# MANUAL ON REAL-TIME MOTORIST INFORMATION DISPLAYS



Research, Development, and Technology

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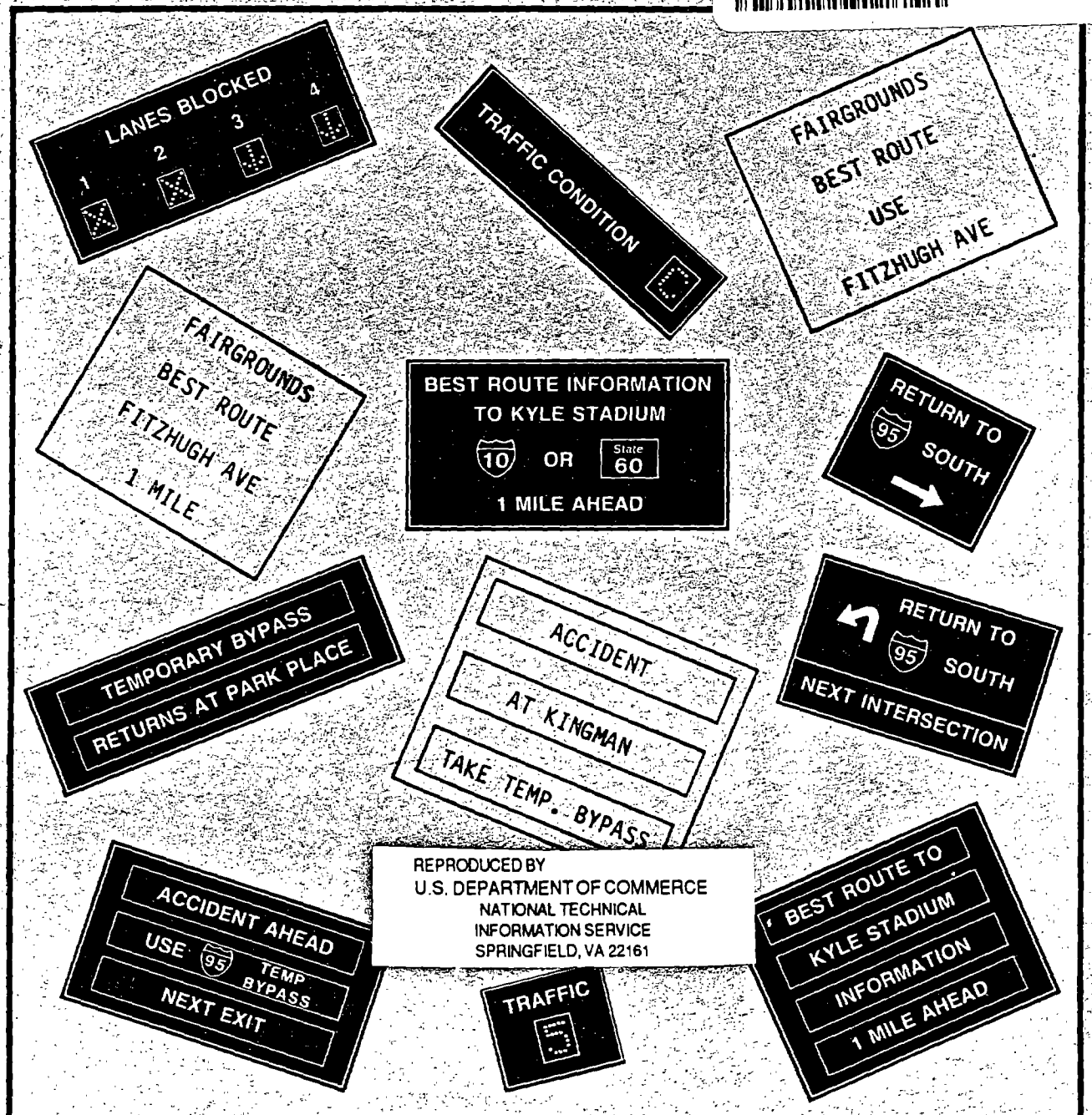

## FOREWORD

This Implementation Package is essentially a condensation of the report entitled, "Human Factors Requirements for Real-Time Motorist Information Displays, Volume 1--Design Guide," prepared for the FHWA by the Texas Transportation Institute. The manual provides practical guidelines, based on research and operational experience, for the development, design, and operation of real-time driver displays, both visual and auditory, for traffic management in freeway corridors. Both incident management and route diversion problems are addressed from a human factors point of view. The emphasis is on the recommended content of messages to be displayed including format, coding, style, length, load, redundancy, and number of repetitions. The manual will be primarily useful to State and local traffic engineers, to traffic engineering students, and FHWA engineers responsible for project reviews.

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16. Abstract

This Manual is a condensation of a Design Guide report entitled, "Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 1--Design Guide," written by the Texas Transportation Institute for FHWA. The Manual provides practical guidelines for the development, design, and operation of real-time driver displays, both visual and auditory, for freeway corridor traffic management.

The emphasis is on the recommended content of messages to be displayed in various traffic situations; the manner in which messages are to be displayed--format, coding, style, length, load, redundancy, and number of repetitions; and where messages should be placed with respect to the situations they are explaining. The Manual also provides guidance in selection of the appropriate type of display, and guidance in design of the display to improve the target value and reception of the message.

Although the Manual is primarily intended for traffic engineers working in city, county, state or private organizations, it should also be useful to traffic engineering students or trainees and to FHWA engineers at the district and regional levels who are responsible for project review and approval.

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# 1. INTRODUCTION

## A. Purpose

This Manual is essentially a condensation of the report entitled "Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 1-Design Guide" prepared for FHWA by the Texas Transportation Institute (1). The purpose of this document is to provide practical guidelines, based on research and operational experience, for the development, design, and operation of real-time driver displays, both visual and auditory, for traffic management in freeway corridors. It is addressed principally to problems of incident management and route diversion.

The emphasis is on the recommended content of messages to be displayed in various traffic situations; the manner in which messages are to be displayed--format, coding, style, length, load, redundancy, and number of repetitions; and where messages should be placed with respect to the situations they are explaining. The Manual also provides guidance in selection of the appropriate type of display, and guidance in design of the display to improve the target value and reception of the message.

Although the Manual is primarily intended for traffic engineers working in city, county, state or private organizations, it should also be useful to traffic engineering students or trainees and to FHWA engineers at the district and regional levels who are responsible for project review and approval.

## B. Scope

The subject matter in the Manual is basically restricted to human factors design considerations with respect to motorist information displays for traffic management (incident management and route diversion) in freeway corridors. Once a decision has been made by the engineer to implement a motorist information system, the Manual should provide guidance in message selection and the manner of message presentation for specific situations.

The Manual does not establish specific criteria to determine whether to implement displays, but concentrates on design recommendations for visual and audio displays given that the need for such displays has been established. Topics such as freeway corridor surveillance, control, and operations are not within scope except as they directly affect or are affected by motorist information display designs.

The emphasis is on displays for managing traffic when freeway incidents occur or when special events cause severe freeway congestion. Many of the recommendations and principles of message design discussed in the Manual may also be useful for traffic management during freeway maintenance or construction.

The recommendations presented herein are based on the following sources: 1) human factors laboratory and field studies; 2) real-world experience of one or more agencies; and 3) expert opinion in generalizing from other sources.

The Manual is addressed to a wide audience of users ranging from individuals who are developing their first system and are not familiar with real-time display technology to those responsible for the operation of existing systems. Thus, the experienced designer or operator of real-time displays may find those sections of the Manual dealing with existing changeable message signs (CMS) and audio techniques somewhat elementary.

The intent is to address display design issues for diverse systems ranging from highly versatile signing systems integrated with elaborate freeway corridor surveillance and control operations to low cost, less sophisticated surveillance and signing systems intended to alleviate a single specific problem.

Because of the diverse objectives, audience, problems, freeway and arterial system configurations, etc., it is impossible to present specific messages and designs to solve every conceivable situation. Guidelines are presented for some of the more common situations. Should these guidelines not include the user's specific situation, the user may develop specific messages for his own problem and facility by using the principles of design presented herein. The Manual provides the tools for effective message construction including how the messages should be displayed and pitfalls to be avoided.

In summary, the Manual is in no way a step-by-step procedures handbook. It is designed to provide useful guidelines in making engineering decisions, particularly concerning the content of messages and the manner in which they are to be displayed in incident management/route diversion situations.

## C. The Need for a Design Guide

Many agencies are contemplating driver information systems to solve specific problems, other systems are on the drawing boards, and some agencies are currently operating systems. Questions that often arise concerning the installation and operation of the displays include:

- What type of information should be displayed?
- Which messages are more effective; which are less?
- What are the better ways to present the information within constraints of viewing time and available message space?
- Where should the displays be located?
- What types of displays, if any, are necessary to guide drivers along alternate routes?

This Manual is intended to help answer these types of message design and placement questions when they arise.

## D. Making Better Use of Existing Facilities

### D.1 Problems in Traffic Management

Four categories of problems related to freeway corridor traffic operations can be listed as follows:

- **Recurring problems** - Mainly peak-period traffic congestion where demand exceeds capacity for relatively short time periods. Problems associated with special events (e.g., ball games, parades, etc.) also fall into this category.

- **Non-recurring problems** - Caused by random or unpredictable incidents such as traffic accidents, temporary freeway blockage, maintenance operations, etc.

- **Environmental problems** - Caused by acts of nature such as rain, ice, snow, fog, etc.

- **Special operational problems** - Operational features such as reversible, exclusive, or contraflow lanes and certain design features such as drawbridges, tunnels, tollbooths, and weigh stations are included in this category.

Peak-period congestion occurs daily and is quite predictable in both effect and duration. In many instances freeway ramp control systems have proved their effectiveness in reducing recurrent peak-period congestion and consequently have improved the quality of service. Freeway corridor control systems are under development and are expected to further improve operations.

Special events oftentimes generate large volumes of traffic that are somewhat predictable in nature. Generally, congestion occurs on certain freeway segments at or near the generator. In many cases, alternate routes are available but are not used because drivers are either unaware of them or have no knowledge of the severity of congestion on their primary route to the special event.

The occurrence of an accident or other lane-blocking incident on a freeway significantly reduces capacity. Freeway incidents occur randomly, are unpredictable, and result in what is termed "non-recurrent congestion." Non-recurrent congestion can also result from some programmed activities such as maintenance or construction work.

When a major incident causes a bottleneck, significant freeway congestion results even though unused capacity may exist on parallel routes within the freeway corridor. Not all incidents result in significant delay; however,

each creates queuing on the freeway, which can be a serious traffic hazard to uninformed drivers.

Adverse weather conditions reduce capacity as well as create safety hazards. Occasionally, conditions may warrant complete freeway closure or closure of portions of the facility.

Reversible, exclusive, or contraflow lane operations often present operational problems that require special signing treatments in addition to, or in place of, static signs. Design features such as drawbridges, tunnels, tollbooths, etc., sometimes require special warning devices.

Real-time displays can perform a critical role in alleviating many of the above operational problems by furnishing drivers with real-time information about the problem and the best course of action.

## D.2 Are Real-Time Display Systems for My Facility?

When the term "real-time information displays" is mentioned, many individuals immediately think about the necessity for electronic surveillance and control systems comparable to those existing in several cities in the United States. Some operational problems dictate the need for the more sophisticated systems. However, many problems are such that they can be handled with less hardware.

Let's consider a definition of real-time control. A real-time control system, as used in this Manual, is defined as a control process with continuous monitoring of the system such that changes can be made in the system in ample time to improve the operation within the system. One key phrase is "in ample time." Some situations require almost instantaneous response. Others can tolerate considerable time delay before a display is needed.

Other factors one must consider are the function(s) the display is to serve and the anticipated frequency of usage for the function(s). Both factors influence the requirements for surveillance. Some agencies are interested in developing freeway corridor surveillance, control and information systems to manage traffic continuously. Others have expressed a desire to install an information system designed for responding only to the major accidents. Detection would be accomplished by the police dispatcher receiving calls from citizens or information from patrols at the site. Observers in the field would provide surveillance until the incident was removed and congestion dissipated.

Surveillance using human observers at key locations in the field may be all that is necessary to manage traffic for once-a-year type special events. Frequent events at the major generator may dictate the need for electronic surveillance. The relationship between surveillance capability and message selection and display is discussed later in the Manual. It suffices to say at

this time that the ability to know exactly what is occurring on the affected freeways and streets will have an impact on message recommendations.

## E. Incident Management and Single Point Diversion Signing Systems Concepts--Is There a Difference?

Prior to discussing specific types of displays and providing design recommendations, it would be well to examine some basic functions the driver information displays will serve. Throughout the literature, one will often read about "incident management" and "point diversion" signing systems. Although these terms refer to the same objective--managing traffic during congested freeway conditions--some authors make a fine distinction between the two concepts.

Figure 1-1 illustrates the concept of incident management signing. The typical objectives of incident management signing are to advise drivers of unusual conditions on the freeway and to recommend a course of action. The advisory might provide a warning of stopped or slow traffic downstream of unsuspecting drivers, information concerning the occurrence of an accident, or warnings and information about other unusual freeway conditions. Drivers may be advised to travel in specific lanes or, in the case of heavy congestion, to leave the freeway and reroute around the congested area.

Systems in which drivers are either diverted along an alternate route directly to their destination or diverted from a congested radial freeway to a loop freeway around the downtown area of the city are sometimes called "point diversion signing systems." Figure 1-2 illustrates the concept.

The major distinction between the two concepts is that in the case of single point diversion, all the traffic for which the message is intended is diverted at a single location. In the case of incident management, traffic is oftentimes diverted or rerouted at more than one location along the freeway.

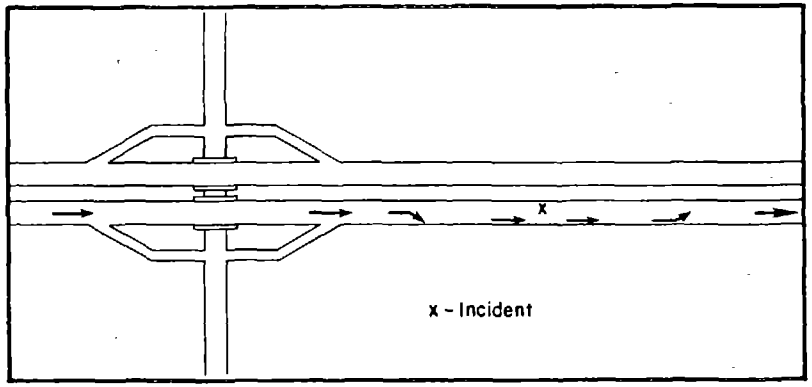
Although the literature sometimes differentiates between the two concepts, they both apply to traffic management, and as such the signing system elements are essentially the same.

## F. When Is a Sign a Sign?

Throughout the Manual reference will be made to "signs" and "displays." Be aware that, unless specified, signs and/or displays are intended to mean that the mode of presentation can either be visual or auditory.

