TRAFFIC AND SAFETY MANUAL

Message Design

Originally Issued: 12-16-05, Last Revised: 12-16-05

Introduction

To be effective, a CMS must communicate a meaningful message that can be read and comprehended by motorists within a very short time period. Human factors and traffic operations research have led to the development of fundamental principles and guidelines for CMS message design. The principles and guidelines are based on a solid understanding of motorist physical and information-processing capabilities and are valid *so long as they are consistently and properly applied*.

Basic Message Design Considerations

Knowledge of basic message design considerations is a necessary prelude to designing and displaying effective messages. Message design involves recognition of the basic principles for the following:

- ***Message content*** refers to specific information displayed on a CMS. Essentially, what is wrong ahead and what the motorist should do about it are the key elements.
- ***Message length*** refers to either the number of words or the number of characters and spaces in a CMS message.
- ***Message load*** refers to the amount of information in the total message, usually expressed in terms of units of information (informational unit).
- ***Unit of Information (Informational Unit)*** refers to the answer to a question a motorist might ask. Stated another way, a unit of information is each data item in a message that a motorist could use to make a decision. Each answer is one unit of information. A unit of information typically is one to three words, but at times can be up to four words. The message in the following table has five units of information and serves to illustrate the concept of units of information.

UNITS OF INFORMATION

Question		Answer		Info Unit
1. What happened?	,	ACCIDENT	,	1 unit
2. Where?	,	AT EXIT 12	,	1 unit
3. What effect on traffic?	,	MAJOR DELAY	,	1 unit
4. Who is advisory for?	,	NEW YORK	,	1 unit
5. What is advised?	,	USE ROUTE 46	,	1 unit

- ***Message format*** refers to the order and arrangement of the units of information on a CMS.

Message Content

If CMSs are to be read and believed by motorists, the content of the message must provide information relative to the wants of the motorist. Above all, motorists want to know if something "ahead" has occurred on the roadway that requires some action on their part such as changing routes. If an incident did occur or roadwork is taking place, then the motorist wants to know the location. If the incident or roadwork is far away, it may not affect them because they planned to exit long before then. Motorists also want to know the effects of the incident or roadwork. Since it is difficult for agencies to accurately estimate delay, the effects of the incident or roadwork can be given in terms of the number of lanes closed (or open).

A CMS message should also present "advice." This appears at the end of the brief message. It may be *REDUCE SPEED, EXIT AND TAKE OTHER ROUTES*, or some other advice.

Advice may be ignored unless a reason is offered for the advice. The "reason" in most cases is implied by the problem (e.g., *MAJOR ACCIDENT*) or the effect of the problem (e.g., *2 LEFT LANES CLOSED*). However, an explicit reason statement may sometimes be used in a message (e.g., *AVOID 20 MIN DELAY*).

Message Length

Because of limited CMS line capacity, it becomes necessary to count the characters in a message to determine if the message will fit. If the message does not fit then approaches to reducing the message length must be employed such as a) the use of acceptable abbreviations, b) elimination of redundant words, and/or c) partition of the message in two frames. It may at times be necessary to reduce the message content. The following subsections deal with various aspects related to message length.

Reading Time

The maximum allowable length of a CMS message is controlled in part by *reading time*--the time the motorist has available to read the message. Reading time is affected by a) the time that the motorist is within the legibility zone of the CMS message, and b) by the amount of activity in the traffic stream which the motorist must attend to (e.g., reading signs, adjusting vehicle speed, lane positioning, etc.). The entire message must be short enough to allow motorists to glance at the sign (often multiple times) and read and comprehend the message while attending to the driving situation.

Message Familiarity

Message familiarity enhances motorist reading time. When information displayed on a CMS is unfamiliar or when the information being presented is unusual, longer reading times will be required. Obviously, site-specific characteristics and normal CMS operating procedures dictate what information is usual and what is not, and so this factor varies from location to location.

Driver Workload

Motorists must time-share their attention to the roadway, to traffic, and to reading signs. Adults can read quite fast while sitting at home or while in stopped traffic. However, motorists cannot always devote full attention to reading a CMS while moving. Often drivers must pay attention to more than one task while driving (e.g., driving the vehicle and reading the information on a CMS). In this example, because these tasks must be time-shared, it will take longer to read the CMS than if all of their attention was to be dedicated to the sign.

Reading the CMS Message

Another important consideration is that motorists must generally read the entire message on a CMS to properly comprehend its meaning. In contrast, they do not have to read the entire guide sign to obtain relevant information about guidance. Therefore, it takes a motorist longer to read a CMS message than to read the message on a guide sign.

Maximum Message Length

In a driving situation, the motorist has a limited amount of time to read a message on a sign. He/she can start reading a sign when the words become legible at the *legibility distance* of the sign. About 85 percent of motorists can begin reading a message on LED CMSs with 18-inch characters at about 650 feet. Research strongly suggests that motorists can read an 8-word message (excluding prepositions such as *TO* and *AT*) in 8 seconds, or one word per second. Based on the known legibility distance of CMSs, this translates to a maximum message length of 8 words while motorists are traveling at 55 mph and 7 words at 65 mph. Longer messages should be avoided because motorists will often reduce their speeds in order to read the message.

Need to Reduce Message Length

When the complexity of the driving situation increases due to extremes in geometrics, heavier traffic volumes, increased traffic conflicts (e.g., merging, lane changing), or climatic conditions, motorists will attend to those information needs they feel are most important to them and to their safety. These demands on the motorist will result in less time available to read the sign message.

In addition, lighting and environmental conditions change. For example, during part of the day, the sun may not affect the legibility of the CMS. However, at those times of the day where the sun shines directly in the eyes of the motorist, the legibility of the distance at which the motorist can read the sign message can be greatly reduced. It may be necessary to reduce the length of the message to account for the reduced visibility during these times.

The CMS message designer should always look for ways to reduce the message length without losing the intent of the message. Unfortunately, there is too much temptation on the part of the message designer to use as much of the space on a CMS as possible. The thought being "if it fits on the CMS, the message is OK." However, this philosophy results in messages that are too long and sometimes too difficult for motorists to read under prevailing speeds. Reducing message length can sometimes be accomplished by using alternative phrases that are understandable by motorists and have the same meaning as the original. Also, there may be redundancy or unimportant information in the message that can be omitted.

Units of Information

Research and operational experience indicate that no more than four units of information should be in a CMS message when the operating speeds are 35 mph or more. No more than five units of information should be displayed when the operating speeds are less than 35 mph.

In addition, no more than three units of information should be displayed on a single message frame.

Normally, only one unit of information appears on each line of the CMS. However, a unit of information may be displayed on more than one line. A sign line, however, should not contain more than two units of information.

When a CMS message meeting all informational requirements exceeds the maximum number of units of information that should be displayed on a single sign, tradeoffs must be made to determine what elements of the messages should be omitted.

Message Format

The CMS message must contain the proper information in the expected order to allow motorists to easily read and interpret the information and make rational decisions based on that information.

Placement of message elements on the wrong line or in the wrong sequence will result in driver confusion and will increase the time it takes drivers to read messages. Conversely, consistent formatting of information enhances motorist expectations and reduces the time required to read and understand messages.

The Basic CMS Message

Introduction

It has been stated in some publications that the CMS messages for incidents and roadwork should display the following message elements in the order shown:

- Problem
- Location of problem
- Recommended driver action

However, an examination of typical messages indicates that, although these are desirable message elements, it is not always possible to provide information on each element because:

- Sign space and sign legibility constraints may require the CMS operator to reduce the number of informational units that are displayed; and
- It may be beneficial to substitute other message elements for the *Problem* and *Action* with other message elements that will convey more useful information.

