redirect traffic in case an incident occurs. The CMS should be used in a way which fits into a traffic management plan for the event. The plan should be designed by a team having representation of the sponsor, law enforcement, operations staff and engineering staff of appropriate jurisdictions including the Department of Transportation.

Incident Management

Changeable Message Signs may be used if available to assist law enforcement personnel with traffic management when an incident occurs. If the incident will be of sufficient duration to warrant traffic diversion, the sign should be used in conjunction with standard signs and channelizing devices to detour traffic using the appropriate standard or detail sheet. The changeable message sign may also be used to display a warning message if traffic is continuing past the incident at reduced speeds, causing congestion and back up. Use of the sign for incident management is to be in the context of Maintenance Instructional Memorandum 1.255 unless it is within a temporary traffic control zone for which a specific Incident Management Plan has been written.

Extreme Environmental Conditions

Traffic control on interstate or other freeways during emergencies is to be handled as set forth in Policy 610.17. The same messages provided on fixed message signs at the traffic diversion locations listed in the policy are suitable for use on CMS. Similar messages may be used at other locations as required by conditions. Portable CMS can be useful in rerouting traffic to avoid flooding, but fixed message signs should be considered for locations that routinely flood. They can also be used to divert traffic around locations where motorists encounter fog that is generated by a nearby industry. In this case the units may be dedicated to that use during the season of the year when it tends to occur.

Message Design And Selection

Programmed Messages

When operating a portable changeable message sign, it is necessary to use messages that are readily understood by drivers. This may be done by using standard sign messages that are included in the programmed memory of the CMS control system or that have been designed later and stored in memory.

Customized Messages

When the standard messages do not fulfill the needs, a customized message should be used. The following information should be useful in designing customized messages. The State Traffic Engineer will provide assistance with message design at the request of the District Office.

Messages should be designed taking into account the following factors:

- No more than two displays should be used for any message for speeds of more than 45 mph.
- Messages should be as brief as possible.
- Abbreviations should be easily understood.
- The entire message cycle should be readable at least twice.
- Messages shall not scroll or travel horizontally or vertically across the face of the sign.
- Graphics and symbols shall not be used.

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)

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.

Message length is limited by reading time - a good rule of thumb is that a driver will need at least two seconds per display to read and recall a well designed message. The entire message should be legible at least twice at the prevailing operating speed. This requires a message to be no longer than two displays when the prevailing speed is 55 mph or more. Table 1 shows display rates for speeds of 35 mph to 65 mph. It includes only two panel displays. The table is based on the CMS being placed 10 feet from the edge of the pavement.

Table 1
Message Display Rate

MPH	35		45		55		65	
Number of Lanes	2	3	2	3	2	3	2	3
Sec/Display	3.0	3.0	3.0	2.9	2.8	2.4	2.4	2.0
	3.0	3.0	3.0	2.9	2.8	2.4	2.4	2.0
	-	-	-	-	-	-	-	-

Single display messages should be sequenced at a display rate of 3 seconds

Abbreviations

Abbreviations are acceptable, with a maximum of one per display. Tables 2, 3 and 4 show acceptable and unacceptable abbreviations from the MUTCD.

Table 2
MUTCD Acceptable Abbreviations

Word Message	Standard Abbreviation
Afternoon / Evening	PM
Alternate	ALT
Avenue	AVE
Boulevard	BLVD
Center	CNTR
Drive	DR
East	E
Emergency	EMER
Entrance, Enter	ENT
Expressway	EXPWY
Feet	FT
FM Radio	FM
Freeway	FRWY, FWY
Friday	FRI
Hazardous Material	HAZMAT
Highway	HWY
Information	INFO
Junction / Intersection	JCT
Lane	LN
Left	LFT
Maintenance	MAINT
Mile(s)	MI
Miles Per Hour	MPH or M.P.H.
Minute(s)	MIN
Monday	MON

Word Message	Standard Abbreviation
Morning / Late Night	AM
Normal	NORM
North	N
Parking	PKING
Right	RHT
Road	RD
Saturday	SAT
Service	SERV
Shoulder	SHLDR
Slippery	SLIP
South	S
Speed	SPD
Street	ST
Sunday	SUN
Temporary	TEMP
Thursday	THURS
Traffic	TRAF
Travelers	TRAVLRS
Tuesday	TUES
US Numbered Route	US
Vehicles	VEH
Warning	WARN
Wednesday	WED
West	W

Table 3
Abbreviations That Are Acceptable With a Prompt Word

Word Message	Acceptable Abbreviation	Prompt Word
Access	ACCS	Road
Ahead	AHD	FOG*
Blocked	BLKD	Lane*
Bridge	BRDG	*[name]**
Chemical	CHEM	Spill
Condition	COND	Traffic*
Congested	CONG	Traffic*
Construction	CONST	Ahead
Downtown	DWNTN	Traffic*

Eastbound	E-BND	Traffic
Exit	EX, EXT	Next*
Express	EXP	Lane
Frontage	FRNTG	Road
Hazardous	HAZ	Driving
Interstate	I	*[number]*
Local	LOC	Traffic
Lower	LWR	Level
Major	MAJ	Accident
Mile(s)	MI	*[number]*
Minor	MNR	Accident
Northbound	N-BND	Traffic
Minute(s)	MIN	*[number]*
Oversized	OVRSZ	Load
Prepare	PREP	To Stop
Pavement	PVMT	Wet*
Quality	QLTY	Air*
Roadwork	RDWK	Ahead
Route	RT	Best*
Southbound	S-BND	Traffic
Township	TWNSHP	Limits
Turnpike	TRNPK	*[name]**
Upper	UPR	Level
Vehicle	VEH	Stalled*
Westbound	W-BND	Traffic

*** These prompt words should precede the abbreviation**

Table 4
Unacceptable Abbreviations

Abbreviation	Intended Word	Common Misinterpretations
ACC	Accident	Access (Road)
CLRS	Clears	Colors
DLY	Delay	Daily
FDR	Feeder	Federal
L	Left	Lane (Merge)
Lt	Light (Traffic)	Left
Park	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

Message Formatting

Message formatting is the arrangement of informational units to form a total message. Compatibility must be maintained between words within a display and between message displays 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.