## G. Manual Format

In addition to "signs" and "displays," a third concept used throughout the Manual is "message." A message refers to the content of either visual or



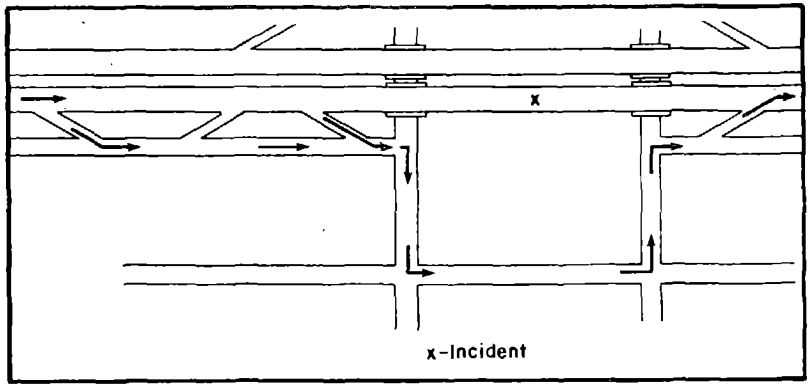
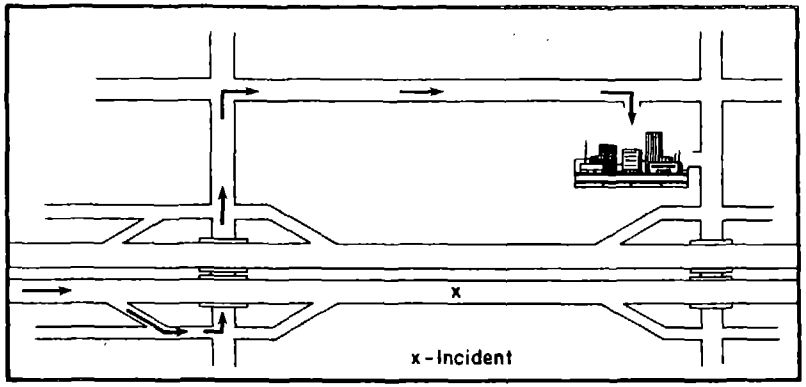




Figure 1-1. Illustrations of Incident Management



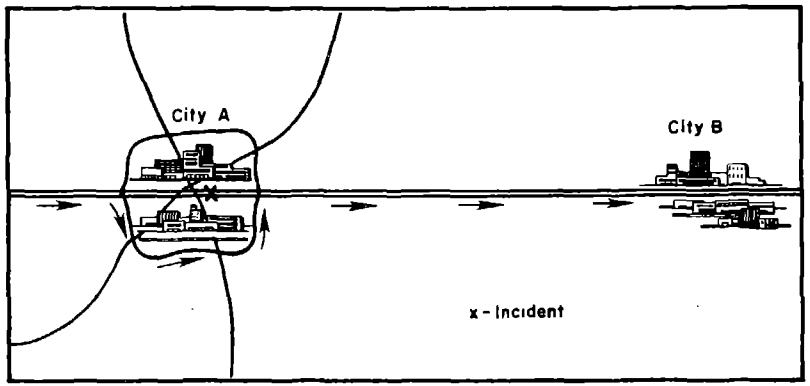




Figure 1-2. Illustration of Diversion

audio displays. The drivers' requirements for messages or information exist independently of the mode of presentation. However, due to the greater constraints on the amount of visual information that may be displayed at one time, the audio and visual messages may differ somewhat in format and length. Visual messages rely heavily on coding and other abbreviations. In addition, the location of the driver viewing a sign can be known approximately, whereas the increased range of a radio system may result in reception by drivers at various points along the freeway.

For these reasons, the Manual has been divided into Visual and Audio signing sections. However, much of the information on "message content" applies to either mode. For example, the recommended ways of describing traffic state variables such as incidents, congestion, location, delay, etc., are common to both modes of presentation and could be as appropriately organized and discussed within either section.

The differences, again, lie primarily in the inapplicability of certain visual signing codes (symbols, trailblazers, and arrows) to audio presentations. The visual message is restricted to a fixed space, limiting the viewer to brief, interrupted glimpses of parts of the message. The audio message may be continuous and free-flowing in syntax, but must be repeated due to the human's limited audio retention span.

Finally, the Manual has addressed the issue of how to effectively employ one mode of message presentation as an aid in compensating for the limitations of the other mode, e.g., the use of trailblazers when audio retention limits are exceeded.

## 2. SOME GENERAL CONSIDERATIONS

### A. Maintain Credibility

---

**THE SYSTEM WILL WORK ONLY IF THE DRIVERS BELIEVE IN THE SYSTEM.**

---

An important consideration in a successful driver information system (where success is measured by achieving desirable driver response) is to develop and maintain credibility--drivers' faith in the system. The quickest way to fail is to lose driver confidence.

The most elaborate and costly system with presumably well-planned messages deteriorates into an operational headache if the confidence of the motoring public is lost.

---

**DRIVER EXPECTATIONS MUST BE CONSIDERED WHEN OPERATING REAL-TIME DISPLAYS.**

---

Drivers view these systems as furnishing them with reliable, accurate, and up-to-date information. All precautions must be taken to insure that these driver expectations are met. This requires additional effort and operational procedures on the part of the operating agency. In contrast to fixed messages on static regulatory, warning, and guide signs that always apply regardless of traffic conditions, changeable message displays elicit different driver expectations.

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**THE AGENCY MUST BE WILLING TO DEVOTE THE ADDED TIME AND RESOURCES NECESSARY TO OPERATE THE SYSTEM PROPERLY FOR IT TO BE AN ASSET. OTHERWISE, THE MESSAGES WILL LOSE CREDIBILITY AND BE IGNORED.**

---

Operating real-time displays will require extra care and time to insure the right messages are displayed at the proper time. It cannot be assumed that this is being accomplished without monitoring the operation while messages are displayed. Drivers will have negative attitudes about a system that displays information contrary to existing conditions, displays information that is not understood or cannot be read in ample time to make the appropriate maneuvers, recommends a course of action that is not significantly better than their intended action, or often tells them something they already know. Once the drivers lose faith in the system, do not expect them to

respond appropriately in the future. Thus, money may be spent operating a system that no longer is doing a job.

---

**IT WOULD BE BETTER TO DISPLAY LESS INFORMATION OR NO INFORMATION AT ALL IF THE SIGN OPERATOR IS UNSURE OF THE TRAFFIC CONDITIONS.**

---

It is important that the information displayed is reliable. A relevant question to ask is: "Can the drivers disprove the information given?" If they can, don't expect the drivers to respond to information they know is incorrect. Repeated display of erroneous information is one way of losing driver confidence. Therefore, extreme care must be exercised to assure that the proper message is displayed.

It is sometimes enticing to display information that exceeds the surveillance capabilities. In other cases, the operator simply fails to change the messages with changing conditions.

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**MAKE SURE THE RECOMMENDED ALTERNATE ROUTE RESULTS IN A SIGNIFICANT IMPROVEMENT IN TRAVEL.**

---

Credibility may be lost when drivers respond to real-time information, but feel as though they have been placed in a worse situation than that experienced on the freeway or along their intended course. This is particularly true when drivers are encouraged to reroute. The alternate route must provide a very significant improvement in travel. Drivers are more receptive to diverting before they get on the freeway (2). Once on, drivers are not concerned with saving only a few minutes. The savings must be very significant and must be perceived by the drivers as such. If not, don't expect the same drivers to respond the next time.

---

**DON'T USE THE DISPLAYS TO BALANCE DEMANDS WITH AVAILABLE CAPACITY DURING RECURRENT CONGESTION.**

---

There have been attempts to balance on-ramp demands for recurrent congestion during the peak periods by suggesting that drivers use other on-ramps. This approach was found to be ineffective (3) and is a good way to

lose credibility. Some possible reasons why drivers do not respond to the messages during recurrent congestion situations are:

- Drivers know what delays to expect on the ramp they intend to use and have certain expectations of what conditions they will encounter once on the freeway.

- Drivers are concerned with their individual travel times and are unconcerned with "optimizing" flow in a corridor. Thus, they must realize a significant reduction in their personal travel time. Asking them to drive through additional signalized intersections simply won't work unless it results in a significant improvement in their travel.

- Commuters are not naive drivers. Many have explored alternative routes and have selected routes that appear to be "optimum" for them. Therefore, they must be convinced that the new route will be better for them, and that they are not sacrificing time or comfort for the benefit of other drivers.

---

**BE ON THE ALERT FOR POSSIBLE OPERATOR BOREDOM PROBLEMS (4).**

---

The tendency in many operational systems is to establish a library of messages and then assign the task of displaying the appropriate messages to technicians and assume they do the job properly.

Real-time information displays are basically intended for incident responsive traffic management, that is, response to abnormal conditions such as freeway accidents. The display operators must make timely responses to detected incidents. The major problem inherent in this task is that incidents involve only a small percentage of the time the operator is working. The bulk of his or her time is spent waiting for something to happen. In time, personnel become less motivated and efficient. This leads to failure to display appropriate messages at the proper time and thus, a rapid loss of credibility.

The boredom problem often leads to personnel turnover that requires new people to be trained.

Bognaff and Thompson (4) suggest that job enrichment techniques need to be employed to insure job motivation and performance. Surveillance personnel need to function more broadly. This might require using higher grade personnel to both operate and evaluate or upgrade the systems simultaneously. They also suggest that a team concept might be used where teams alternate between operation and evaluation work. Another approach that might be considered is to assign the surveillance personnel additional tasks relating to roadway operations.

## B. When to Display Messages

Once a system is installed in a freeway corridor, a question always arises concerning when messages should be displayed. There are two schools of thought on this issue:

1. Always display a message on a sign regardless of whether or not there is an incident on the freeway. Or, as a minimum, always display a message during the peak period and when incidents occur during off-peak.

2. Display a message only when unusual conditions exist.

The authors subscribe to the latter of the two approaches. This stems in part from the human factors principles of:

---

**1. DON'T TELL DRIVERS SOMETHING THEY ALREADY KNOW (TRIVIAL INFORMATION).**

**2. FOR MORE EFFECTIVE SYSTEMS, USE THE DISPLAYS ONLY WHEN SOME RESPONSE BY DRIVERS IS REQUIRED, i.e., CHANGE OF SPEED, PATH, OR ROUTE.**

---

The display of trivial information will result in many drivers failing to read the CMS even when important information is given. To circumvent any possible adverse public reaction to seeing blank signs, the public could be educated through the media that the signs will be activated only when unusual freeway conditions exist. When so advised, drivers should be alert whenever any message is displayed because they know that it will likely affect them.

To circumvent the possible problem with blank signs, some agencies occasionally display relevant information concerning conditions on other freeways, when messages are not required for the primary freeway. For example, current or future roadwork information on other freeways is sometimes displayed.

## C. Set Objectives

---

**DIFFERENT OBJECTIVES WILL REQUIRE DIFFERENT MESSAGES.**

---

It is extremely important for the operating agency to specify what is to be achieved with the information display. This may sound like an absurd statement, because an obvious reply is: "Of course we know what we want to do; we want to alleviate congestion!" This is certainly a credible goal, but it is necessary to be more specific in defining:

- What the problem is

and then to specify:

- Who is to be communicated with
- What type of driver response is desired
- Where the change should take place
- How the system will be operated

In other words, the problem needs to be defined and objectives must be established. The importance of setting objectives cannot be overemphasized because objectives directly influence message content, format, length, redundancy, placement, etc.

Interacting with objective setting are boundary conditions or constraints. The area of influence (location and freeway length) of the sign system must be established. Which drivers will be affected? Are they on the freeway, frontage road, or perhaps on an arterial approaching the freeway? To what length of freeway will the messages apply?

Cost and personnel constraints will affect design and operation of the sign system. These constraints in turn affect (and oftentimes restrict) the message selection.

What is displayed will be influenced by the information available to the agency about traffic conditions in the freeway corridor. Keep in mind that the displayed message must be accurate, timely, and reliable so that credibility is maintained. The available information about the traffic conditions and its accuracy, timeliness, and reliability, are directly related to the type of surveillance used to monitor the street and highway routes involved. Thus, the type of information that can be displayed to maintain credibility is different if the surveillance system consisted of an observer sitting in a car watching one section of freeway in comparison to one having detector and television surveillance over a longer section of freeway.

---

**SOME CONGESTION PROBLEMS CAN BE ALLEVIATED USING LOW COST SIGNING SYSTEMS.**

---

Setting objectives and evaluating the operational constraints may at times lead to the decision to employ low cost signing techniques as an interim measure to alleviate congestion due to incidents. One such technique would involve displaying a single message only when a traffic state of a pre-specified level of severity exists.

The examples below serve to illustrate objectives for two CMS systems:

1. An agency in a large city responsible for freeway operations would like to advise approaching drivers of major accidents that occur on a section of an inbound radial freeway. Because of funding, personnel, and surveillance constraints, they want a sign containing a single message to be displayed during the peak and off-peak periods only when major accidents block the freeway for 20 minutes or more. They would like to encourage a portion of the drivers to utilize an adjacent frontage road to bypass the incident and congestion. The display would be operated by local police who would drive to the sign site to activate the display.

2. Same conditions as above, except the agency desires to encourage the freeway drivers to reroute around the incident via a predesignated alternate arterial route.

Although the objectives of the two examples are only slightly different, each necessitates a different signing message.

## D. Determine the Audience Before Selecting a Message

Drivers who may view or hear an incident-type message on a freeway obviously are different in many ways. They differ with respect to their destinations, their familiarity with the area, their trip purposes, and their willingness to be diverted in incident situations. There are some differences between the familiar and unfamiliar driver in terms of their informational needs, but, by and large, their reasons for selecting one route rather than another are quite similar (5).

However, the fact that diverse groups may in general desire a common type of information does not mean that they will be able to understand equally well any language system. For example, the local driver may be more familiar with local terminology such as freeway names, while the driver passing through may be keying on interstate route numbers. There are also known regional differences in terminology. Local drivers also have the benefit of having seen the sign many times and knowing the type of information displayed, coding conventions, etc. The unfamiliar driver must rely on whatever backlog of experience he has had with similar signs and, in some instances, is entirely dependent on the verbal content of the messages displayed. The local driver may know about alternate or bypass routes with a minimum of advisory information while the visitor may need to be directed by trailblazers along any temporary bypass route designated.

Therefore, it is not likely that any signing system will be in a form suitable for all the drivers reading it. This problem is not as serious as it might at first appear. First, many problems can be solved if only a portion of the traffic demand is diverted from the congested freeway section. Secondly, the message designer may know (from the location of the facility

within the metropolitan area and from the time of day or week) the approximate composition of the drivers who will be viewing the sign (i.e., whether they are predominantly local commuters or visitors passing through the city).