Two examples for one-frame messages are shown below. In the first example, Message 2 with *Problem*, *Location*, and *Lanes Affected* message elements contains more useful information than Message 1 with *Problem*, *Location*, and *Action* message elements. Displaying *2 LEFT LANES CLOSED* in Message 2 not only implies that motorists should merge right, but also gives some indication of the degree of the problem by informing motorists of the number of lanes closed.

ACCIDENT **PAST ROWLAND** **KEEP RIGHT**	*(Problem)* *(Location)* *(Action)*	**ACCIDENT** **PAST ROWLAND** **2 LEFT LANES CLOSED**	*(Problem)* *(Location)* *(Lanes Affected)*
Message 1		Message 2	

In the second example, Message 2 shows a substitution of the *Problem* with a *Lanes Affected* message element that informs the driver about the direction of lane change necessary to move out of the closed lanes.

ROADWORK **PAST ROWLAND** **USE OTHER ROUTES**	*(Problem)* *(Location)* *(Action)*	**2 LEFT LANES CLOSED** **PAST ROWLAND** **USE OTHER ROUTES**	*(Lanes Affected)* *(Location)* *(Action)*
Message 1		Message 2	

General Concept of Basic CMS Message

The *Basic CMS Message* is the sum total of all the information that motorists need on the CMS in order to make a fully informed driving decision (e.g., whether to take an alternative route). In most cases, the Basic CMS Message will exceed the maximum amount of informational units that should be displayed on a CMS. Therefore, the Basic CMS Message must be reduced in length and content to allow motorists to read, understand, and react to the message.

The Basic CMS Message elements are as follows:

- ***Incident/Roadwork Descriptor*** informs the motorist of the unusual situation;
- ***Incident/Roadwork Location*** informs the motorist about the location of the unusual situation and thus must directly follow the *Incident/Roadwork Descriptor;*
- ***Lanes Affected*** gives specific information about which lanes or exit ramps are closed or blocked;

- ***Closure Descriptor*** is used in place of the *Incident/Roadwork Descriptor* when all lanes on the facility or exit ramp are closed;
- ***Location of Closure*** specifically states the location of the freeway closure and is used in place of the *Incident/Roadwork Location;*
- ***Effect on Travel*** (e.g., *MAJOR DELAY*) informs the motorist of the severity of the situation (i.e., delay or travel time) and helps the motorist make decisions about whether diversion is appropriate;
- ***Audience for Action*** is used when the *Action* message element applies to a specific group of motorists rather than all of the motorists traveling past the CMS;
- ***Action*** message element tells the motorist what to do; and
- ***Good Reason for Following the Action*** gives a motorist confidence that following the advice on the CMS will result in safer travel and/or significant savings in time.

The *Effect on Travel* and *Good Reason for Following the Action* message elements are oftentimes implied by other elements and need not always be displayed. The possible Basic CMS Message elements for various incident and roadwork scenarios are summarized in Table 1.

It should be noted that the specific terms for the *Incident/Roadwork Location*, *Lanes Affected*, and *Action* message elements will be different depending upon whether the CMS is on a) the same freeway and relatively close to the incident/roadwork; b) the same freeway but relatively far from the incident/roadwork; or c) a different freeway than the incident/roadwork.

Table 1
Possible Basic CMS Message Elements in a Message

Message Element	Incidents			Roadwork	
	Lane(s) Closed	**Freeway Blocked[A]**	**Freeway Closed**	**Lane(s) Closed**	**Freeway Closed**
Incident/ Roadwork Descriptor	X	X	X	X	X
Incident/Roadwork Location	X	X		X	
Lanes Affected	X	X	X	X	X
Closure Descriptor			X		X
Location of Closure			X		X
Effect on Travel	X	X	X	X	
Audience for Action	X	X	X	X	
Action	X	X	X	X	X
Good Reason for Following the Action	X	X	X	X	

[A] **"**Motorists interpret 'blocked" as a temporary blockage due to an incident, whereas "closed" indicates a prolonged closure and would be used when law enforcement personnel arrive and close the freeway.

Incident/Roadwork Descriptor

Having a small number of descriptors that induce driver response will a) reduce the number of descriptors that need to be placed in the computer CMS message library, and b) enhance consistency of displayed messages. Displaying specific descriptors should be avoided. For example *ACCIDENT* is preferred to more exact descriptions such as *VEHICLE OVERTURNED*. Note that the word *accident* is recommended rather than *crash*. *Crash* is not a common term used by the general public, so displaying the word may increase drivers' reading times. Some useful descriptors are:

- ACCIDENT
- MINOR ACCIDENT
- MAJOR ACCIDENT
- ROADWORK

- SPILLED LOAD
- BROKEN PAVEMENT
- FOG

Incident/Roadwork Location

The *Incident/Roadwork Location* message element must directly follow the *Incident/Roadwork Descriptor*. Knowing the location helps the motorist in making judgments as to the distance he/she could be affected. It also provides basic information that can help a motorist determine whether or not he/she wants to leave the freeway. If a motorist decides to leave the freeway, it also helps determine where the motorist can return to the freeway.

Referencing Location for Familiar and Unfamiliar Motorists

The location can be defined in terms of specific highways, streets, exit ramps, exit ramp numbers or prominent landmarks, or in terms of distance ahead. Results of research shows that in some cases commuters and visitors have different informational needs. The visitor has very limited information about a city other than interstate route numbers, whereas, commuters understand most of the intersecting and parallel streets. Thus, messages with local street or highway names familiar to commuters may not be understood by motorists unfamiliar with the area. Also, abbreviations used for local landmarks, bridges, and entertainment and recreational facilities may not be well understood by motorists unfamiliar with the area.

Messages for commuters and motorists familiar with the area should be referenced to highways, streets, exit ramps, exit ramp numbers, or prominent landmarks. Motorists unfamiliar with the area prefer to have the location referenced by distance or exit ramp numbers.

When a majority of motorists are commuters, the incident/roadwork location should be referenced to the nearest cross-street or exit ramp. Commuters are highly familiar with cross-street names and exit ramp names (or numbers). When there are no cross-streets or exit ramps in the vicinity of the incident, a prominent landmark (airport, factory, etc.) may be substituted.

When a majority of motorists would be unfamiliar with the names of local cross-streets, the incident/roadwork location should be described in distances to the nearest half-mile. Where numbers are used for exit ramps, the incident location can be referenced by the exit ramp number.

ACCIDENT AT ROWLAND	ACCIDENT AT EXIT 12	ACCIDENT 1 MILE
For motorists familiar with the area	For all motorists	For motorists unfamiliar with the area

When a lane is closed, it is advisable to display both where the lane closure begins and where it ends. This information is useful to the motorist in assessing where to return to the freeway if he/she leaves the freeway to avoid the congestion. An example follows.

LEFT LANE CLOSED FROM EXIT 12 TO EXIT 14
Shows where the lane closure begins and ends

Modifiers to Street, Road, and Avenue Names

The abbreviations *ST*, *RD* and *AVE* are used with the names of streets, roads and avenues, respectively. These abbreviations are not required and could be omitted. However, these abbreviations must be used for streets and avenues with the same numeric names in the region (e.g., *7TH ST* vs. *7TH AVE*). An example follows.

ACCIDENT AT ROWLAND	ACCIDENT AT 7TH AVE
AVE not required	*AVE required*

Descriptors for Location

Some common descriptors are listed below.

1 MILE ***(AHEAD)***

[number] **MILES** ***(AHEAD)***

AT *[highway name, street name, exit ramp number, exit ramp name, landmark]*

NEAR *[highway name, street name, exit ramp number, exit ramp name, landmark]*

BEFORE *[highway name, street name, exit ramp number, exit ramp name, landmark]*

PAST *[highway name, street name, exit ramp number, exit ramp name, landmark]*

The advantage of *BEFORE* and *PAST* is that they give the driver information about the location of the incident or roadwork relative to the highway, street, exit, or landmark. This information helps the motorists familiar with the area to know:

- Whether the incident will have an impact on the driver's ability to use the exit ramp near the location of the incident; and
- Which entrance ramps downstream of the incident can be used to reenter the freeway.