Word and Phrase Meanings

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 abbreviating the word *CONSTRUCTION*. 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.

Calendar Dates

If it is desired to notify motorists of upcoming roadwork or of a special event that will impact traffic, the use of days of the week (e.g., *TUE – THUR*) rather than calendar dates (e.g., *OCT 10 – OCT 12*) is preferred.

Sample Messages

It is not possible to list messages for all situations for which the use of CMS would be appropriate. These messages should be viewed as examples and used only if they will provide accurate and timely information necessary for a given situation. The fact that they are listed here does not mean that they should be used if the information can be adequately presented with fixed message signing. Many of the listed displays can be combined to provide cohesive information. An example is LFT LANE CLOSED 4 MILES and TRAFFIC DELAY AHEAD. A Message Programming Sheet follows the sample message listing.

SAMPLE MESSAGE LISTING

	DISPLAY 1	DISPLAY 2
1.	TRAFFIC/DELAY/AHEAD	PREPARE/TO/STOP
2.	LFT LANE/CLOSED/4 MILES	MERGE/RIGHT
3.	RHT LANE/CLOSED/4 MILES	MERGE/LEFT
4.	I-35/CLOSED/AHEAD	TAKE/EXIT 124
5.	CONST/DELAY/AHEAD	ALT/ROUTE/EXIT NOW
6.	I-235/CLOSED/AHEAD	THRU/TRAFFIC/USE I-35
7.	ROAD/CLOSED/AT 141	TAKE/NEXT/EXIT
8.	I-80/CLOSED/AT 141	TAKE/NEXT/EXIT
9.	ART/FESTIVAL	USE/3RD / STREET
10.	PREPARE/TO/STOP	20/MINUTE/DELAY

11.	SAFETY/CHECK	4 MILES/AHEAD
12.	I-235/CLOSED	USE/I-80
13.	CONCERT/TRAFFIC	TAKE/EXIT 113
14.	HWY 30/CLOSED/10 MILES	USE/HWY 17
15.	I-235/CLOSED/7 MILES	THRU/TRAFFIC/USE I-80
16.	I-80/CLOSED/40 MILES	SNOW/BLOCKAGE
17.	RAMP/CLOSED/AHEAD	TAKE/EXIT xxx
18.	SHARP/CURVE/AHEAD	MAX/SPEED/35 MPH
19.	ROUGH/ROAD/AHEAD	
20.	CONST/DELAY/AHEAD	THRU/TRAFFIC/USE 235
21.	BLOWING/SNOW	NEXT/20/MILES
22.	WATCH/FOR/TRUCKS	STAY/ALERT
23.	ACCIDENT/AHEAD	USE/RIGHT/LANE
24.	SIGNAL/NOT/WORKING	STOP/AHEAD
25.	SIGNAL/ACTIVE/TUESDAY (day of week) for use when activating a new signal	
26.	TRAFFIC/SIGNAL/AHEAD for use when activating a new signal	
27.	BUTMP/AHEAD	
28.	KEEP/OFF/SHOULDER	
29.	TRUCKS/USE/RHT LANE	
30.	LANES /SHIFT	STAY/IN/LANE
31.	LEFT/TWO/LANES	CLOSED/AHEAD
32.	FRESH/OIL	ON/SHOULDER
33.	NARROW/ROAD/10 FEET	WIDE/LOADS/EXIT NOW

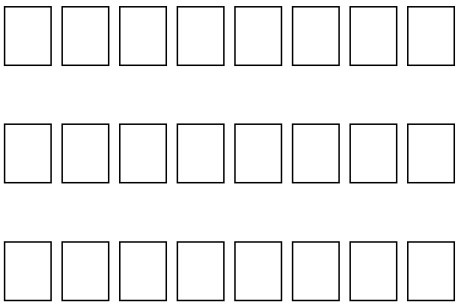
PROGRAMMING SHEET FOR PORTABLE CMS

Location of CMS: _____

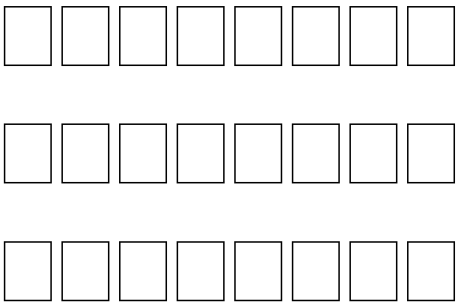
Used: from _____- _____ - _____ at _____: _____ am / pm
to _____- _____ - _____ at _____: _____ am / pm

Message programmed by: _____

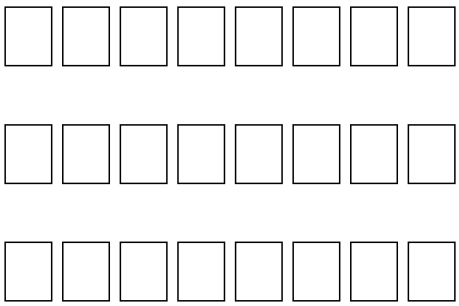
DISPLAY 1



DISPLAY 2



DISPLAY 3



Timing:

Message 1 will run ____:____ seconds.

Message 2 will run ____:____ seconds.

Message 3 will run ____:____ seconds.

NOTES_____

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