The driving population on a highway segment can be classified in several different ways: familiar/unfamiliar; local/non-local; commuter/non-commuter; large city/small city driver. The familiar, local, commuter, and large city categories of drivers obviously have much in common in terms of their understanding of messages. The unfamiliar, non-local, non-commuter, and small city or rural drivers also have much in common. However, the categories are not synonymous. For example, a driver may be quite familiar with a city through periodic visits, but may not actually live there. In addition, residents of a particular geographic area from both larger cities and smaller cities may use local name conventions while those from other geographic areas may not. Moreover, the city and state agencies may use a terminology on signs not consistent with local usage.

---

**DON'T ASSUME THAT THE NAMES USED IN DAILY TRAFFIC OPERATIONAL ACTIVITIES OR BY THE CITY FATHERS ARE THE BEST. THEY MAY NOT BE THE ONES THE DRIVERS USE AND UNDERSTAND.**

---

Daily commuters, for example, are quite familiar with the names of cross-streets and intersecting freeways, and locations of accidents or congestion may be most effectively communicated to them in these terms. On facilities which service primarily non-commuters, locations and distances should be given in terms of miles ahead. To determine local usage of names, it is recommended that a survey of local drivers be conducted.

---

**DON'T ASSUME THE COMMUTER IS KNOWLEDGEABLE ABOUT WHETHER OR NOT ADJACENT FRONTAGE ROADS ARE CONTINUOUS OR WHERE THEY BECOME DISCONTINUOUS.**

---

In many cases, a frontage road is available and offers an excellent route for bypassing incidents and associated congestion. Drivers must be given the assurance by proper message design that they will not become trapped on a discontinuous facility. There are also some reported differences between large and small city drivers.

**SMALL CITY DRIVERS PERCEIVE CONGESTION AT A MUCH LOWER TRAFFIC DENSITY THAN LARGE CITY DRIVERS.**

Congestion is relative. This factor has a significant effect on message selection for describing freeway traffic states. Recommended words for describing various levels of traffic conditions for both large city and small city drivers are presented in later sections of the Manual.

## E. Some Reasons Why Drivers Will Not Divert

The primary function of a CMS system is to manage traffic by rerouting along alternate facilities. Success of the diversion strategy will be dependent upon convincing drivers that they are better off by taking the recommended alternate route, in addition to having established credibility in the signing operations. Although it is possible to convince a large percentage of drivers, it may be difficult to convince all drivers. For example, when CMSs were used for special event traffic in Dallas, averages between 71% and 85% of the freeway traffic destined to the special event used the recommended route (6). The small percentage (15% to 29%) of drivers who did not divert cited the following reasons:

1. Anticipated unsatisfactory conditions (principally traffic problems) on the alternate route.

2. Did not see or understand the message.

3. Were unfamiliar with the alternate route recommended and were uncertain of adequate guidance along it.

4. Lacked confidence in the information.

The implication of this study is that a small percentage of drivers will not divert even to an effectively designed sign due to skepticism based upon previous driving experiences. However, an agency can build confidence in most drivers by establishing message credibility through accurate, timely, and reliable messages and operations.

## 3. SIGNING ELEMENTS AND CHARACTERISTICS

This chapter describes the real-time signing system elements and their characteristics. Several message design issues are defined and explained. These include message content, load, unit, length, format, and redundancy.

### A. Signing System Elements

Experience and research have shown that real-time signing systems, either visual or audio, will consist of one or more of the following three elements:

- Advisory Signs
- Guide Signs
- Advance Signs

Figure 3-1 illustrates a signing system incorporating all three of these elements. The effectiveness of the signing system will in part depend on the relationship of these three elements to each other.

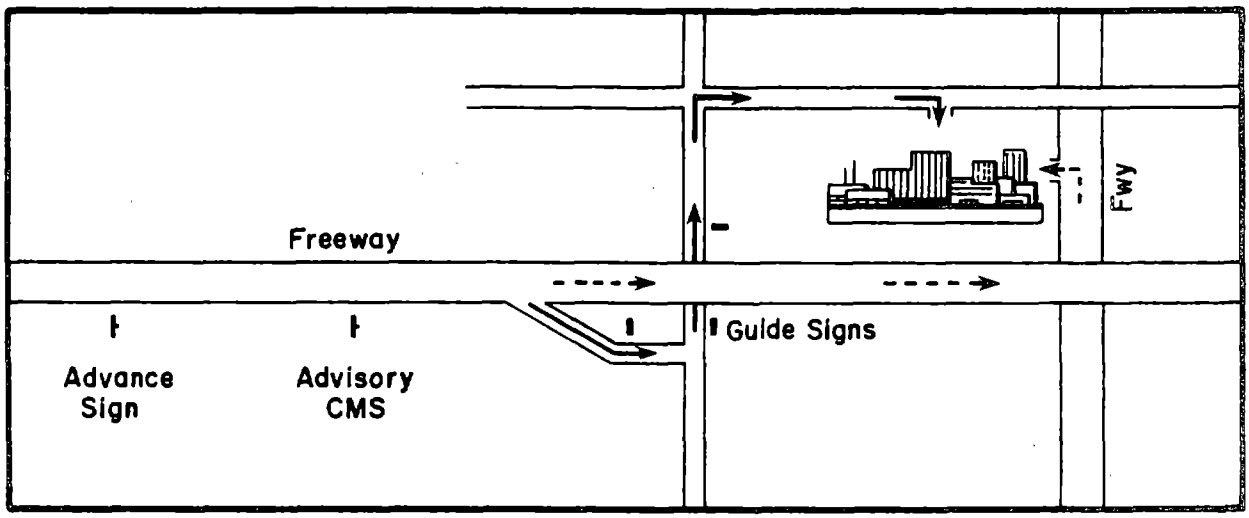



Figure 3-1. Signing System Elements

#### A.1 Advisory Signs

These are the displays that most people think of when referring to real-time displays. These signs display real-time information about the freeway status and advisories concerning the best course of action. Advisory signs

can be located on the freeway, at the entrance ramps, or on arterial streets approaching the freeway.

### A.2 Guide Signs

Occasionally, drivers are advised to take a specific alternate route to their destination or to divert to another route to travel around an incident and associated congestion. If the affected drivers are not familiar with the route or area, guide signs along the alternate route are essential. Although the guide signs may in some cases be changeable displays, most often they are specially designated visual static trailblazer signs or standard route trailblazers.

Guide signs or trailblazers can be located along the alternate route for both incident management functions and freeway-to-arterial point diversion functions. In the special case of freeway-to-freeway point diversion, guidance along the alternate or bypass route can be provided by existing route markers or destination names trailblazed on existing freeway signs, or by innovative trailblazed symbols or codes.

### A.3 Advance Signs

Sometimes it is necessary to inform the drivers that displays located farther downstream will provide them with up-to-date information concerning traffic conditions and advisories. These advance signs will always be visual displays used in conjunction with either visual or audio advisory displays. Advance signs are sometimes necessary to supplement visual advisory signs, but are always required upstream of audio message systems.

## B. Message Content

Message content refers to the specific words, numbers, symbols, and codes used on a display.

### B.1 Advisory Sign Message Elements

Advisory sign messages consist of the following elements:

- A problem statement (accident, maintenance, construction, etc.)
- 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 is the problem and action statements. The driver needs to know what to do and one reason for doing it. The location of the problem is also sometimes useful in a diversion decision. An example is as follows:

| | |
|---|---|
| ACCIDENT<br>AT MILFORD STREET | ◀ **Problem Statement** |
| HEAVY CONGESTION | ◀ **Effect Statement** |
| UTOPIA TRAFFIC | ◀ **Attention Statement** |
| USE WILLIAMS STREET | ◀ **Action Statement** |

---

**THE ESSENTIAL CHARACTERISTIC OF ADVISORY SIGN MESSAGES IS TO PROVIDE DRIVERS WITH ENOUGH INFORMATION TO MAKE DECISIONS.**

---

The length of message and number of words displayed will be affected by the amount of available reading time and the information processing limits of drivers.

### B.2 Guide Sign Message Elements

Guide signs provide the mechanism for drivers to follow a route other than the intended primary route to their destination, or to follow a diversion route to bypass an incident and associated congestion. As such, the signs must give drivers the assurance that they are traveling on the correct route and provide them with advance notice when turning movements are required. The essential message elements to accomplish this are:

- Destination affirmation
- Route affirmation and direction

Destination affirmation assures the drivers they will reach their destination. Route affirmation and direction information provide assurance that they are still on the correct route heading in the proper direction to their destination or to bypass the incident. Symbols, codes, and logos can be effectively used within the limits set forth in Chapters 7 and 12.

## B.3 Advance Sign Message Elements

The message elements for an advance sign used in conjunction with an advisory visual display consist of the following four basic elements (not necessarily in the order shown);

- Information alert
- Nature of information (best route, traffic conditions, etc.)
- Destination for which information applies
- Location of the information ("ahead" or specific distance)

For single point diversion signing situations where two known alternative major routes are available (such as a radial freeway and loop freeway for drivers traveling through the city), the following additional informational element is desirable:

- Route markers of the two major alternative routes

The message for an advance sign used in conjunction with an audio advisory system contains the following elements:

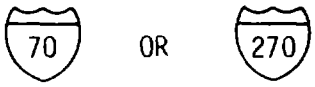
- Nature of information
- Information alert
- Action statement (radio tuning)
- Location of the information

Examples of message elements for advance signs used in conjunction with advisory visual displays recommending a route to a specific destination are as follows:

| | |
|---|---|
| BEST ROUTE TO | ◀ **Nature of information** |
| FAIRGROUNDS | ◀ **Destination** |
| INFORMATION | ◀ **Information alert** |
| AHEAD | ◀ **Location of information** |

BEST ROUTE INFORMATION ◀ **Nature of information, information alert**

1/2 MILE AHEAD ◀ **Location of information**




◀ **Route markers**

TO CINCINNATI ◀ **Destination**

An example of message elements for an advance sign used in conjunction with an audio advisory display is as follows:

RADIO TRAFFIC ALERT ◀ **Nature of information, information alert**

TUNE TO 1610 ◀ **Action**

BROADCAST - 1 MILE ◀ **Location of information**

## C. Message Load (Unit) and Length

The message **load**, as used herein, will refer to the informational "load" in the message expressed in terms of **units** of information. Message **length** refers to the number of words or characters in the message.

The **informational unit** refers to each separate data item given in a message which a motorist could recall and which could be a basis for making a decision. The following example of the message shown in Section B.1 serves to illustrate the concept of units of information:

| | Question | Info. Unit Required |
|---|---|---|
| 1. | What happened? | Accident |
| 2. | Where? | At Milford Street |
| 3. | What effect on traffic? | Heavy Congestion |
| 4. | Who is the advisory intended for? | Utopia Traffic |
| 5. | What is advised? | Use Williams Street |

Hence, the above message contains five (5) **units** of information.

Typically, a unit of information is two words, but a unit could contain one to four words. A unit of information provides an answer to a question which a driver may pose. For example, **ACCIDENT** is a one-word unit relative to a problem. **AT ROWLAND** is a two-word unit; **USE NEXT EXIT** is a three-word unit.

## D. Message Format

Message format is the arrangement of the units of information on a sign to form a total message. For example, message units for an advance sign could conceivably be formatted in various ways (not necessarily all acceptable), including:

| | | |
|---|---|---|
| WASHINGTON | BEST ROUTE TO | INFORMATION |
| BEST ROUTE | WASHINGTON | 1 MILE |
| INFORMATION | INFORMATION | FOR BEST ROUTE |
| 1 MILE | 1 MILE | TO WASHINGTON |

Since incident management/route diversion messages typically are longer than normal freeway guide signs, proper formatting is essential for effective communication. Compatibility must be maintained between words within a line and between message units on a sign. Recommended formats for typical incident management and route diversion messages are presented in subsequent Chapters.

Another usage of the term **format** is the manner in which word messages are arrayed on the CMS.

### D.1 Discrete (Static) Formats

When the entire message is presented at one time, this is referred to as **discrete** or **static display.** Figure 3-2 presents four discrete formats: vertical, compact, chunk extended and message extended.

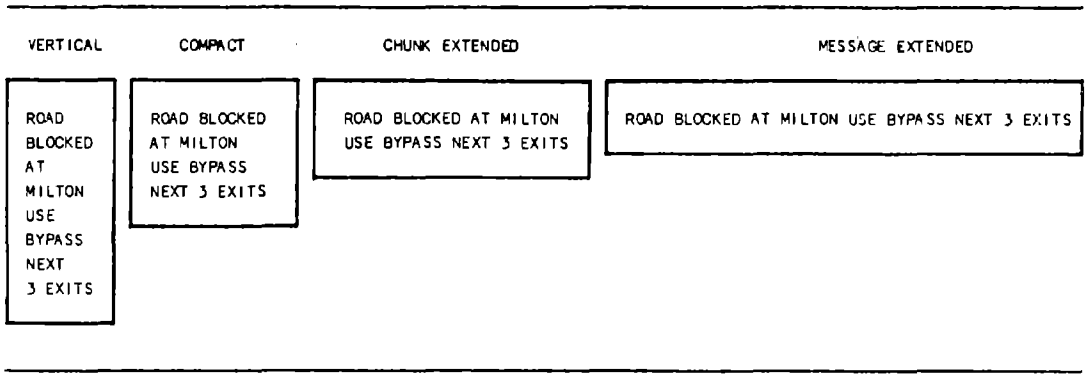



Figure 3-2. Types of Discrete (Static) Formats

**THE COMPACT AND THE CHUNK EXTENDED ARE THE RECOMMENDED FORMATS FOR DISCRETE DISPLAYS.**

For most freeway installations the compact and the chunk extended formats are the most effective discrete formats (7). When volumes and speeds are very low and the driver has unlimited time to view the CMS, then any of the four discrete formats may be used without affecting reading or recall.

### D.2 Sequential and Run-on Formats

Certain types of matrix sign systems have automatic sequential or run-on capabilities. **Sequencing** refers to presenting in discrete manner two or more different message elements within the same signing space. **Running** messages do the same thing, but in a continuous manner so that the reading speed is paced by the speed of the running message.

Sequential formatting is accomplished by dividing the message into parts. Each part is displayed or exposed in sequence for a set period of time. For example, the message **LEFT LANE CLOSED AHEAD, SPEED LIMIT 30 MPH** could be presented in a two-part sequence as **LEFT LANE CLOSED AHEAD** followed by the display of **SPEED LIMIT 30 MPH.** An illustration of a sequential format of this message is presented in Figure 3-3. The message format illustrated is an 8-word presentation using a sequence of two exposures to display the entire message. The message can be repeated several times by continuously cycling (in this case, alternating) through the two parts of the message.

Run-on format sign displays present messages as a train of words moving continuously across a display from right to left. Run-on sign displays are also called moving message or continuous message displays. A common example of run-on messages is the special message bulletins frequently shown on television. An example of a run-on message is shown in Figure 3-3.