The information is particularly useful when the incident/roadwork is near a major freeway-to-freeway interchange.

CMS on Same Freeway as Incident/Roadwork

If the CMS is on the same freeway as the incident or roadwork, there is no need to display the freeway route number or name because motorists will assume the incident/roadwork is on the same freeway. The sign space could be used to display other information, or the number of units or information could be reduced.

CMS on Different Freeway than Incident/Roadwork

When displaying information about an incident that has occurred on an intersecting freeway, the route number or name must be displayed. An example of a message that can be used when the crash occurs on a downstream intersecting freeway (e.g., I-75 South) is shown below. Note that only the *Problem* and *Location* message elements can be displayed on a one-frame message.

MAJOR ACCIDENT	*(Problem)*
ON I-75 SOUTH AT OXFORD	*(Location)*

A common error in displaying this message is to divide and separate the *Location* descriptor within the message. An example is shown below:

I-75 SOUTH	*(Location)*
MAJOR ACCIDENT	*(Problem)*
AT OXFORD	*(Location)*

This message format violates the principles of a) displaying the location after the problem, and b) keeping compatible message units together.

Lanes Affected

The *Lanes Affected* message element gives specific information about which lanes or exit ramps are closed or blocked. It helps the driver make a decision (e.g., merge into an open lane, reduce speed, leave the freeway, use another exit ramp, etc.).

Acceptable terms when one lane is affected on the left or right side of the freeway are listed below.

LEFT LANE CLOSED	**LEFT LANE BLOCKED**
RIGHT LANE CLOSED	**RIGHT LANE BLOCKED**

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.

When more than one lane is affected on either the left or right side of the roadway, then the following terms are acceptable:

***[number]* LEFT LANES CLOSED**	***[number]* LEFT LANES BLOCKED**
***[number]* RIGHT LANES CLOSED**	***[number]* RIGHT LANES BLOCKED**

When the center lane of a three-lane directional freeway is affected, then the descriptors CENTER LANE CLOSED and CENTER LANE BLOCKED are acceptable. The *Lanes Affected* descriptors discussed above apply to cases where the number of freeway lanes at the incident location is the same as the number of lanes at the CMS location. In these cases, the driver will know that on a three-lane directional section, for example, if two lanes are closed, only one is open. However, there are many situations where the number of through lanes downstream is not the same as at the CMS location. Thus, it may be more appropriate to display the number of lanes that are open rather than the number closed. Acceptable descriptors are **1 LANE OPEN** and [number] **LANES OPEN**. When all of the lanes are affected by the incident then the ALL LANES CLOSED or ALL LANES BLOCKED descriptors can be used:

Closure Descriptor

The *Closure Descriptor* message element is used when the police or traffic control personnel close all lanes on the freeway or exit ramp. It can be used in place of the *Incident/Roadwork Descriptor* and displayed on the top line of the CMS. An example of replacing an *Incident Descriptor* with the more meaningful *Lanes Affected Descriptor* is shown below.

ACCIDENT **PAST ROWLAND** **ALL LANES CLOSED**	*(Problem)* *(Location)* *(Lanes Affected)*	**FREEWAY CLOSED** **AT ROWLAND** **FOLLOW DETOUR**	*(Lanes Affected)* *(Location)* *(Action)*

Closure Location

The location of a freeway closure will be at an exit ramp that will normally be different than the actual incident location. The *Location of Closure* message element specifically states the location where the freeway is closed and would be used in place of the *Incident/Roadwork Location*. Typical *Location of Closure* descriptors are shown below.

- **1 MILE *(AHEAD)***
- ***[number]* MILES *(AHEAD)***
- **AT *[exit ramp number, exit ramp name]***

Effect on Travel

The Effect on Travel message element informs the motorist of the severity of the situation in terms of delay or travel time and helps the motorist make informed decisions about whether diversion is appropriate. In addition, it can imply the expected arrival time (in general terms) to the motorist's destination.

Delay

Motorists interpret *DELAY* (shown in minutes) as being relative to their normal expected travel time to traverse the freeway and arrive at their destination. *DELAY* implies that it will take that much longer than usual. *DELAY* does not mean that the motorist will be held up in traffic at one location for that long or that it will take that long to remove an incident.

Delay information can be displayed in terms of "*[number]* Minutes Delay," "Avoid *[number]* Minutes Delay," or "Save *[number]* Minutes." If the delay is expressed in the first form, it refers to travel time on the primary route and should appear in the CMS message after the *Incident/Roadwork Descriptor* and the *Incident/Roadwork Location* (if displayed). If delay is expressed in terms of "Avoid *[number]* Minutes Delay," or "Save *[number]* Minutes," the reference is to an advantage of using the alternative route and should appear after the *Action* message element that mentions the alternative route. The following examples illustrate the different ways that delay information could be displayed.

20 MIN DELAY **TAKE US-33**	**TAKE US-33** **AVOID 20 MIN DELAY**	**TAKE US-33** **SAVE 20 MIN**
Example of xx MIN DELAY	Example of AVOID xx MIN DELAY	Example of SAVE xx MIN

Specific delay times used must be reasonably accurate because motorist confidence in the CMS system can be adversely affected by the display of inaccurate information.

As an alternative to displaying a specific delay value, it is safer to display generic information such as **MAJOR DELAY or MINOR DELAY**.

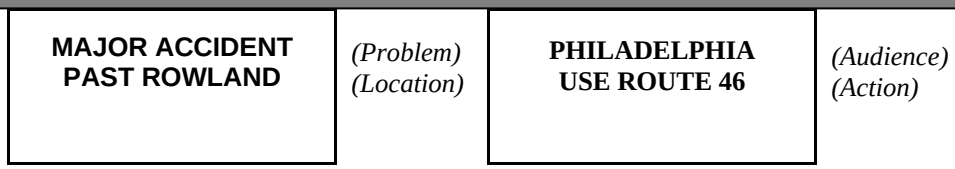
Sometimes the *Effect on Travel* element can be combined with the *Incident/Roadwork Descriptor*. In the case of delay, the **MAJOR ACCIDENT** and **MINOR ACCIDENT** descriptors have specific meaning to motorists in terms of delay.

Audience for Action

The *Audience for Action* message element is used when the *Action* applies to a specific group of motorists rather than all of the motorists traveling past the CMS. It alerts a specific group of motorists that the action part of the message applies to them. When the *Audience for Action* applies to all motorists on the highway at the location of the CMS, then the statement is not displayed. When the *Action* applies to only a segment of the motorists, then the *Audience for Action* message element should be displayed. Alerting only the motorists to whom the action applies avoids confusion. Motorists expect that when they see an *Audience for Action* message element on the CMS, they will also see an *Action* message element. An *Audience for Action* message element must always be accompanied with an *Action* statement.

MAJOR ACCIDENT **PAST ROWLAND**	*(Problem)* *(Location)*	**USE** **OTHER ROUTES**	*(Action)*
Message Frame 1		Message Frame 2	

Action message element applies to all drivers passing CMS



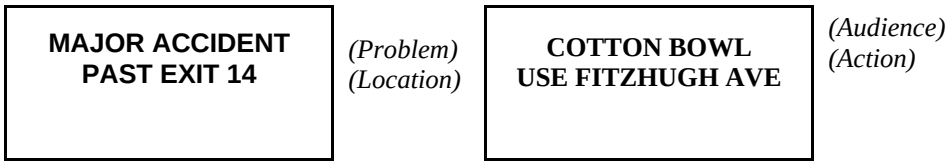
Message Frame 1 Message Frame 2

Action message element applies to a specific group of drivers (Philadelphia traffic)

The CMS message designer must know the intended audience for the message that will be displayed. In some cases, commuters and visitors have different informational needs. The visitor has very limited information about a city other than interstate route numbers, whereas, commuters understand most of the intersecting and parallel streets. Thus, messages with local street or highway names familiar to commuters may not be understood by motorists unfamiliar with the area. Also, the same is true for abbreviations used for local landmarks, bridges, and entertainment and recreational facilities. City destinations appearing on a CMS must be identical to those appearing on existing static signs.