**RESEARCH HAS INDICATED THAT RUN-ON MESSAGES ARE NOT SUITABLE FOR DISPLAYING MESSAGES TO DRIVERS TRAVELING AT HIGH FREEWAY SPEEDS, AND ARE THEREFORE NOT RECOMMENDED FOR INCIDENT MANAGEMENT AND ROUTE DIVERSION SIGNING (8).**

Typically, a sequencing or run-on message is repeated several times on a sign. The number of seconds allocated to display the complete message one time on a sign is called the **message cycle.** A message cycle includes the time used to delineate the end of the message (stars or blank time).

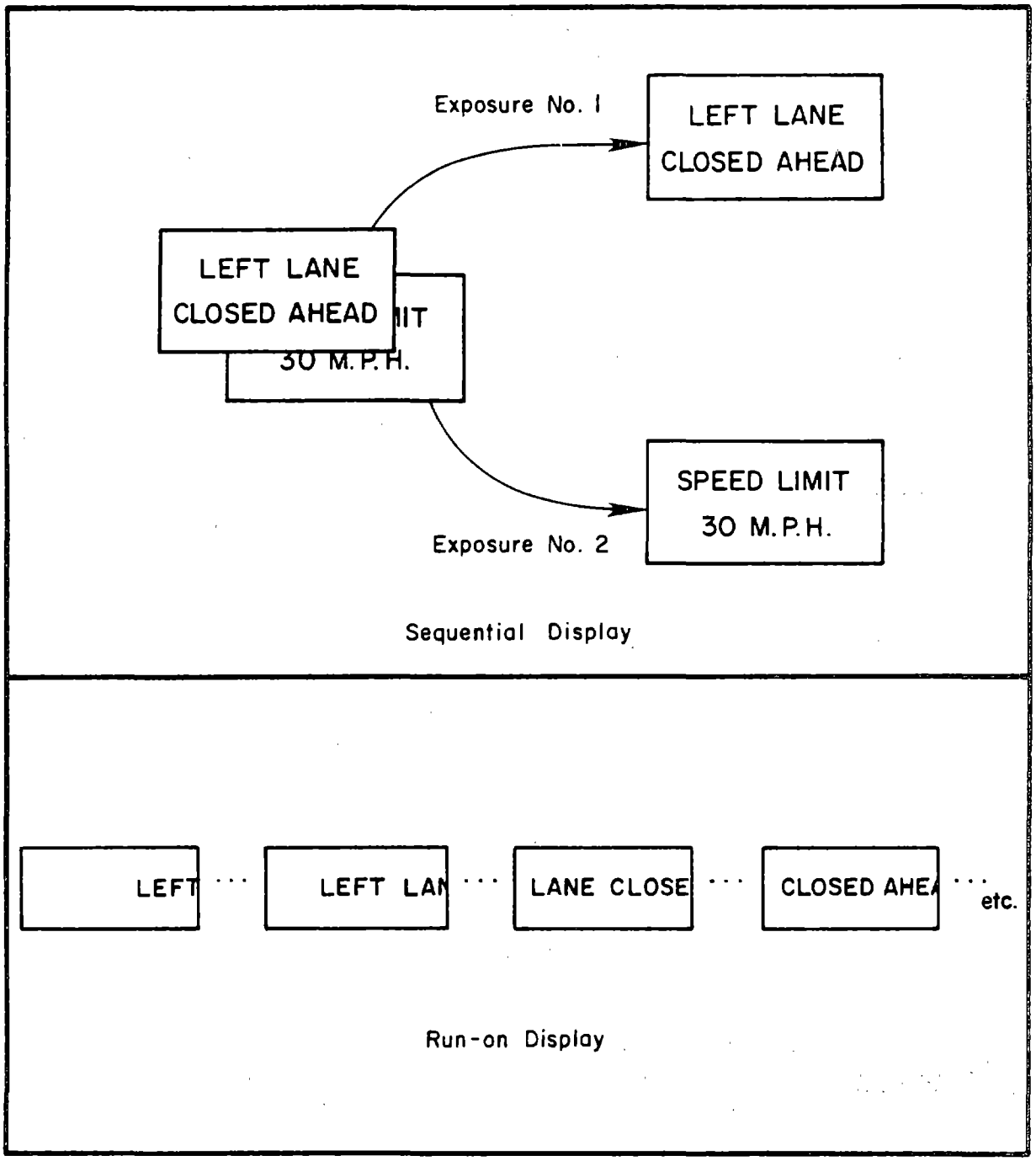


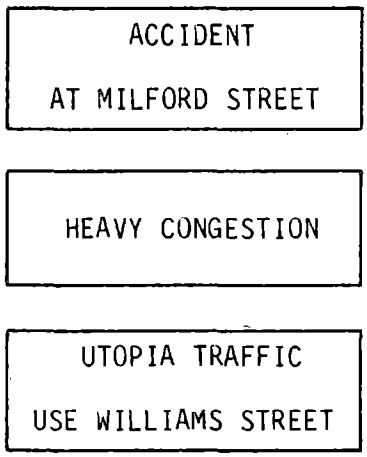

Figure 3-3. Illustration of Sequential and Run-on Display Formats

## D.3 Splitting Messages (Chunking)

Quite frequently incident management or point diversion situations dictate the need for longer messages than can be processed by drivers viewing a CMS or placed on the CMS due to size limitations. Long messages displayed at one time on a CMS tend to overwhelm drivers to the extent that they are not able to read and process the information in the short time they are within the viewing distance of the message (8). This phenomenon has not been completely researched in the highway environment. However, there is evidence to indicate that drivers cannot efficiently scan long messages, and considerable time is lost in the scanning process. Laboratory studies, for example, have indicated that drivers can read and recall an 8-word message better when it is broken up into smaller "chunks" than if the 8 words were displayed all at one time (8).

A message can be displayed by sequencing message chunks on a sign or, if necessary, displaying separate chunks of information on two signs.

Chunking must be accomplished by splitting the message into compatible units of information. For example, the advisory message shown in Section B.1 can be chunked into the following compatible phrases:




Note that **HEAVY CONGESTION/UTOPIA TRAFFIC** are not compatible phrases and therefore would not be chunked together. **UTOPIA TRAFFIC/USE WILLIAMS STREET** are compatible in the sense that the action statement refers to the destination group. Collectively, the message elements form a message that will stand alone like a sentence.

## D.4 Sequential Message Formats

There are three ways in which a sequenced message can be displayed. It can be displayed at one word per sequence (word sequencing), two words per sequence (line sequencing), or four words per sequence (chunk sequencing) (7).

Word, line and chunk sequencing for an 8-word message are illustrated in Figures 3-4, 3-5, and 3-6.

---

**EITHER WORD, LINE OR CHUNK SEQUENCING CAN BE USED FOR MESSAGES UP TO 4 WORDS. FOR 8-WORD MESSAGES, BEST RESULTS ARE OBTAINED WITH EITHER CHUNK OR LINE SEQUENCING IN EITHER THE COMPACT OR CHUNK EXTENDED FORMATS.**

---

Word sequencing of 8-word messages should be avoided. The message extended format should also be avoided.

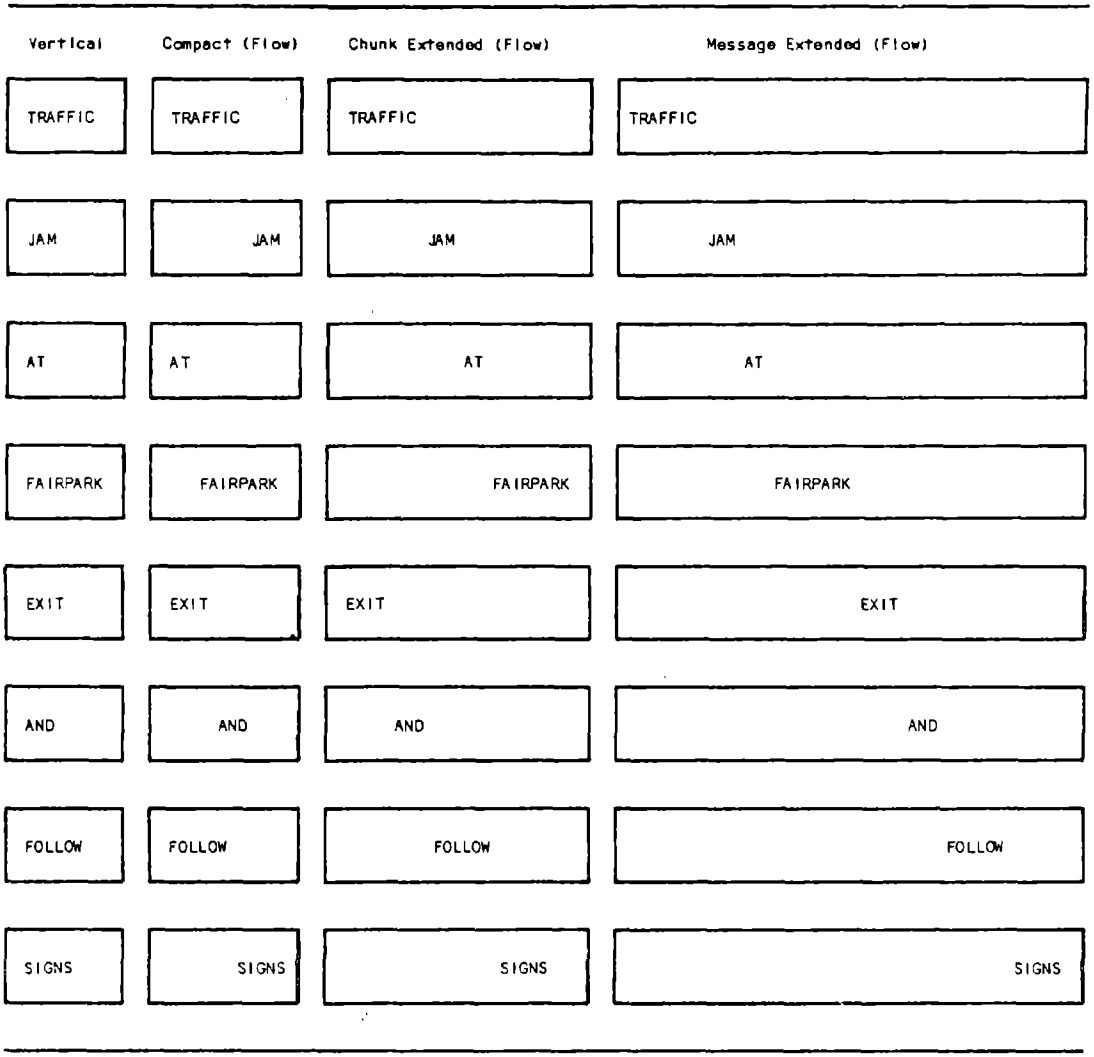



Figure 3-4. Word Sequencing (8 Sequences, 1 Word per Sequence)

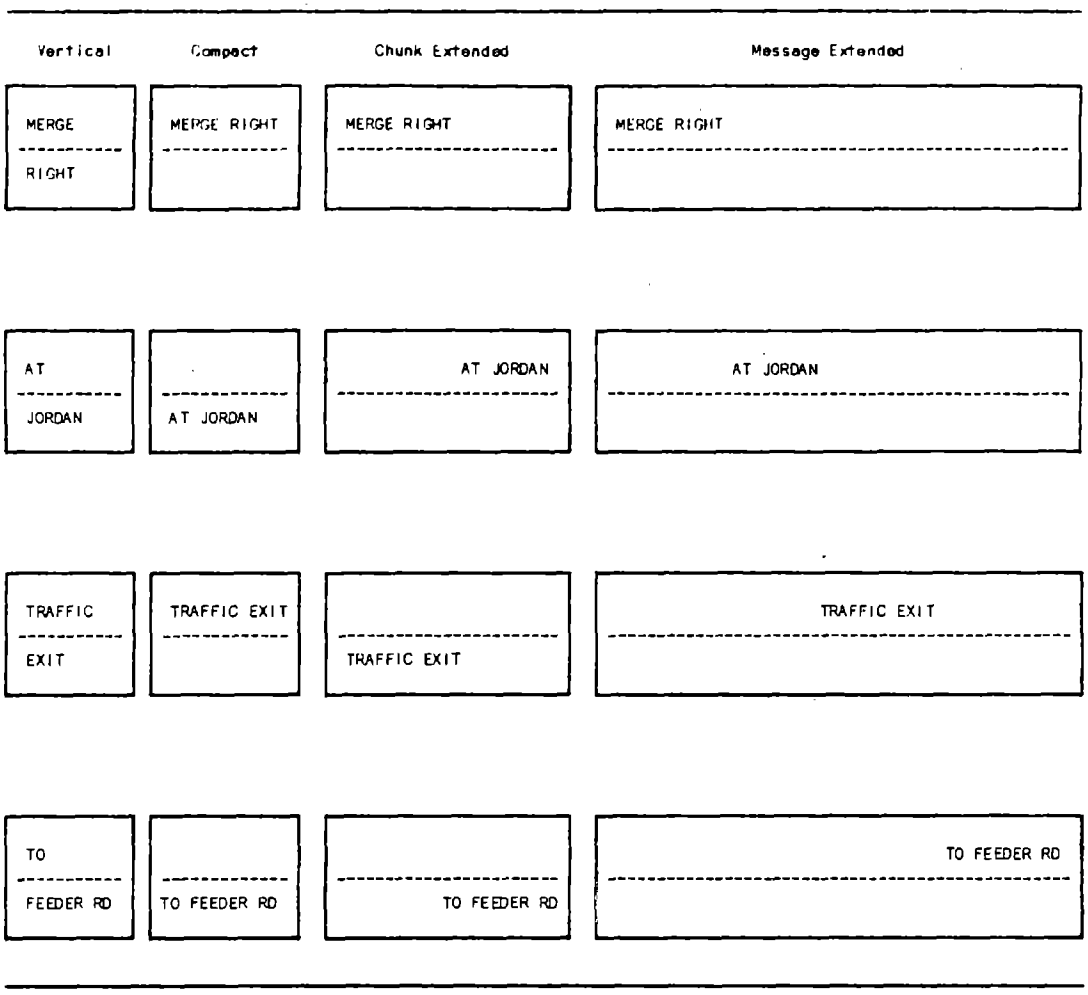



Figure 3-5. Line Sequencing (4 Sequences, 1 Line or Unit per Sequence)

## E. Message Redundancy

### E.1 Repetition

Redundancy is a concept which has been employed in several different ways. Sometimes it refers to repetition of the complete message or key words in the message. In this sense it provides assurance that all or nearly all drivers see the message at least once. If the information must be learned, such as a street name or trailblazer code, repetition gives drivers an additional learning trial. They will then be able to recognize these names or symbols when they appear later on other signs.

As discussed in Section D, sometimes the length of the total message required for a visual display is too long to either be displayed on a single

sign at one time or be read by drivers in the available reading time. It then becomes necessary to divide the message into parts and to use a sequential format, display separate parts of the message on two signs, or use a combination of the two. When sign space permits, it is recommended that key words be repeated which appear in the first part of a message sequence or on the first sign.

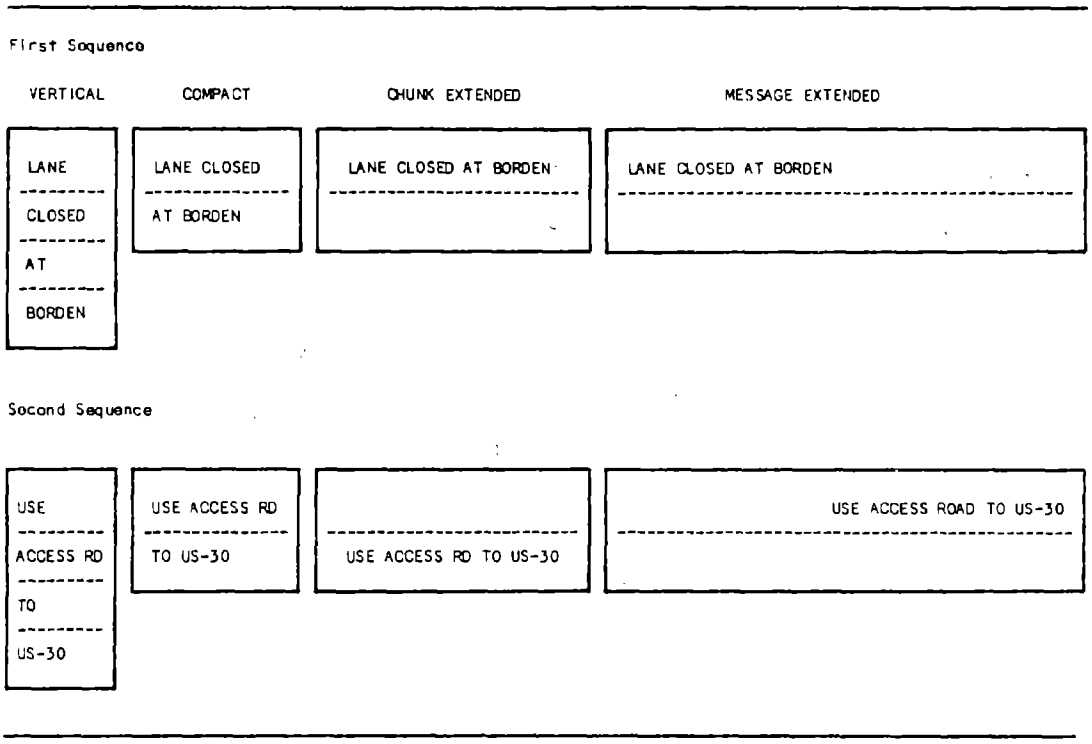



Figure 3-6. Chunk Sequencing (2 Sequences, 1 Chunk per Sequence)

An example of a sequential format incorporating repetition of a key word is as follows:

| | |
|---|---|
| ACCIDENT | ACCIDENT |
| AT KINGMAN | TAKE TEMP. BYPASS |

The key word **ACCIDENT** is repeated in the second message, thus insuring that all drivers see the reason for taking the temporary bypass and, perhaps, stressing the urgency of doing so.

An example of repetition of nearly an entire message on two signs which may be located a mile or more apart is as follows:

| FAIRGROUNDS |
| --- |
| BEST ROUTE |
| USE |
| FITZHUGH AVE |

| FAIRGROUNDS |
| --- |
| BEST ROUTE |
| FITZHUGH AVE |
| 1 MILE |

In this example, the first part of the message is identical; the second part adds the notation of distance to the exit. Again, the repetition insures that drivers who may have entered the freeway after the first sign or who inadvertently missed it will see the message once. The cross-street **FITZHUGH AVENUE** may be an unfamiliar name to many drivers and its repetition facilitates learning. Thus, the two signs have a certain "continuity" or "compatibility" with key elements repeated as well as new elements added.

## E.2 Redundancy in Coded Information

In addition to its usage as repetition, the word **redundancy** has been employed in the context of coded information. For example, the interstate shield is redundant in its shape, color, and route number. A driver viewing the route marker at a distance, or when it appears with state route markers on a sign, may be able to distinguish the interstate marker either from the cue of its shape or from the red, white, and blue color pattern or from the number.

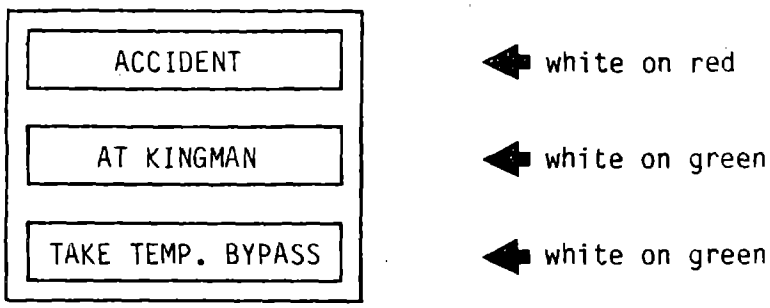
These cues reduce the amount of visual search required and provide for quicker recognition. Another example of redundancy in the visual cues is as follows:


This trailblazer logo has redundancy in several respects: the distinctive shape and color of the "FP" logo; the background color of the sign; the shape of the sign; and in this instance, the word name explaining

the code. Once the association between the logo and the generator name is made, the word name is unnecessary.

The distinctive coding of a critical message element has been used to enhance its probability of being read and also to stress its urgency.

An example on a rotating drum sign is as follows:




The red background of the word message **ACCIDENT** plus the fact that its background differs from that of the other two messages increases the probability that this message will be read first, and also may stress the urgency of the message. Thus, the red background is a redundant cue to the word message.

Research has not yet substantiated which color combinations are most effective for advisory CMSs. Agencies in Dallas and Pennsylvania are using white-on-green, black-on-yellow, and white-on-red panels on advisory rotating drum signs to display, in increasing severity, three levels of traffic conditions. The New Jersey Turnpike Authority uses white-on-red panels on signs located on a dual-dual turnpike segment to display regulatory messages designed to close one of the two roadways in a particular direction. Experience by these and other agencies as well as additional laboratory studies should eventually lead to more specific recommendations.

### E.3 Redundancy in Word Messages

Redundancy has also a third meaning. It has been employed in a negative sense to imply unnecessary information or information which may be understood from the context and, hence, adds little new information for most drivers. For example, the fact that a familiar street name is an "avenue," "boulevard," or "lane," may be well understood and redundant in this sense. The message **ACCIDENT AHEAD**, when it appears on a freeway sign, has a redundant word, since most certainly the accident is somewhere downstream of the drivers viewing the sign. Eliminating unnecessary words helps conserve space on limited capacity signs.

## 4. DESIGN OF ADVISORY SIGNS - PROBLEM AND EFFECT MESSAGE STATEMENTS

Advisory sign messages should display one or more of the following elements:

- A problem statement (accident, roadwork, etc.)
- An effect statement (delay, heavy congestion, etc.)
- An attention statement which addresses a certain destination group where applicable
- An action statement (what to do)

This Chapter presents message design guidelines for problem and effect statements on visual advisory signs. Guidelines for attention and action statements are given in Chapter 5.

### A. Warning of Slow Traffic

In traffic management, drivers on freeways should be alerted to stoppages or slowdowns ahead especially when visibility is restricted. When incidents occur, high speed traffic should be alerted of stoppages and queues of slow moving traffic.

The recommended message is: **CAUTION SLOW TRAFFIC.** When static signs with amber flashing beacons are used **When Flashing** should be added. Black letters on a yellow background are recommended for static signs.

---

**THE ABOVE MESSAGE SHOULD BE USED ONLY WHEN THE BACK OF THE QUEUE IS ABOUT ONE-HALF MILE DOWNSTREAM OF THE SIGN.**

---

Most drivers believe the slowdown will occur between a block to one-half mile downstream of the sign (4, 9, 10). Field studies in Houston (9) found that a 6' X 12' (1.8 X 3.6 m) sign placed near the shoulder at a minimum height of 17'6" (5.3 m) from curb to sign bottom was effective in reducing rear-end collisions.

### B. Incident Messages

Warnings of hazardous incidents should be displayed under all traffic conditions in peak or off-peak periods (11, 12). Examples of incidents which should be displayed are:

| | |
|---|---|
| ACCIDENT | SPILLED LOAD |
| MINOR or MAJOR ACCIDENT | ROADWORK |
| ICE (ICY BRIDGE) | PAVEMENT BROKEN |
| FLOODED | SNOW or FOG |

Do not display information on incidents off the roadway which can be readily seen and avoided by lane changing (11, 12). Examples of minor off-roadway objects are grass cutters, stalled vehicles, trash, or small dead animals.

A convoy of slow-moving vehicles which cannot be passed or which requires diversion should be displayed:

| | |
|---|---|
| SLOW MOVING VEHICLES | MILITARY CONVOY |
| FUNERAL PROCESSION | |

If an accident does block part of the roadway or slows down traffic, drivers want advance knowledge. The word **ACCIDENT** is preferred to more exact descriptions such as **VEHICLE OVERTURNED.** A large portion of traffic will voluntarily divert in response to the word.

To communicate the severity of an incident, describe it in terms of "effects" rather than assign a gradation level such as **A, B, C.** Effects refers to number of lanes blocked, delay, or congestion (See Sections D through H).

General classification messages such as **ACCIDENT, ROADWORK,** or **SPILLED LOAD** are preferred and reduce the need for a library of messages for every conceivable incident. Also, credibility is weakened when overly precise messages are not later verified.

## C. Location of Incidents

When a majority of drivers would be unfamiliar with the names of local cross-streets, incident location should be described in distance to the nearest half-mile. Highway travelers are accustomed to seeing distances to cities. However, when a majority of drivers are commuters, incident location should be referenced to the nearest cross-street. Research (11) indicates commuters are highly familiar with cross-street names and can relate to the named locations better than to distances. Commuters are poor at estimating distances to major cross-streets. Giving distances does not easily translate in terms of whether the location is upstream or downstream of an exit ramp of interest. When there are no cross-streets in the vicinity, a prominent landmark (factory, water tower, airport, etc.) may be substituted (13).

Examples of incident location messages are:


Unfamiliar Driver


Familiar Driver

The word **AHEAD** may be given after **MILES** although it is largely understood.

## D. Traffic State Messages

In describing downstream traffic states on a CMS, there is a large continuum of possible traffic conditions from nearly empty to totally jammed and stopped. While there are many points along the continuum, there is little value in signing for more traffic states than drivers can visualize. (See D.1). Laboratory studies (11) investigated the number of states and the words which most aptly described each state for driver understanding.

---

**TRAFFIC STATE DESCRIPTOR MESSAGES SHOULD NOT ROUTINELY BE DISPLAYED IN THE COURSE OF TRAFFIC OPERATION. THEY SHOULD BE RESERVED FOR WHEN FREEWAY CONGESTION IS NOT ANTICIPATED OR IS MORE SEVERE THAN EXPECTED.**

---

Nevertheless, some agencies will elect to display traffic states and the following guidelines apply.

### D.1 Number of Traffic States

Drivers cannot make fine discriminations between levels, but tend to think in terms of only three or at most four levels of operation. Commuters during peak periods and other drivers during off-peak periods are both limited to three levels, but they may possibly think in terms of different levels (i.e., the same descriptor words may be interpreted slightly differently).

---

**DISPLAY ONLY THREE, OR AT MOST FOUR, TRAFFIC STATES.**

---

## D.2 Effects of City Size

Laboratory studies (11) conducted in four cities of different populations, investigated the meanings of traffic state descriptor words in terms of levels of traffic density implied. Tables 4-1 and 4-2 summarize the findings. Words listed under a single traffic state level are highly specific to that level whereas those under several traffic state levels are less specific. The expression covers a wider range of traffic conditions, and may be described as vague.

---

**IN TABLES 4-1 AND 4-2, DESCRIPTORS IN ITALICS ARE VAGUE AND SHOULD BE AVOIDED.**

---

Since the expressions can be interpreted differently, they should be avoided. In addition, two other expressions (**STOP-AND-GO TRAFFIC** and **NORMAL TRAFFIC**) were highly variable and should be avoided also.

Drivers in larger cities tend to be more accustomed to dense traffic whereas those in smaller cities are apparently more apprehensive about it. (Small city drivers may refer to level 1 as "light congestion" and level 2 as "moderate congestion" whereas large-city drivers refer to levels 1 and 2 as **UNCONGESTED** and levels 3 and 4 as **MODERATE.**) These differences must be considered in signing.

Several different descriptor sets are appropriate to describe three levels, but the recommended descriptors differ for large and small cities. In large cities, use the following combinations:

- [NO CONGESTION — MODERATE CONGESTION — HEAVY CONGESTION]
- [NO DELAY — MINOR DELAY — MAJOR DELAY ]
- [LIGHT TRAFFIC or FREE-FLOWING TRAFFIC — SLOW TRAFFIC — JAMMED TRAFFIC ]

In smaller cities, use:

- [LIGHT CONGESTION or NO DELAY — CONGESTION — MAJOR DELAY ]
- [FREE-FLOWING TRAFFIC — HEAVY TRAFFIC — JAMMED TRAFFIC ]

---

**TRAFFIC STATE 5 (TABLES 4-1, 4-2) SHOULD BE LIMITED TO UNANTICIPATED SEVERE CONGESTION (E.G., WHEN AN ACCIDENT OCCURS) RATHER THAN ROUTINE PEAK-PERIOD TRAFFIC.**

---

TABLE 4-1

SUMMARY OF DESCRIPTOR ASSOCIATION FOR LARGE CITIES

| *VERY LOW TRAFFIC DENSITY* | | TRAFFIC STATES | | *VERY HIGH TRAFFIC DENSITY* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | FREEWAY OK<br>MOVING WELL | | | VERY CONGESTED<br>JAMMED TRAFFIC<br>EXTRA DELAY<br>HEAVY CONGESTION<br>TRAFFIC JAM<br>MAJOR DELAY<br>TRAFFIC STOPPED<br>FREEWAY JAMMED |
| FREE FLOWING TRAFFIC<br>LIGHT TRAFFIC<br>NO DELAY<br>UNCONGESTED<br>NO CONGESTION | | MODERATE CONGESTION<br>MINOR DELAY<br>SLOW TRAFFIC | | |
| | MODERATE TRAFFIC | | | |
| | | *HEAVY TRAFFIC*<br>*DELAY*<br>*CONGESTED* | | |

Note: Descriptors shown in italics have vague meanings and should not be used.