Generally, the word *TRAFFIC* after a destination is not necessary. The reader of a sign can only be a motorist who is a part of the traffic stream, so *NEW YORK, TAKE NEXT EXIT* can only mean *NEW YORK TRAFFIC, TAKE NEXT EXIT*.

The primary exception to this message design principle is when the location of the incident--either in terms of the cross street, miles ahead, or simply *AHEAD*--is not displayed, it is frequently necessary to display *TRAFFIC* after the destination. The following examples are presented to illustrate messages for a major event.



Message Frame 1 Message Frame 2

"TRAFFIC" not required

"TRAFFIC" required

If *TRAFFIC* were omitted from the second message, motorists could interpret the message to mean that a crash occurred near the site of the Cotton Bowl.

Action

The *Action* message element is necessary because it tells the motorist what to do. Every incident management CMS message should have an action statement. Omitting the *Action* leaves the motorist with a great deal of uncertainty as to the best course of action. The *Action* message element will vary depending upon whether the CMS is on the same freeway as the incident or on an upstream intersecting freeway.

Action message elements are classified according to signing situations that involve either a "No diversion" or a "Diversion."

No Diversion

When there is no need to encourage drivers to divert from the freeway, then typical action message elements for CMSs located on the same freeway as the incident are as follows:

PREPARE TO STOP

REDUCE SPEED

Diversion to a Non-Specific Route (Soft Diversion)

A Soft Diversion Action message element is used when drivers are advised to take other routes but the specific route is not specified in the CMS message. It might be displayed for a variety of reasons including:

- The CMS operator is unaware of the traffic conditions on the most logical alternative routes
- It is important to display an Action before the CMS operator has had a chance to assess the full impact of the incident
- It is important to display an Action before the police arrive and establish positive diversion routes

Typical descriptors for soft diversion messages are listed below.

USE OTHER ROUTES
EXIT AND USE OTHER ROUTES

The term *USE OTHER ROUTES* is preferred to *USE ALTERNATE ROUTES* because it is shorter and well understood by drivers.

Diversion to a Specific Route

In this case, drivers are advised to take a specific alternative route. A requirement for diversion routes is the availability of surveillance on the diversion route. The CMS operator must know the conditions on the alternative route before messages advising drivers to use that route are displayed. Acceptable terms for the *Action* message element are shown below for diversion to a pre-established route that is designated as the detour route when emergency conditions require closing the freeway or to the roadwork detour specified in the Traffic Control Plan. Note that the cardinal direction must be included when applicable.

EXIT AND FOLLOW DETOUR

EXIT AND FOLLOW SIGNS

EXIT AT *[highway name, street name, route number]* /

FOLLOW DETOUR

EXIT AT *[highway name, street name, route number]* /

FOLLOW SIGNS

TAKE *[exit ramp name]* EXIT /

FOLLOW DETOUR

TAKE *[exit ramp name]* EXIT /

FOLLOW SIGNS

TAKE EXIT *[exit ramp number]* /

FOLLOW DETOUR

TAKE EXIT *[exit ramp number]* /

FOLLOW SIGNS

TAKE *[highway name, street name, route number]* /

FOLLOW DETOUR

TAKE *[highway name, street name, route number]* /

FOLLOW SIGNS

Good Reason for Following the Action

When a motorist is advised to take an alternative route, he/she must be confident that it is the correct decision and that doing so will result in significant savings in time. Therefore, the motorist should be given a *Good Reason for Following the Action*. In most cases, the good reason is implied through the *Incident* or *Roadwork Descriptor*, *Lanes Affected* and *Effect on Travel* elements of the message and need not be displayed separately. For example, *MAJOR ACCIDENT* implies major delay and gives the reason for following the advice. However, in other situations, a specific *Good Reason for Following the Action* may be needed. When needed, the following message elements are acceptable:

AVOID DELAY

AVOID MAJOR DELAY

BEST ROUTE TO *[destination]*

If the delay and/or travel times can be accurately estimated, then specific information can be displayed as follows:

AVOID *[number]* MIN DELA

SAVE *[number]* MIN

Examples of messages that include a *Good Reason for Following the Action* are shown below:

KYLE STADIUM USE OXFORD AVE AVOID MAJOR DELAY	BEST ROUTE TO KYLE STADIUM USE OXFORD AVE
KYLE STADIUM USE OXFORD AVE AVOID 20 MIN DELAY	KYLE STADIUM USE OXFORD AVE SAVE 20 MIN

Reducing Units of Information From the Basic CMS Message

In most cases, a Basic CMS Message for the incident or roadwork situation will contain more units of information than is acceptable to display for the prevailing freeway speed and current environmental conditions. Therefore, the number of units of information must be reduced. The CMS message designer should first use the *Initial Reduction Approaches* and then the *Secondary Reduction Approaches* that are discussed in the sections that follow. After these approaches are applied, then the message designer should follow the *Priority Reduction Principles*.

Initial Reduction Approaches

CMS messages should be as short as possible. Therefore, the message designer should look for ways to reduce long messages or Basic CMS Messages that exceed the maximum number of information units that should be displayed for the given situation. Units of information can be reduced without losing information content or the important information by

- Omitting unimportant words/phrases
- Omitting redundant information
- Combining Basic CMS Message elements

Omitting Unimportant Words/Phrases

At times it is possible to use alternative phrases that are understandable by motorists and have the same meaning as the original. The example below illustrates how message length can be reduced.

The Original Message:

ROAD CLOSED AHEAD
DUE TO CONSTRUCTION
FOLLOW DETOUR ROUTE

Can Be Shortened To:

ROAD CLOSED
1 MILE
FOLLOW DETOUR

With Better Results.

In the above, the most important message elements are the road is closed and the location of the closure. The reason *DUE TO CONSTRUCTION* is not necessary to display and can be omitted. In addition, the word *AHEAD* can be omitted because it is obvious to motorists by simply stating *ROAD CLOSED.*

Omitting Evident or Redundant Information

It is not necessary nor is it desirable to make reference to the freeway if the CMS is on the same freeway as the incident/roadwork. For example, if a major crash occurs on northbound I-276 just past I-80 which blocks all the lanes, reference to *ON I-276 NORTH* in the first example message in Table 2 should be omitted since this information is evident to motorists and increases the units of information and the length of the message. In the second example in Table 2, the *Action* message element (i.e., *KEEP RIGHT*) is redundant to the *Lanes Affected* message element (i.e., *2 LEFT LANES CLOSED*), and should be omitted. It is obvious that motorists should move to the right lanes if the left lanes are closed.

Table 2
Examples of Omitting Evident or Redundant Information

Message Element and Message	Revised Message
<u>Incident on Same Freeway as CMS</u> *Incident Descriptor* **MAJOR ACCIDENT** *Location* **ON I-276 NORTH** **PAST I-80** *Lanes Affected* **ALL LANES BLOCKED**	**MAJOR ACCIDENT** **PAST I-80** **ALL LANES BLOCKED**
<u>Redundant Lane Affected and Action Message Elements</u> *Incident Descriptor* **MAJOR ACCIDENT** *Location* **PAST EXIT 32** *Lanes Affected* **2 LEFT LANES CLOSED** *Action* **KEEP RIGHT**	**MAJOR ACCIDENT** **PAST EXIT 32** **2 LEFT LANES CLOSED**

Combining Basic CMS Message Elements

In an effort to reduce the length of CMS messages, it is sometimes necessary and, in most cases, useful to combine the *Incident Descriptor*, *Incident Location* and *Lanes Affected* message elements. For example, when a major crash occurs that blocks all of the lanes, the term *FREEWAY BLOCKED* can be used in place of the longer combination of *MAJOR ACCIDENT* and *ALL LANES BLOCKED*. Examples of combining *Incident Descriptor*, *Incident Location* and *Lanes Affected* message elements are shown in Table 3.

When the freeway is closed and a detour route set in place with signs, police and/or traffic control personnel, and the CMS is on the same freeway and close to the closure, then the *Location of Closure* message element becomes unnecessary to display because it will be contained in the *Action*

message element. One of the examples in Table 3 is repeated in Table 4 to illustrate the concept. Also in Table 4, the *Location of Closure* (*AT I-80*) is combined with the *Action* (*EXIT AT I-80/ FOLLOW DETOUR*) and should be omitted because it is redundant.

When motorists are about to encounter roadwork on the freeway, it is more important for them to know that lanes are closed and, more specifically which lanes are closed, rather than be given information on a CMS that roadwork is taking place on the freeway. The information about the roadwork will ordinarily be displayed on static signs as part of the work zone traffic control plan, and displaying the information on a CMS is redundant and takes up space needed for more relevant information. For example, if roadwork requires closure of the two left freeway lanes, the *Roadwork Descriptor (ROADWORK)* can be omitted on the first line of the CMS and replaced with the *Lanes Closed* message element *2 LEFT LANES CLOSED* as shown in Table 5.

When the CMS gives information about roadwork closures on an intersecting freeway, it is oftentimes desirable and necessary to combine the *Roadwork Descriptor*, *Closure Location*, and *Lanes Closed* message elements. An example is shown in Table 6.

When the freeway is closed and a detour route set in place with signs, police and/or traffic control personnel, and the CMS is on the same freeway and close to the closure, then the *Location of Closure* message element becomes unnecessary to display because it will be contained in the *Action* message element. One of the examples in Table 3 is repeated in Table 7 to illustrate the concept. In Table 7, the *Location of Closure (AT I-80)* is combined with the *Action* (*EXIT AT I-80/ FOLLOW DETOUR)* and should be omitted because it is redundant.

Table 3
Examples of Combining *Incident Descriptor, Incident Location* and *Lanes Affected* Message Elements

Message Element and Message		Revised Message
Incident on Same Freeway as CMS		
Incident Descriptor	**MAJOR ACCIDENT**	**FREEWAY BLOCKED**
Location	**PAST I-80**	**PAST I-80**
Lanes Affected	**ALL LANES BLOCKED**	
Incident on Another Freeway than CMS		
Incident Descriptor	**MAJOR ACCIDENT**	**I-76 WEST BLOCKED**
Location	**ON I-76 WEST** **AT WALT WHITMAN BRIDGE**	**AT WALT WHITMAN BRIDGE**
Lanes Affected	**ALL LANES BLOCKED**	
Closed Roadway Due to Incident on Same Freeway as CMS		
Incident Descriptor	**TRUCK ACCIDENT**	**FREEWAY CLOSED**
Location	**PAST I-80**	
Lanes Affected	**ALL LANES CLOSED**	
Location of Closure	**AT I-80**	
Audience for Action	**I-287 NORTH TRAFFIC**	
Action	**EXIT AT I-80** **FOLLOW DETOUR**	**EXIT AT I-80** **FOLLOW DETOUR**
Closed Exit Ramp at Major Interchange on Same Freeway as CMS		
Incident Descriptor	**MAJOR ACCIDENT**	**RAMP CLOSED**
Location	**ON I-80 EAST RAMP**	

Lanes Affected	**RAMP CLOSED**	
Location of Closure	**TO I-80 EAST**	**TO I-80 EAST**
Audience for Action	**I-287 NORTH TRAFFIC**	
Action	**EXIT AT US-10**	**EXIT AT US-10**
	FOLLOW DETOUR	**FOLLOW DETOUR**

Table 4
Example of Combining *Location of Closure* Message Element With *Action* Message Element

Message Element and Message		Revised Message
Closed Roadway Due to Incident on Same Freeway as CMS		
Incident Descriptor	**TRUCK ACCIDENT**	**FREEWAY CLOSED**
Location	**PAST I-80**	
Lanes Affected	**ALL LANES CLOSED**	
Location of Closure	**AT I-80**	
Audience for Action	**I-287 NORTH TRAFFIC**	
Action	**EXIT AT I-80**	**EXIT AT I-80**
	FOLLOW DETOUR	**FOLLOW DETOUR**

Table 5
Examples of Combining *Roadwork Descriptor* with *Lanes Closed* Message Element

Message Element and Message		Revised Message
Roadwork on Same Freeway as CMS		
Roadwork Descriptor	**ROADWORK**	**2 LEFT LANES CLOSED**
Lane Closure Location	**PAST I-80**	**PAST I-80**
Lanes Closed	**2 LEFT LANES CLOSED**	
Roadwork on Same Freeway as CMS		
Roadwork Descriptor	**ROADWORK**	**2 LEFT LANES CLOSED**
Lane Closure Location	**AT EXIT 42**	**AT EXIT 42**
Lanes Closed	**2 LEFT LANES CLOSED**	
Closed Roadway Due to Roadwork on Same Freeway as CMS		
Roadwork Descriptor	**ROADWORK**	**FREEWAY CLOSED**
Lane Closure Location	**AT ROUTE 46**	
Lanes Closed	**ALL LANES CLOSED**	
Location of Closure	**I-80**	
Audience for Action	**I-287 NORTH TRAFFIC**	
Action	**EXIT AT I-80**	**EXIT AT I-80**
	FOLLOW DETOUR	**FOLLOW DETOUR**

Table 6
Example of Combining *Roadwork Descriptor, Closure Location* and *Lanes Closed* Message Elements

Message Element and Message		Revised Message
Roadwork on Different Highway than CMS		
Roadwork Descriptor	**ROADWORK**	**I-80 EAST CLOSED**
Closure Location	**ON I-80 EAST**	**FROM EXIT 52**
	FROM EXIT 52	**TO EXIT 53**
	TO EXIT 53	
Lanes Closed	**ALL LANES CLOSED**	*(Note: The above message can be shortened by using EXIT 52 – EXIT 53, thus eliminating the third line.)*

Table 7
Example of Combining *Location of Closure* Message Element and *Action* Message Element

Message Element and Message		Revised Message
Closed Roadway Due to Roadwork on Same Freeway as CMS		
Roadwork Descriptor	**ROADWORK**	**FREEWAY CLOSED**
Lane Closure Location	**AT RIVERSIDE**	
Lanes Closed	**ALL LANES CLOSED**	
Location of Closure	**AT I-80**	
Audience for Action	**I-287 NORTH TRAFFIC**	
Action	**EXIT AT I-80**	**EXIT AT I-80**
	FOLLOW DETOUR	**FOLLOW DETOUR**

Secondary Reduction Approach

After the Initial Reduction Approaches have been applied to the Basic CMS Message, it may still be possible to reduce the number of informational units, if required, when the *Action* message element contains more than two *Audiences*. A decision will have to be made by the message designer concerning which of the two *Audiences* should be addressed in the message. The second *Audience* must then be omitted from the *Action* message element. In the example shown in Table 8, a Basic CMS Message with eight units of information was reduced to the message shown on the left side.

Table 8
Example of Reducing Number of Destinations in the *Action* Message Element

Reduced Message After Applying Initial Reduction Approaches		Revised Message	
Roadwork on Different Highway than CMS			
I-76 CLOSED	**BEST ROUTE TO PHILADELPHIA/ I-95 USE RTE 73 NORTH**	**I-76 CLOSED**	**BEST ROUTE TO PHILADELPHIA USE RTE-73 NORTH**
Frame 1	*Frame 2*	*Frame 1*	*Frame 2*

The original message has the following five units of information:

- *I-76 CLOSED* 1 unit
- *BEST ROUTE TO* 1 unit
- *PHILADELPHIA/ I-95* 2 units

- *USE RTE-73 NORTH* 1 unit

Five units of information exceed the maximum number of units that motorists can read and comprehend while traveling at high freeway speeds. The message must therefore be reduced to four units of information. In the revised message, the destination *I-95* is omitted in preference to *PHILADELPHIA*, resulting in an acceptable four-unit message.