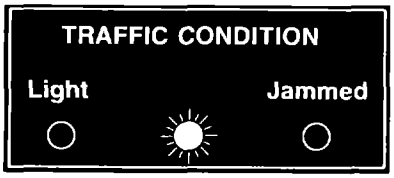
TABLE 4-2

SUMMARY OF DESCRIPTOR ASSOCIATION FOR SMALLER CITIES

| *VERY LOW TRAFFIC DENSITY* | | TRAFFIC STATES | | *VERY HIGH TRAFFIC DENSITY* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| UNCONGESTED<br>NO CONGESTION<br>LIGHT TRAFFIC | MODERATE TRAFFIC<br>MOVING WELL | | | JAMMED TRAFFIC<br>MAJOR DELAY<br>FREEWAY JAMMED<br>TRAFFIC STOPPED |
| FREE FLOWING TRAFFIC<br>FREEWAY OK<br>LIGHT CONGESTION<br>NO DELAY | | CONGESTED<br>HEAVY TRAFFIC<br>SLOW TRAFFIC | | |
| | *MODERATE CONGESTION*<br>*MINOR DELAY* | | | |
| | | | HEAVY CONGESTION | |
| | | *DELAY*<br>*EXTRA DELAY* | | |

### D.3 Coding Traffic State Descriptor Messages - Anchored and Unanchored Messages

The term, "anchoring," refers here to displaying the full range of possible traffic conditions on a sign (from "best" to "worst") so that when one condition is illuminated, its relative position on the scale is clearly identifiable. An example of an anchored display is:




The two extreme conditions should be labeled so that unfamiliar drivers may quickly learn that the left end is light traffic and the right end, jammed traffic. Once this concept is grasped, the illuminated beacon may be read at a distance without reference to the labels. Three or at most four conditions should be displayed.

Absolute coding systems are not as effective as anchored messages. Absolute systems employ letter grades such as **A, B, C,** or numbers to designate various levels of traffic conditions, for example:



Laboratory studies (11) found that such absolute systems (letters or numbers) are ambiguous because the reader does not initially know what they mean or the range of scale. For example, the scale could be A to C or A to F; 1 to 5 or 1 to 10. Their proper interpretation requires an extensive educational program which the unfamiliar viewer may not be exposed to.

---

**AVOID UNANCHORED DESCRIPTORS IN DISPLAYING TRAFFIC CONDITIONS.**

---

## E. Lane Blockage (Closure)

The overhead red "X" and green arrow, lane-use control signals have been used successfully and have been adopted by the MUTCD (14) to indicate lane blockage and availability on urban freeways (14-18). Since they are mounted

above each lane, drivers readily associate them with the lane. Some agencies may desire to use side-of-the-road signs to inform drivers of blocked or closed lanes. When this is necessary, care in choice of words is essential to avoid ambiguity, as described in E.1 and E.2.

## E.1 Two- and Three-lane Freeway Sections

When there are only two or three lanes, the word message may be either descriptive (**LEFT LANE BLOCKED** or **RIGHT LANE BLOCKED**) or it may be directive (**KEEP RIGHT** or **KEEP LEFT**).

When the center lane is blocked or closed on a three-lane section, a directive message is not recommended. The preferable message is **CENTER LANE BLOCKED (CLOSED).**

The message **FREEWAY BLOCKED AHEAD** was interpreted in laboratory studies (11) and field experience (19) to mean the entire freeway is blocked.

---

**NEVER DISPLAY "FREEWAY BLOCKED" WHEN AT LEAST ONE LANE IS OPEN TO TRAFFIC. DISPLAY IT ONLY WHEN ALL LANES ARE BLOCKED.**

---

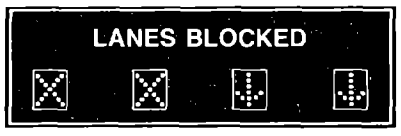
Drivers (11) felt that **LANE BLOCKED** indicated a temporary blockage due to an accident, stall, etc., whereas **LANE CLOSED** indicated a prolonged closure. Therefore, use **RIGHT (LEFT) LANE BLOCKED** when the obstruction is due to an incident.

## E.2 Four or More Lanes

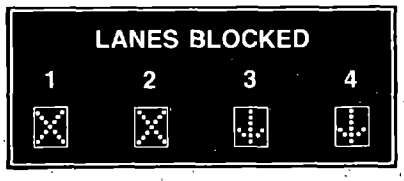
When the freeway section has four or more lanes in one direction, word descriptors like **LEFT, CENTER,** and **RIGHT** are ambiguous in designating specific lane blockages. Therefore, anchored displays are recommended. These may present word messages or "Xs" and "arrows", as follows:

(A)

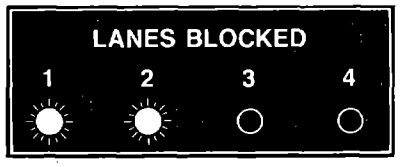

(B)




(C)




(D)



All four are acceptable methods for depicting that the first and second left-hand lanes are blocked.

When words are employed (A), place the blocked lanes on a separate line. This will aid in noting which lane is different. If drivers know the top line indicates only blocked lanes, they do not need to read the word and, hence, legibility distance for lane changing is increased.

Anchored signs with "Xs" and "arrows" are correctly interpreted by drivers even when they are all white rather than coded red and green. Thus, they may also be used on matrix or rotating drum side-mounted signs. If the lanes are not numbered (B), both Xs and arrows must be displayed to provide anchoring. If lanes are numbered (C), only the blocked lanes need to be shown by Xs. For side-mounted CMSs, numbered lanes are recommended, particularly when red-and-green illuminated beacons are employed as in (D).

---

**"LANE BLOCKED (CLOSED)" IS CLEARER THAN "LANE CONDITION" AS A TITLE.**

---

## F. Location and Length of Congestion

As noted previously (Section C), familiar drivers are highly familiar with cross-street names or major intersecting freeways. Congestion locations should be referenced to these names, as follows:



When a majority of drivers are unfamiliar with local cross-streets (for example, on a bypass, loop, beltway, or rural interstate), the locations should be given in odometer miles to the nearest half mile.



When drivers are approaching a queue, they wish to know when the queue will begin. When they are already engulfed in congestion, they desire to know when it will end. Therefore, use of the first or second message above depends upon where the drivers are located relative to congested traffic when they read the sign.

**NEVER DISPLAY THE OBVIOUS. TELLING DRIVERS THEY ARE IN CONGESTED TRAFFIC IS USELESS INFORMATION AND LESSENS CREDIBILITY OF THE SYSTEM.**

Never display the word **CONGESTION** when drivers are engulfed in congestion. Drivers prefer **TRAFFIC CLEARS.** Also, measuring precise distances (to one-tenth of a mile) is difficult when queues change quickly and inaccuracies may weaken credibility. One-half mile is sufficiently precise for this application.

Queues will not likely begin exactly at a cross-street. Reference should be to the nearest cross-street. All that drivers want to know is that they may avoid being "caught up" in the queue if they exit at the first cross-street upstream of the referenced cross-street.

When there are no cross-streets in the vicinity of a queue onset or clearing, use a prominent landmark, (e.g., **TRAFFIC CLEARS AT JACKSON FIELD**).

The use of exit numbers in lieu of street names has not been researched, but numbers (other than one's own) are probably less familiar to local commuters. Given the choice of either, cross-street names are preferable in describing locations.

## G. Delay and Time Saved Information

In addition to congestion, another form of "effect" statement is to express the effect in terms of so-many minutes of delay. Typically, this statement will be followed by an action statement to use an alternative route. Thus, the statement should be to "avoid X minutes delay, use (facility)." An alternative approach is to express the advantage of taking the alternate route in terms of time saved in minutes.

### G.1 Effect on Diversion

Surveys in Los Angeles, St. Paul, Houston, and College Station revealed highly consistent results regarding drivers' reported tolerance for delay times (11).

- The average (median) driver will divert to avoid a delay of 20 minutes or more.
- If the delay is less than 5 minutes, only 8 percent stated they would divert.
- If the delay duration was as much as an hour, 95% would divert.

- A few (4 or 5%) would not divert regardless of the delay time.

- Drivers base their decision to divert or continue upon delay information more so than the type of incident (e.g., accident, roadwork, etc.). Type of incident did not matter given equal delay durations.

Table 4-3 indicates the effects of various delay periods upon drivers' reports of a decision to divert. The same type of information is given for a time saved message.

From this research, it was concluded that if a traffic engineer desired to induce various percentages of drivers to divert:

- Use no more than six levels of delay

- Do not display less than 5 minutes delay

- Do not display more than 1 hour delay

The results are somewhat misleading in suggesting that more drivers would divert to the time savings of comparable minutes. In the time-saved research, an alternate route was specified (i.e., they would save X minutes by taking this route). In the delay study, no alternate route was mentioned specifically, hence, possibly a greater delay tolerance.

Field experience (20) found that **TIME SAVED** and **DELAY** were equally effective where both delay and time saved messages were presented with an advisory to a diversion route.

It is further cautioned that delays are easily checked by drivers and misrepresenting them to manipulate traffic demand is discouraged. The consequences could be loss of message credibility and confidence in the system.

## G.2 Meaning of Delay

Drivers interpret **DELAY** (shown in minutes) as being relative to their normal travel time to traverse the freeway and arrive at their destination. It will take that much longer than ususal. **DELAY** does not necessarily mean they will be held up in traffic at one location for that long or that it will take that long to remove an accident.

Another study (11) found that the words **MAJOR ACCIDENT** and **MINOR ACCIDENT** were translatable into delay duration. To the average driver, **MAJOR ACCIDENT** implies at least 20-25 minutes delay, whereas **MINOR ACCIDENT** implies not more than 15 minutes delay.

TABLE 4-3

PERCENTAGE OF DRIVERS STATING THEY WOULD DIVERT TO VARIOUS DURATIONS OF DELAY OR TIME SAVED (GIVEN AN ALTERNATE ROUTE)

| DELAY PERIOD (min) | Percent Diverting from Freeway | TIME SAVED (min) | Percent Diverting from Freeway |
|---|---|---|---|
| 5 | 8 | 5 | 42 |
| 10 | 18 | 10 | 19 |
| 15 | 34 | 15 | 72 |
| 20 | 63 | 20 | 80 |
| 30 | 83 | 30 | 92 |
| 60 | 95 | 60 | 92 |
| 120 | 96 | 120 | 94 |

Another way of showing temporal information is in terms of comparative travel time along two routes (e.g., I-94 - 25 minutes; Temporary Bypass - 10 minutes). This approach requires subtraction by the driver to determine the time savings. Drivers feel that all three methods are saying the same thing, but the comparative travel time is least preferred because the message takes longer to read and interpret. (See G.3).

### G.3 Formats of Delay or Time Saved Messages

If the delay is expressed in the form of "X minutes delay," it refers to travel time on the primary route and should appear immediately after the incident warning as illustrated:

If delay is expressed in terms of "Avoid X minutes delay" or "Save X minutes," the reference is to an advantage of the temporary bypass and should appear after the advisory which mentions the bypass:



Note that the time saved message uses fewer characters, which is an advantage when line capacity is limited. Also, it offers a positive reason for taking the bypass.

### G.4 Travel Time Messages

Some designers may also consider displaying comparative travel times along the primary and alternate routes. Problems with this approach are:

- Travel time information is easily disputed. If the sign says 10 minutes and they take 15 minutes, credibility is weakened. Delay is more difficult to refute.
- Travel times alone do not specify the best route to take. Also, when times are very similar on each route, the driver may question the usefulness.
- As noted, drivers must subtract to determine the time savings, which is really what they want to know anyway.

There is no need for a more complex system when delay and travel time information have proven effective.

---

**AVOID THE USE OF TRAVEL TIME INFORMATION.**

---

### G.5 Variable Speed Displays

Experience with variable speed message signs indicates that drivers are not willing to reduce their speeds to coincide with the posted speed unless there is an apparent reason to do so (e.g., drivers see slow traffic ahead) (17, 21). Displayed speeds less than 40 mph (64 km/hr) seem to have little, if any, additional effect on lowering speeds. No research to date, however, has shown whether the lower displayed speeds reduce the frequency of rear-end collisions or near misses by alerting drivers to slow traffic downstream.

## H. Abbreviations

Highway agencies employing CMS need an acceptable list of abbreviations for frequently used words in real-time traffic operations. The following are a set of abbreviations which at least 85% of the driving public would understand if they appeared on a road sign (7):

| Word | Abbreviation | Word | Abbreviation |
|---|---|---|---|
| Boulevard | BLVD | Maintenance | MAINT (Use RDWK) |
| Center | CNTR | Normal | NORM |
| Emergency | EMER | Parking | PKING |
| | | Road | RD |
| Entrance, Enter | ENT | Service | SERV |
| Expressway | EXPWY | Shoulder | SHLDR |
| Freeway | FRWY, FWY | Slippery | SLIP |
| Highway | HWY | Speed | SPD |
| Information | INFO | Traffic | TRAF |
| Left | LFT | Travelers | TRVLRS |
| | | Warning | WARN |

These words will likely be understood independent of the specific context of usage. Other words are easily understood (>85%) whenever they appear in conjunction with a particular word commonly associated with it. In addition to those above, these words and abbreviations are as follows:

| Word | Abbreviation | Prompt Word | Word | Abbreviation | Prompt Word |
|---|---|---|---|---|---|
| Ahead | AHD | • Fog | Mile | MI | • [Number] |
| Blocked | BLKD | • Lane | Minute(s) | MIN | • [Number] |
| Access | ACCS | Road | Oversized | OVRSZ | Load |
| Bridge | BRDG | • [Name] | Prepare | PREP | To Stop |
| Chemical | CHEM | Spill | Pavement | PVMT | • Wet |
| Construction | CONST | Ahead | Quality | QLTY | • Air |
| Exit | EX, EXT | • Next | Route | RT | • Best |
| Express | EXP | Lane | Turnpike | TRNPK | • [Name] |
| Hazardous | HAZ | Driving | Vehicle | VEH | • Stalled |
| Interstate | I | [Number] | Cardinal | N,E,S,W | [Name] |
| Major | MAJ | Accident | Directions | | |
| Minor | MNR | Accident | Upper,Lower | UPR,LWR | Level |

• = prompt word given first

The user should be cautious in employing these abbreviations with other prompt words since their high understanding has been established only with the words given in the table.

Certain abbreviations are prone to inviting confusion because another word is abbreviated or could be abbreviated in the same way. The following are the abbreviations, the word intended, and the word commonly given. AVOID USING THESE ABBREVIATIONS without prompt words and extensive public education.

| Abbreviation | Intended Word | Word Erroneously Given |
|---|---|---|
| WRNG | Warning | Wrong |
| ACC | Accident | Access (Road) |
| DLY | Delay | Daily |
| LT | Light (Traffic) | Left |
| STAD | Stadium | Standard |
| L | Left | Lane (Merge) |
| PARK | Parking | Park |
| RED | Reduce | Red |
| POLL | Pollution (Index) | Poll |
| FDR | Feeder | Federal |
| LOC | Local | Location |
| TEMP | Temporary | Temperature |
| CLRS | Clears | Colors |

There are many words for which traffic agencies sought an acceptable abbreviation. Many simply could not be abbreviated efficiently (i.e., by an abbreviation less than 67% of the word's length). Employing what may appear to be an obvious abbreviation runs the risk of misunderstanding since the drivers may not be thinking in the same vein as the highway agency.