- *I-76 CLOSED* 1 unit
- *BEST ROUTE TO* 1 unit
- *PHILADELPHIA* 1 unit
- *USE RTE-73 NORTH* 1 unit

Priority Reduction Principles

After the Initial and the Secondary Reduction Approaches are applied and the Basic CMS Message still has more units of information than should be displayed to motorists at the prevailing freeway speed, then the Priority Reduction Principles discussed in this section should be applied.

There is a priority of information that motorists need in order to make driving decisions when incidents occur or lanes are closed due to roadwork. The information needed by motorists in order of priority for incidents and roadwork is shown in Tables 9 and 10.

Table 9
Information Order of Priority For Incidents

Message Elements For Lane Closure Incidents	Message Elements For Freeway Closure Incidents
1. Lane Closure (Blockage	1. Freeway Closure (Blocked)
2. Lane Closure Location	2. Location of Closure
3. Diversion Action	3. Diversion Action
4. Audience for Action (if needed)	4. Audience for Action (if needed)

Table 10
Information Order of Priority For Roadwork

Message Elements For Lane Closure for Roadwork	Message Elements For Freeway Closure for Roadwork
1. Lane Closure (Blockage)	1. Freeway Closure (Blocked)
2. Lane Closure Location	2. Location of Closure
3. Action Concerning Speed Reductions	3. Action Concerning Speed Reductions
4. Diversion Action	4. Diversion Action
5. Audience for Action (if needed)	5. Audience for Action (if needed)

Although *the Incident Descriptor* and the *Roadwork Descriptor* are useful to motorists, these message elements can be replaced with the *Lanes Closed* message element.

When the number of information units exceeds the maximum that should be displayed under prevailing speeds and the Initial Reduction Approaches and the Secondary Reduction Approach have been applied, then the message designer must begin eliminating informational units. **This is done by eliminating units of information starting with the lowest priority.**

Reducing Message Length

Message length can be reduced without losing the intent of the message by:

- Deleting “dead” words, and/or
- Using abbreviations.

Deleting “Dead” Words

“Dead” words should be deleted whenever possible. "Dead” words are ones that 99 percent of local motorists would assume without being told. One example of a “dead” word is the use of "street", "avenue", or "boulevard" following a familiar arterial name. These words are not required and could be omitted. There are exceptions to this principle that are discussed on *Modifiers to Street, Road, and Avenue Names* discussed on page 6. Another “dead” word is “ahead.” It is not necessary to tell motorists that an incident or roadwork is “ahead” when the CMS is on the same freeway as the event because it will be understood by motorists that the event is ahead.

Using Abbreviations

Section 1A.14 of the MUTCD contains abbreviations for use on traffic control devices. Table 11 shows acceptable abbreviations from the MUTCD list for a number of words that might sometimes be used in CMS messages. Table 12 shows acceptable abbreviations from the MUTCD list that might be appropriate for use in CMS messages when used with the indicated prompt word. Table 13 shows the MUTCD list of unacceptable abbreviations.

Table 11

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 12
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 13

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	Left
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

Word And Phrase Meanings And Criteria

Use, Take, and Follow

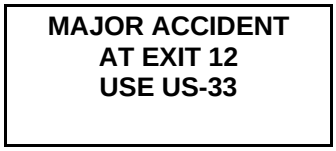
The *Action* message element requires an action verb. In general, the three verbs *USE*, *TAKE*, and *FOLLOW* are synonymous and no strong preference exists. The verb *USE* has been employed more often because it is slightly shorter. There are, however, small differences in meaning which make one verb preferable to another in certain CMS messages. The verb *USE* should be selected to indicate a route that will carry the motorist to his/her destination. The destination could be a major generator or a point of return to the freeway.

The verb *TAKE* should be selected to identify an interconnecting highway or ramp that motorists are advised to use. The highway might be the exclusive diversion highway, or it might define the first "leg" of the of a diversion route. For example, *TAKE US-33* indicates that the diversion route US-33 interconnects with the current highway or *Take Exit 22* identifies the exit ramp that motorists should use.

The verb *FOLLOW* carries the additional connotation that the motorist will be guided by other signs along the route. *FOLLOW* should never be used when guidance is not available.

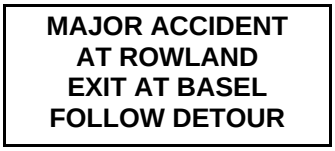
The verb *EXIT* may also be used as a verb in action message statements that are displayed on a freeway. When *EXIT* is employed as a verb, it should usually be followed by the name of the cross street or highway associated with the exit ramp (e.g., *EXIT AT ROWLAND*). It is never followed with an exit number (e.g., ~~*EXIT AT EXIT 22*~~).

The verb *GO* is not used in CMS messages for route guidance, but may be used in highway advisory radio messages. It connotes initiation of action, but would be out of place in situations where *USE* or *TAKE* is appropriate.



Example of USE

Example of TAKE



Example of FOLLOW
(Note: the message should be split into two frames.)

Construction Vs. Roadwork

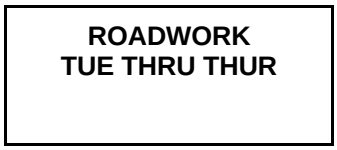
The word *ROADWORK* may be substituted for the longer word *CONSTRUCTION*. The disadvantage to displaying the word *CONSTRUCTION* is that it is a longer and more complex word than *ROADWORK* and, therefore, will take longer for motorists to read.

Exit vs. Ramp

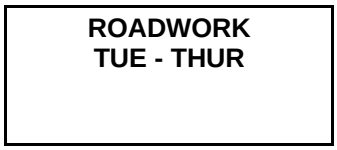
When referring to an off ramp on CMSs located on a freeway, the word *EXIT* should be used. The word *RAMP* should not be used because it has different shades of meaning for some motorists.

A Dash vs. Thru

A hyphen may be substituted for the term *THRU* to indicate a set of inclusive days (e.g., TUE – THURS to indicate Tuesday thru Thursday. A space should be inserted on both sides of the hyphen.



Message 1
Acceptable



Message 2
Acceptable

Nite vs. Night

The term *NITE* may be used in place of *NIGHT* if needed for space constraints.

Message 1
Acceptable

Message 2
Acceptable

For 1 Week

Frequently roadwork is performed over a one-week period (i.e., seven consecutive days). Although the term *FOR 1 WEEK* takes less CMS space, it should not be used to indicate the seven-day work period because the term is ambiguous.

Weekend

Oftentimes, major lane or roadway closures are necessary on the weekend. Although it is desirable to present the inclusive days and hours (e.g., *FRI 6 PM – MON 5 AM), WEEKEND* can be used if a shorter length message is needed due to space constraints and if the work begins on Saturday morning and ends on Sunday evening.

The word *WEEKEND* should not be used if either the roadwork begins on Friday evening or ends on Monday morning.

Lane Shift, Traffic Shifts, Lanes Change, and New Traffic Pattern

There are several terms that have sometimes been used in work zones to indicate a temporary alignment change (i.e., all lanes shift left or right). The following terms should not be used:

- *LANES SHIFT*
- *TRAFFIC SHIFTS*
- *LANES CHANGE*

- *NEW TRAFFIC PATTERN*

Instead, the following term should be used:

- *LANES SHIFT* / *STAY IN LANE*.

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.

~~**ROAD CLOSED**~~ ~~***[OCT 10 - OCT 12]***~~	**ROAD CLOSED** **TUES - THUR**
Message 1 Unacceptable	Message 2 Acceptable

Message Length And Viewing Distance Requirements

The maximum length of message that should be displayed on a CMS at a location depends not only on the perception and information processing capabilities of motorists, but also on their speed, how far they can detect the sign and how far they can adequately read the message.

Highway signs must project a message so that the driver can detect the sign, read and understand the sign and make appropriate decisions based on the information gained from the sign.

Some of the relationships involved for a driver traveling in the third lane from the shoulder to read a portable changeable message sign (PCMS) or a ground-mounted sign are shown in Figure 1. Line M represents the eye of the driver while traveling from left to right. Point A in the figure is the location at which the driver detects the sign in the environment although he/she cannot yet read the message. Point B is the location at which the sign message becomes legible and the driver can begin reading the message. Point C represents a cut-off location. The cut-off location, established by the angle θ (theta), is the point where the driver may no longer read the sign without losing peripheral sight of the roadway ahead. Thus, the message is exposed to the driver while he/she is between Points B and C (distance B-C).

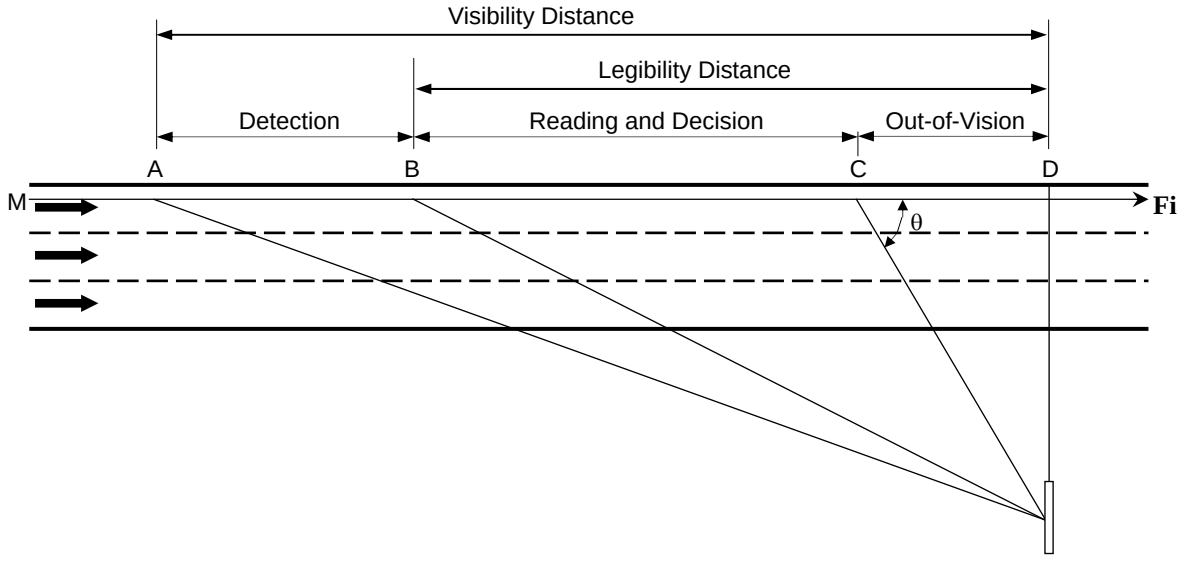


Figure 1. CMS Detection, Reading, Decision, and Out-of-Vision Relationships

The minimum required visibility distance (A-D) in Figure 1 is the distance for the driver to first detect the presence of the CMS. The minimum required legibility distance (B-D) represents the distance from the CMS that a driver must begin reading the CMS message. Similar relationships exist for permanently mounted overhead CMSs. The only difference is that the angle θ is in the vertical rather than horizontal direction.

The message viewing distance (B-C), coupled with the speed that the driver is traveling, dictates the amount of time he/she has available to read a CMS. The message viewing distance necessary to read a message of a given length (in terms of units of information presented) is illustrated in Figure 2. Any obstruction that comes between the motorist and the sign within the minimum required viewing distance hinders the motorist from reading the entire message. At higher speeds, distances as great as 800 feet are needed for messages that contain 4 units of information.

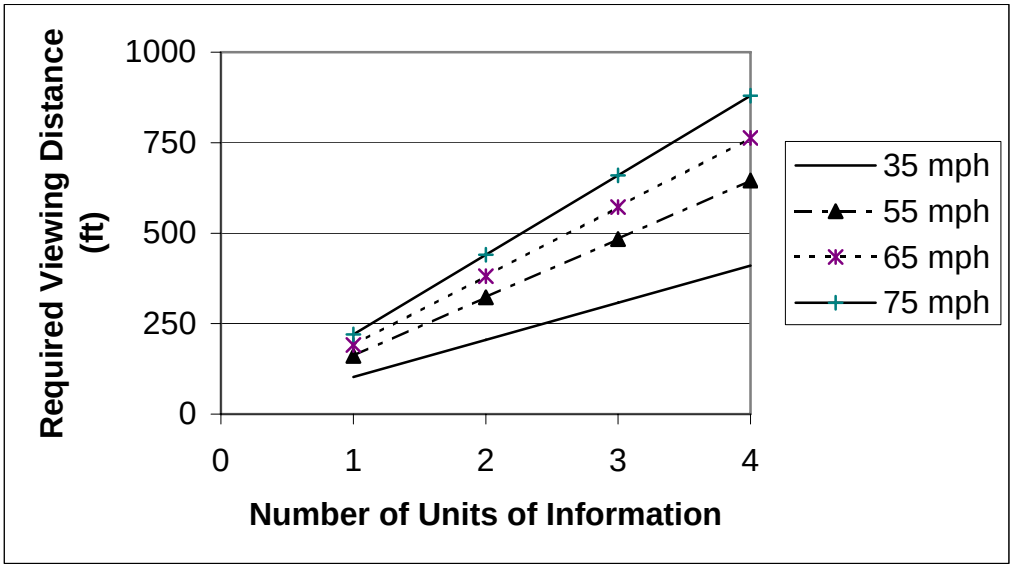


Figure 2. Required CMS Message Viewing Distances

The maximum distance at which a motorist can first correctly identify letters and words on a CMS is termed the *legibility distance* of the sign. In some situations, a motorist may not be able to utilize the maximum possible legibility distance (and thus, viewing time) of a particular CMS technology or design. Lighting conditions (day vs. night and position of the sun) can reduce the legibility distance to the CMS. Roadway geometric features such as vertical or horizontal curvature (around sight obstructions) as well as spot obstructions such as overpasses and sign bridges can also restrict CMS viewing distances. A number of environmental factors or conditions also impact CMS visibility. Rain and fog (and even snow) all scatter and block light rays from a CMS as that light travels through the atmosphere. Finally, the presence of a significant number of trucks on the roadway will likewise limit the ability of motorists to adequately view a CMS. This means that there may not always be enough viewing time for a motorist to read a CMS message providing four units of information (5 units on lower speed roadways), and so shorter messages may have to be used. For permanently mounted overhead CMSs the only practical and quantifiable legibility distance adjustments are those involving day and night operations.

The legibility of a CMS depends on the design characteristics of the sign. Key design parameters are the type of display technology, height and width of the characters, the stroke width of the characters, and the type of font displayed. Legibility distances for use in CMS message design (based on results of several studies) are presented in Table 11. These distances represent standard font (all uppercase), 18-inch character heights, 13-inch (approximate) character widths, and about 2.5-inch stroke (pixel) widths. Smaller characters would yield shorter distances. The legibility distances shown in Table 14 affect the maximum number of units of information that can be displayed on a

CMS, which will allow motorists to read and comprehend the message at prevailing highway operating speeds.