The following abbreviations were understood with a prompt word by about 75% of the drivers. These abbreviations would require public education .

| Word | Abbreviation | Prompt Word | Word | Abbreviation | Prompt Word |
|---|---|---|---|---|---|
| Downtown | DWNTN | Traffic | Roadwork | RDWK | Ahead |
| Northbound | N-BND | Traffic | | | (Distance) |
| Congested | CONG | Traffic | Township | TWNSHP | Limits |
| Temporary | TEMP | Route | Frontage | FRNTG | Road |
| Condition | COND | • Traffic | Local | LOC | Traffic |

• Prompt word given first

All other abbreviations should be tested prior to usage. When the length of an abbreviation exceeds 67% of the word's length the space savings by abbreviating may not be worth it.

## 5. DESIGN OF ADVISORY SIGN ATTENTION AND ACTION MESSAGE STATEMENTS

Advisory sign messages consist of the following elements, typically in the order shown:

- A problem statement (accident, maintenance, construction, etc.)
- An effect statement (delay, heavy congestion, etc.)
- An attention statement which addresses a certain group or audience
- An action statement (what to do)

When signing space is limited, the effect statement may be deleted.

### A. Attention Message Statement

#### A.1 General

An attention statement is required only when the action statement applies to a portion of the drivers.

---

**AN ATTENTION MESSAGE STATEMENT MUST ALWAYS BE ACCOMPANIED BY AN ACTION STATEMENT.**

---

The attention message statement identifies the audience to whom the action message statement applies. In the absence of an attention statement, the action statement is understood to apply to all freeway drivers. When the action message is directed only to drivers traveling to a specific destination, however, that destination must be displayed on the advisory CMS.

#### A.2 Use of the Word "Traffic"

---

**GENERALLY THE WORD "TRAFFIC" AFTER A DESTINATION NAME IS NOT NECESSARY.**

---

The reader of a sign can only be a driver who is a part of the traffic stream, so **WASHINGTON, TAKE NEXT EXIT** can only mean **WASHINGTON TRAFFIC, TAKE NEXT EXIT.** The following example illustrates an exception:


**TRAFFIC** not required


**TRAFFIC** required

When the location of the accident (or 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. If **TRAFFIC** were omitted from the second message, it can be interpreted to mean that an accident has occurred near Kyle Stadium.

### A.3 City Destinations

---

**NAMES USED FOR CITIES SHOULD BE IDENTICAL TO THOSE USED ON EXISTING STATIC SIGNING.**

---

City destinations appearing on a CMS should be consistent with existing signing practices. Nicknames should be avoided. For example, **San Antonio** is recommended rather than the nickname **Alamo City.**

### A.4 Major Generator Destinations

---

**NAMES USED FOR MAJOR GENERATORS MUST BE SPECIFIC AND ADDRESS THE EXACT PLACE WHERE AN ACTIVITY TAKES PLACE.**

---

Many cities have large areas known locally by a single name, but which house smaller areas of wider general knowledge. An example is Fair Park in Dallas which contains the better known Cotton Bowl and the Texas State Fairgrounds. Caution should be used when signing for such areas so that the name displayed is consistent with the name used by drivers. If the anticipated audience contains non-local, unfamiliar drivers, the more general, lesser known destination name (Fair Park) would be confusing if the activity was being held at a specific, more widely known destination (Cotton Bowl or Fairgrounds).

### A.5 Special Activity Destinations

---

**NAMES DESCRIBING CERTAIN SPECIAL ACTIVITIES SHOULD BE DISPLAYED RATHER THAN THE LOCATION WHERE THE ACTIVITY IS BEING HELD.**

---

Frequently, special activities such as parades and fireworks displays on July 4th attract large audiences, part of which are non-local, unfamiliar drivers. For these events, it is preferred to display the event (such as **parade** or **fireworks**) rather than the location of the event (such as **downtown** or **Kyle Stadium**).

## B. Action Message Statement

### B.1 General

The action statement, which tells drivers what to do, must be remembered. Research found that only about two-thirds of drivers are able to recall completely four pieces of information (problem, effect, attention, and action). However, 80 to 90 percent recalled the action message (13). Obviously, the action message element is most important for diversion.

Drivers want certain reassurances before diverting to temporary bypass routes (5, 22, 23, 24).

- They want to be assured that they won't become lost.
- They want to know that they will be returned to the freeway.
- They prefer to know in advance where they can return to the freeway.

The message devised should strive to provide as much of this information as is feasible within the constraints of the sign's presentation and the driver's viewing time.

### B.2 Highway Names, Route Numbers, and Route Markers

---

**USE OF A HIGHWAY ROUTE MARKER SUCH AS**  **IS PREFERRED TO A WRITTEN HIGHWAY NUMBER SUCH AS "I-95."**

---

Drivers have exhibited a strong preference for having the route marker displayed on the CMS in comparison to the written version (25). There is also evidence that the message is read more quickly and is generally easier to understand when the route marker is used. Unfortunately, several types of CMSs are incapable of displaying a route marker.

---

**HIGHWAY ROUTE NUMBERS (PREFERABLY ROUTE MARKERS) SHOULD BE DISPLAYED WHEN REFERRING TO HIGHWAYS USED FOR INTERCITY TRIPS.**

---

**Intercity travel** refers to those trips in which part of the primary highway is within a rural environment. A local name for a highway should not be displayed unless it is used in combination with the highway route number (25).

---

**LOCAL HIGHWAY NAMES CAN BE USED FOR INTRACITY TRIPS (TRIPS TO DESTINATIONS WITHIN A METROPOLITAN AREA) IF THE INTENT IS TO COMMUNICATE WITH LOCAL COMMUTERS PRIOR TO THEIR ENTERING THE FREEWAY.**

---

Research has shown that local names sometimes are more commonly used by local drivers than highway route numbers for intracity trips (25). Where these local conventions exist, local names can be used to display action message statements on signs located en route to the freeway. Because existing static freeway guide signs display route markers and not local highway names, a CMS on the freeway should display the route number (preferably the route marker) to insure compatibility between the messages on the CMS and static freeway guide signs. Local names can be used in addition to the route number.

---

**THERE ARE LOCAL WORD DESCRIPTOR PREFERENCES DRIVERS ASCRIBE TO THE FRONTAGE ROAD.**

---

National studies revealed that the names used by drivers for frontage roads differ by locality. In some cities **Service Road** is more commonly used; other locations more commonly use **Frontage Road, Access Road,** or **Feeder Street.** Special studies must be conducted to determine what name is common in a particular city. One must not assume that the name used by traffic engineers or by the media is the name most commonly used by drivers in the city.

## B.3 Diversion Route Name

In advising drivers to take an alternate route other than the frontage road for diversion around an incident, you may either tell them the sign names of roads to take, use trailblazers along the route, or assign a name to the route. Route names should aptly describe the type of facility and the likelihood of the driver being returned to the primary highway.

A survey was conducted in four U.S. cities (25) to determine whether certain names connote particular meanings. The results are shown in Table 5-1.

---

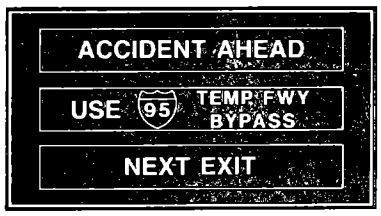
**GIVING A DIVERSION ROUTE A NAME THAT IMPLIES CHARACTERISTICS WHICH THE FACILITY OR ROUTE DOES NOT POSSESS MAY WEAKEN CONFIDENCE IN THE SIGNING. IT IS BETTER TO USE EITHER AN APPROPRIATE NAME OR ONE WHICH CARRIES NO PARTICULAR CONNOTATIONS.**

---

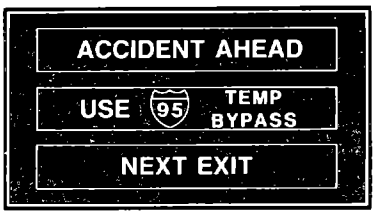
The results on the survey revealed that the name **TEMPORARY BYPASS** was the best overall name. The word **TEMPORARY** connotes a need to divert and **BYPASS** implies the driver will be returned. **TEMPORARY FREEWAY BYPASS**, although lengthy, implies a freeway and the other characteristics as well.

The interstate shield should be included in the message. Obviously, it cannot be included on several types of CMSs.

Examples of signs for diversion:




Diversion to a Freeway




Diversion to an Arterial

Abbreviation of **TEMPORARY** is acceptable because at least 92 percent will readily understand the meaning (25).

**FREEWAY BYPASS** may also be used. While a number of names are almost as effective, the value of standardizing or employing only a few names has been established. Drivers will soon learn to recognize and associate with standardized message.

TABLE 5-1

CONNOTATIONS OF NAMES FOR DIVERSION ROUTES

Facilities Implied by Diversion Route Names

| Name | Means |
|---|---|
| FREEWAY BYPASS | FREEWAY |
| BYPASS | FREEWAY |
| BUSINESS ROUTE | MAJOR, DIVIDED ARTERIAL |
| TEMPORARY BYPASS | MAJOR, UNDIVIDED ARTERIAL (OR FACILITY OTHER THAN FREEWAY) |
| ALTERNATE, DETOUR, SIDE ROAD | TWO-LANE FACILITY |

Facilities Not Implied by Diversion Route Names

| Name | Does Not Mean |
|---|---|
| TEMPORARY BYPASS | FREEWAY |
| DETOUR, ALTERNATE, BUSINESS ROUTE | FREEWAY |
| FREEWAY BYPASS | MAJOR ARTERIAL |
| BYPASS | MAJOR ARTERIAL |
| FRONTAGE, ACCESS OR SIDE ROAD | MAJOR ARTERIAL |
| BUSINESS ROUTE, STREET BYPASS | TWO-LANE FACILITY |

| High Connotation Motorist MUST DIVERT from Primary Route | Low Connotation Motorist MUST DIVERT |
|---|---|
| DETOUR or DETOUR ROUTE | SIDE ROAD, ALTERNATE |
| TEMPORARY BYPASS | BUSINESS ROUTE |

| High Connotation Motorist Will Eventually BE RETURNED to Primary | Low Connotation Motorist Will BE RETURNED |
|---|---|
| TEMPORARY BYPASS | SIDE ROAD |
| DETOUR or DETOUR ROUTE | ALTERNATE |
| BYPASS | BUSINESS ROUTE |

| High Connotation of Being BETTER OFF by Diverting | Low Connotation of Being BETTER OFF Diverting |
|---|---|
| DETOUR or DETOUR ROUTE | BUSINESS ROUTE |
| TEMPORARY BYPASS | SIDE ROAD |

| High Connotation of Being Diverted a Mile or Less | High Connotation of Being Diverted a Mile to 10 Miles |
|---|---|
| ACCESS ROAD | ALTERNATE/ALTERNATE ROUTE |
| STREET BYPASS | FREEWAY BYPASS |

Note: Most names carry no connotation of distance

**DO NOT USE THE FOLLOWING FOR ANY DIVERSION ROUTE TO A FREEWAY OR REMOTE ARTERIAL:**

**BUSINESS ROUTE**
**ALTERNATE ROUTE**
**ALTERNATE**
**DETOUR OR DETOUR ROUTE**

These names already have established meanings which will conflict with the meanings to be conveyed in this application.

### B.4 "USE," "TAKE," and "FOLLOW"--Verb Selection in Action Message Statements

In general, the three verbs **use, take** and **follow** are synonymous and no strong preference has been found. The verb **use** has been employed more often because it is slightly shorter. There are, however, fine shades of differences in meaning which make one verb preferable to another when used in a particular context.

The verb **use** should be selected whenever the advisory is to employ a route which will carry the motorist to his destination. The destination could be a major generator or a point of return to the freeway.

Examples: USE TEMPORARY BYPASS

USE FITZHUGH [TO FIREWORKS]

The verb **take** should be selected whenever the advisory is a directive to begin taking the first street or "leg" of a route.

Examples: TAKE OXFORD AVE EAST

TAKE NEXT EXIT

Normally, a verb will not be used on a freeway sign which displays **NEXT EXIT.** The verb is understood. However, in rare situations a verb may be necessary for grammatical completeness.

Example: TO BYPASS ACCIDENT

TAKE NEXT 2 EXITS

The verb **follow,** although somewhat synonymous, carries the additional connotation that the driver will be guided by references to signs or other cues. It should always be used whenever a trailblazer code is being explained. **Follow** should never be used when guidance is not available.

Examples of correct usage:

FOLLOW MARKED ROUTE

FOLLOW [TRAILBLAZER SYMBOL]

The verb **go** is not used in visual signing for route guidance, but may be used in audio messages. It connotes initiation of action, but would be out of place in situations where **use** or **take** is appropriate.

Similarly, the verb **turn** is used frequently before **left** and **right** in audio messages, but in visual signing the directional arrow is briefer and well understood on road signs.

The word **exit** may also be used as a verb in advisory messages presented on a controlled access facility. 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.

Example: EXIT AT OXFORD AVE

The only exception would be when several exits could be used successfully in diverting to a temporary bypass.

Example: EXIT AND USE GREENVILLE TO LOOP 12

## B.5 Exit Designation

Whenever drivers are asked to "use" a certain type of facility to bypass an incident and ensuing congestion, it is desirable to tell them which exits to take. If the advisory sign is located a considerable distance upstream of the queue and it would not be advisable for the drivers to take the next few exits, then the message must be specific as to the exit ramps recommended.

Example:


If the situation requires that the drivers exit at the next ramp(s), the following exit designation statements would apply:


## B.6 Route Return Assurance Information for Incident Bypass

Earlier sections emphasized that the name given to the diversion route should not violate the driver's expectancies which are based upon his experiences with the names in the past. The name should be appropriate to the actual facility or should be one carrying no particular meaning.

---

**BEFORE DIVERTING, DRIVERS DESIRE TO KNOW THAT THE INCIDENT BYPASS ROUTE WILL EVENTUALLY RETURN TO THE PRIMARY ROUTE AND THE POINT (STREET, CITY) AT WHICH THEY WILL BE RETURNED.**

---

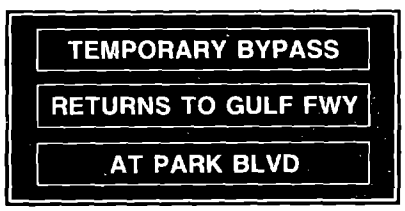
Research has indicated that drivers want certain assurances prior to deciding to take a bypass route, given there is an option (25). Some signing situations may dictate the need for a second sign downstream of the primary CMS to provide this assurance.

The following message is typical of those that might be displayed on the primary CMS:

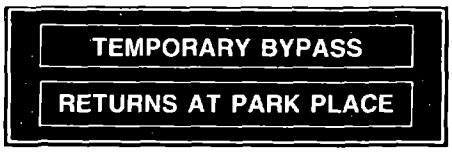

Research has established that the ideal route return assurance message should contain the following information (25):

- The name of the alternate route (e.g., **Temporary Bypass**).
- The geographic point of return.
- The name of the primary route.