Table 14
Suggested CMS Legibility Distances for Use in Message Design (ft)

Condition	Light-Emitting Diode[A]	Fiberoptic	Incandescant Bulb	Reflective Disk
Mid-Day	800	800	700	600
Washout	800	800	700	400
Backlight	600	500	400	250
Nighttime	600	600	600	250

[A] Valid only for the newer aluminum indium gallium phosphide (or equivalent) LEDs

Based on these distances, the maximum number of informational units that motorists can actually read and comprehend in a CMS message is summarized in table 15. These numbers establish the Base Message Length.

Table 15
Maximum Number of Units of Information in CMS Message
(Base Maximum Message Length)

	Light-Emitting Diode [A]			Fiberoptic			Incandescent Bulb			Reflective Disk		
	0-35 mph	36-55 mph	56-70 mph	0-35 mph	36-55 mph	56-70 mph	0-35 mph	36-55 mph	56-70 mph	0-35 mph	36-55 mph	56-70 mph
Mid-Day	5 units	4 units	4 units	5 units	4 units	4 units	5 units	4 units	3 units	5 units	4 units	3 units
Washout	5 units	4 units	4 units	5 units	4 units	4 units	5 units	4 units	3 units	4 units	3 units	2 units
Backlight	4 units	4 units	3 units	4 units	3 units	2 units	4 units	3 units	2 units	2 units	1 unit	1 unit
Nighttime	4 units	4 units	3 units	4 units	4 units	3 units	4 units	3 units	3 units	3 units	2 units	1 unit

[A] Valid only for the newer aluminum indium gallium phosphide (or equivalent) LEDs

Formatting Messages

Introduction

The order that information is placed and arranged on the CMS significantly affects reading time. Guidelines for the order of information is dependent upon whether:

- An *Incident Descriptor* or *Roadwork Descriptor* message element is part of the message; or
- The *Incident Descriptor* or *Roadwork Descriptor* message element is replaced by or combined with a *Lanes Closed* message element.

Order Of CMS Message Elements

Messages With *Incident Descriptor* Message Element

The format order for messages that contain an *Incident Descriptor* message element (e.g., *ACCIDENT)* is summarized in Table 16 for the cases when lane-closure (blockage) incidents occur or when incidents occur that require closing the freeway.

Table 16
Format Order For One-Frame Messages When *Incident Descriptor* Message Element is Used for Incidents

Message Elements For Lane Closure Incidents	Message Elements For Freeway Closure Incidents
1. Incident Descriptor 2. Incident Location 3. Lanes Closed (Blocked) 4. Audience for Action (if needed) 5. Action 6. Good Reason for Following Action[A]	1. Incident Descriptor 2. Incident Location 3. Lanes Closed (Blocked) 4. Audience for Action (if needed) 5. Action

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for following Action* message element is placed before the *Action* message element.

When the message is split into two frames, then the combinations of formatting shown in Table 17 should be used:

Table 17
Format Order For Two-Frame Messages When *Incident Descriptor* Message Element is Used for Incidents

Message Frame 1	Message Frame 2
1. Incident Descriptor 2. Incident Location	3. Lanes Closed (Blocked) 4. Action
1. Incident Descriptor 2. Incident Location	3. Audience for Action 4. Action
1. Incident Descriptor 2. Incident Location 3. Lanes Closed (Blocked)	4. Audience for Action 5. Action
1. Incident Descriptor 2. Incident Location	3. Audience for Action 4. Action 5. Good Reason for Following Action[A]

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

Messages With *Road Work Descriptor* Message Element

The format order for messages that contain a *Road Work Descriptor* message element (e.g., *ROADWORK)* is summarized in Table 18 for the cases when lane closures occur due to roadwork and when the roadwork requires closing the freeway.

Table 18
Format Order For One-Frame Messages When *Roadwork Descriptor* Message Element is Used For Roadwork

Message Elements For Lane Closures	Message Elements For Freeway Closures
1. Roadwork Descriptor 2. Lane Closure Location 3. Lanes Closed 4. Audience for Action (if needed) 5. Action 6. Good Reason for Following Action[A]	1. Roadwork Descriptor 2. Closure Location 3. Lanes Closed 4. Audience for Action (if needed) 5. Action

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

When the message is split into two frames, then the combinations of formatting shown in Table 19 should be used.

Table 19
Format Order For Two-Frame Messages When *Roadwork Descriptor* Message Element is Used For Roadwork

Message Frame 1	Message Frame 2
1. Roadwork Descriptor 2. Lane Closure Location	3. Lanes Closed 4. Action
1. Roadwork Descriptor 2. Lane Closure Location	3. Audience for Action 4. Action
1. Roadwork Descriptor 2. Lane Closure Location 3. Lanes Closed	4. Audience for Action 5. Action
1. Roadwork Descriptor 2. Lane Closure Location	3. Audience for Action 4. Action 5. Good Reason for Following Action[A]

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

Messages Without *Incident Descriptor* Message Element

The format order for messages in which the *Incident Descriptor* message element is replaced by or combined with a *Lanes Closed* message element is shown in Table 20.

Table 20
Format Order When *Incident Descriptor* Message Element is Replaced By or Combined With the *Lanes Closed* Message Element For Incidents

Message Elements For Lane Closure Incidents	Message Elements For Freeway Closure Incidents
1. Lanes Closed (Blocked) 2. Lane Closure (Blockage) Location 3. Audience for Action (if needed) 4. Action 5. Good Reason for Following Action[A]	1. Freeway Closure (Blocked) 2. Location of Closure 3. Audience for Action (if needed) 4. Action 5. Good Reason for Following Action[A]

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

When the message is split into two frames, then the combinations of formatting shown in Table 21 should be used:

Table 21
Format Order For Two-Frame Messages When *Incident Descriptor* Message Element is Replaced By or Combined With the *Lanes Closed* Message Element For Incidents

Message Frame 1	Message Frame 2
1. Lanes Closed (Blocked) 2. Lane Closure (Blockage) Location	3. Audience for Action 4. Action
1. Lanes Closed (Blocked) 2. Lane Closure (Blockage) Location	3. Audience for Action 4. Action 5. Good Reason for Following Action[A]
1. Freeway Closed (Blocked) 2. Location of Closure	3. Audience for Action 4. Action

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

Messages Without *Roadwork Descriptor* Message Element

The format order for messages in which the Roadwork *Descriptor* message element is replaced by or combined with a *Lanes Closed* message element is shown in Table 22.

Table 22
Format Order When *Incident Descriptor* Message Element is Used For Roadwork

Message Elements For Lane Closures	Message Elements For Freeway Closures
1. Lanes Closed 2. Lane Closure Location 3. Audience for Action (if needed) 4. Action 5. Good Reason for Following Action[A]	1. Freeway Closed 2. Closure Location 3. Audience for Action (if needed) 4. Action

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element.

When the message is split into two frames, then the combinations of formatting shown in Table 23 should be used.

Table 23
Format Order For Two-Frame Messages When *Roadwork Descriptor* Message Element is Used For Roadwork

Message Frame 1	Message Frame 2
1. Lanes Closed 2. Lane Closure Location	3. Audience for Action 4. Action
1. Lanes Closed 2. Lane Closure Location	3. Audience for Action 4. Action 5. Good Reason for Following Action[A]
1. Freeway Closed 2. Closure Location	3. Audience for Action 4. Action

[A] When *BEST ROUTE TO* is used as the Good Reason, then *the Good Reason for Following Action* message element is placed before the *Action* message element

Changeable Message Signs can be a very effective tool for communicating with motorists. However, great care must be taken to ensure that messages are properly designed. Displaying messages that are too long for motorists to read and comprehend at prevailing speeds or that are too complex or inappropriately designed can lead to motorist confusion, and adversely affect both traffic flow and the agencies credibility. The State Traffic Engineer will provide assistance with message design at the request of the District Office.

Document Revision History: 00-00-00