Examples of messages recommended for intracity and intercity situations are:




In situations where information requirements may dictate the need to reduce elements of certain message statements, the name of the primary route may be eliminated from the route return assurance messages. This is permitted because the primary route should be "understood" by drivers. The following are acceptable alternatives for the route assurance messages (25):


---

**IF THE DIVERSION ROUTE HAS BEEN NAMED IN THE ADVISORY CMS, USE EXACTLY THE SAME NAME ON THE ROUTE ASSURANCE SIGN.**

---

### B.7 Intracity Bypass Route Pattern

The action statement, following a description of the problem, may describe certain routes at a level to permit driver understanding and recall without requiring trailblazers along the diversion route.

---

**DRIVERS BEING DIVERTED FROM A FREEWAY WILL EXPECT THE BYPASS ROUTE TO BE A LOGICAL "]" or "[" PATTERN. A "]" PATTERN REFERS TO THE MORE COMMON DIVERSION ROUTE TO THE RIGHT, THEN PARALLEL TO THE FREEWAY, AND RETURNING BY TURNING LEFT. THE "[" PATTERN REFERS TO A DIVERSION TO THE LEFT, PARALLEL, AND RETURN ROUTE (22).**

---

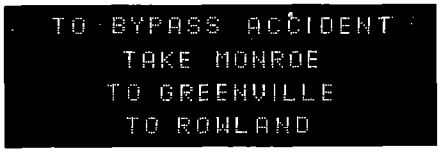
Drivers are direction-oriented relative to their primary freeway facility. After leaving the freeway to a bypass route other than a frontage road, they have expectations of the basic turning movements mentioned above. Any violations of those expectancies can result in driver uncertainty, apprehension, and confusion. For example, drivers do not expect to make two successive right turns after leaving the freeway, placing them in a direction opposite to the destination.

In some cities, the major parallel arterial may be located on the left side of the freeway. When this situation exists, local commuters may expect to follow a "[" pattern route (i.e., left, right, right).

Local commuters may be able to recall and follow brief instructions presented on an advisory CMS describing a simple "]" or "[" pattern bypass route. An example of such a message, assuming Greenville Avenue is the major parallel arterial, is a follows:


Commuters will know that the parallel arterial lies to the right or left and will not need a cardinal direction in the action message statement. An alternative message when more than one cross-street is satisfactory to take to Greenville would be:


The appropriate cross-street to get to the parallel arterial (Greenville) is generally understood to be the next exit unless otherwise specified. In signing situations where another message line is available, the following format is recommended:




or


The second message presumes the drivers know the following:

- They should exit as soon as possible and go right or left to Greenville.
- The idea of a "]" or "[" is obvious.
- They may return to the freeway on Rowland Avenue, another well-known cross-street, or on any cross-street downstream of Rowland. They must not return on a cross-street upstream of Rowland.

Unfamiliar drivers may be aided by a sign located at the first cross-street they encounter immediately after leaving the freeway which gives the direction of turn to the parallel arterial such as:

Research (13) has demonstrated that 80 percent of unfamiliar drivers can recall the route description portion of a message involving up to three street names if the message is received at least twice. They can also drive the course. Local commuters should be able to do much better. The major problem is in having the necessary viewing time to read the action message twice on a single sign while traveling at high freeway speeds.

### B.8 Symbol and Logo Codes

Symbols and logos have a history of being effective means of trailblazing the alternate route to be followed.

---

**SYMBOLS AND LOGOS, AS A RULE, SHOULD NOT BE DISPLAYED ON THE FREEWAY CMS.**

---

Because of the large amount of information that is required to be displayed on the CMS for diversion situations, symbols and logos should not be displayed on a freeway CMS. The usual strategy is to limit the on-freeway message to that information necessary to help the drivers decide to get off and take the alternate route. The most effective way to incorporate symbols and logos into the diversion communication system is to direct drivers off the freeway with word messages, and to then transition into the symbol or logo trailblazer after the drivers leave the freeway and are in a somewhat unloaded driving situation.

### B.9 Interstate Numbers and Designator Names for Loop Freeways

A loop freeway (beltway) in some cities offers a viable alternative route for thru drivers traveling on a radial freeway. Although many unfamiliar drivers use maps in preparing for long trips, a segment of the driving population relies solely on the highway signs for directions (24, 25). The following considerations are important when designing CMS diversion systems for this latter segment of the driving population:

---

**DRIVERS DO NOT UNDERSTAND THE SIGNIFICANCE OF THE THIRD DIGIT USED IN THE INTERSTATE NUMBERING SYSTEM.**

---

Nationwide studies revealed that drivers do not understand that interstate routes with a three-digit number, the first of which is even, represent freeway loops or belt routes around cities (25).

**NO SINGLE DESCRIPTOR NAME COULD BE FOUND THAT DRIVERS THROUGHOUT THE NATION WOULD UNDERSTAND TO DESCRIBE A FREEWAY LOOP.**

There are regional and local differences concerning driver understanding of descriptor names (e.g., **LOOP, BELTWAY, BELT,** and **CIRCLE**) for freeways that route around a city. Generally, the addition of these descriptors would not increase the potential for diverting unfamiliar drivers to freeway loops in comparison to the use of signs containing the shield, destination name, and cardinal direction only (25).

**CARDINAL DIRECTIONS ON LOOP FREEWAYS TEND TO CONFUSE DRIVERS.**

When thru drivers are being diverted from a radial freeway to a loop freeway, some drivers will be confused because of conflicting cardinal directions on the loop (25). For example, a driver traveling north on an interstate freeway will intersect a loop freeway that normally has an **EAST** and/or **WEST** designation. In this instance, the cardinal direction may conflict with the known direction of a destination city. These conflicts were found to be confusing to unfamiliar drivers. They would be less likely to divert unless they know that the freeway loops around the city and returns to a northerly direction (25).

# 6. ADVANCE SIGNS

## A. Introduction

Some situations dictate the need to alert unfamiliar drivers about the existence of the advisory CMS so that they search for it, thus giving them more time to read the message. In such cases, an advance sign is advisable. Circumstances that might arise dictating the need for an advance sign include the following:

- The advisory CMS cannot be located such that optimum target value, legibility, and reading distances are possible because of geometric and/or physical design features of the freeway.
- Conditions upstream of the advisory CMS are such that drivers must devote considerable attention to traffic, thus increasing the probability that many will not notice the sign in ample time to read and comprehend the entire message.
- Some drivers may simply be inattentive and fail to see the advisory CMS in time, particularly if the sign has low target value.

The primary function of the advance sign is to prepare the driver to look for and read the upcoming CMS.

A single message static sign with flashing beacons or any other type of CMS may be used.

---

**INFORMATION ON THE ADVANCE SIGN SHOULD NOT BE DISPLAYED EXCEPT WHEN THE ADVISORY CMS IS DISPLAYING A MESSAGE.**

---

In the case of static signs with beacons, the beacons should only flash when the advisory CMS is in operation. Otherwise, the credibility of the system is compromised.

---

**THE MESSAGE ON THE ADVANCE SIGN SHOULD PREPARE THE DRIVER FOR THE PARTICULAR KIND OF INFORMATION ON THE ADVISORY CMS.**

---

If the advisory CMS presents a recommended "best route" to a specific destination, the advance sign should convey this information. When the advisory CMS presents traffic information and advisories to all the freeway

drivers, an appropriate message should be displayed on the advance sign. If "best route" to a specific destination is amplified by traffic information, **BEST ROUTE TO (Destination)** should be presented on the advance sign.

---

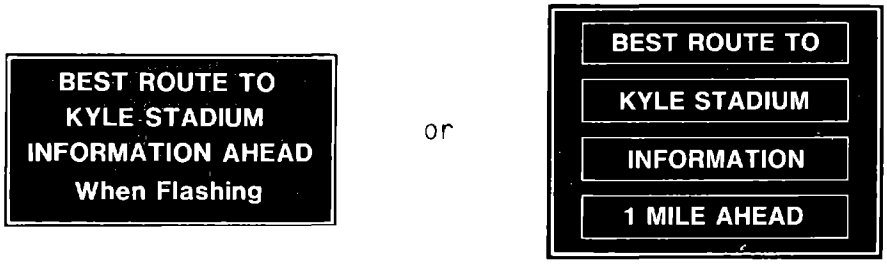
**WHENEVER AN ADVANCE SIGN DISPLAYS "BEST ROUTE," THE ADVISORY CMS MUST CONTAIN AN ACTION MESSAGE STATEMENT TELLING DRIVERS WHICH ROUTE TO TAKE: EITHER REMAIN ON THE PRIMARY FREEWAY OR TAKE SOME ALTERNATE ROUTE.**

---

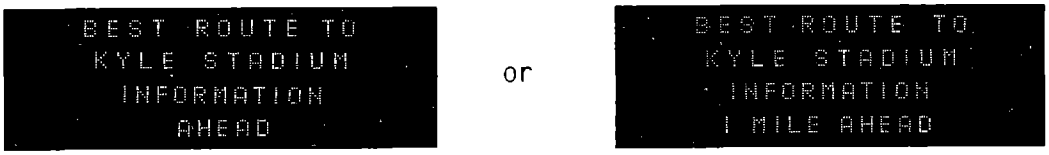
Figure 6-1 illustrates the types of display situations discussed in this chapter.

### B. Diversion to an Arterial Route - Several Possible Alternate Routes

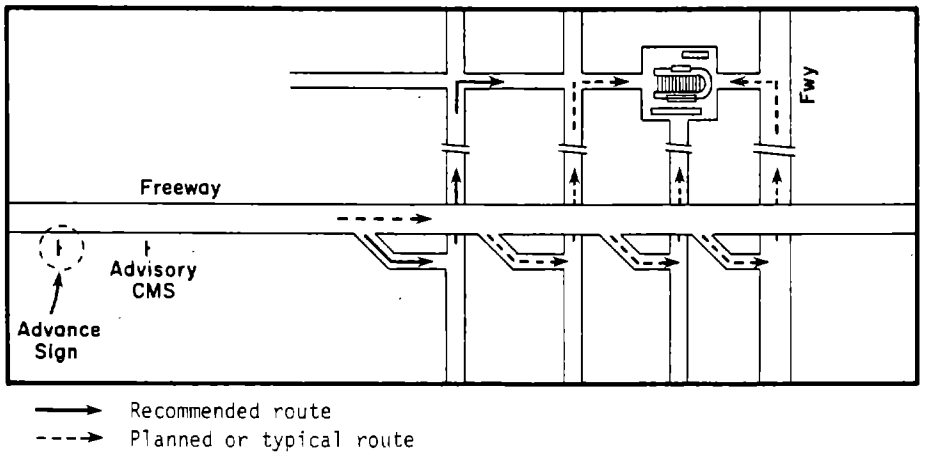
The advance sign can be a single message static sign with flashing beacons or other type of single message CMS. They may present the following type of messages (20):



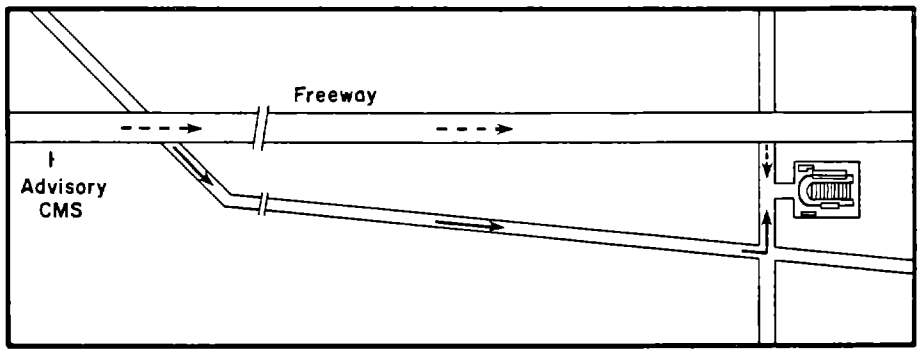

Incident management signing systems often require more than one CMS. When a second CMS is located upstream of the primary diversion CMS, it can be used to serve a similar function as the above single message advance sign. The displayed message can simply be:



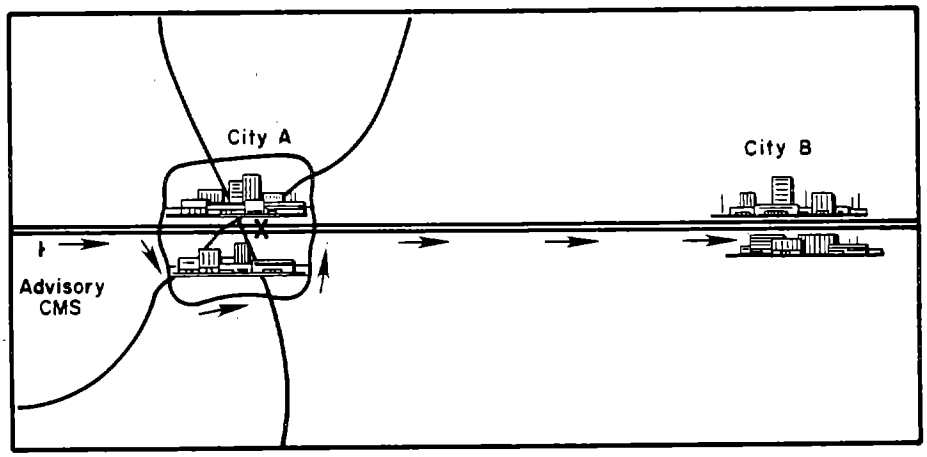

It should be noted that the advance sign can be used more effectively if selected message units are displayed on both the first and second sign. Repeating message units provides a degree of redundancy that increases the likelihood of all drivers heeding the message.




a. Diversion to an Arterial Route - Several Possible Alternate Routes




b. Diversion to a Major Generator - One Possible Alternate Route




c. Diversion of Thru Traffic to a Freeway Loop

Figure 6-1. Display Situations for Advance Signs

An example of CMS messages for diversion to an arterial using two CMSs is as follows:

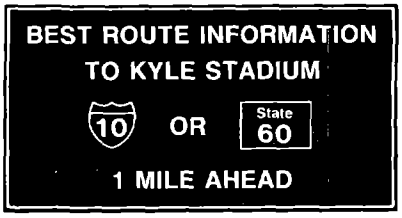

and

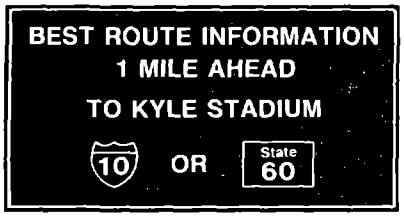

Sign 1 Sign 2

## C. Diversion to a Major Arterial Route - One Possible Alternate Route

When drivers are advised on the CMS to take a cross-road which otherwise only a small percentage of drivers would take, then the recommended message designs for the advance sign are identical to those shown in Section B.

When the freeway and the cross-road are both plausible routes which a substantial number of drivers might take, the advance sign messages recommended in Section B are acceptable. Special signing situations may dictate the need to include the route markers of the two plausible routes on the sign. The importance of including the route markers is that it gives drivers advance notice that they will be asked to take one of the two major highways to the destination. Laboratory studies indicate that the following formats for advance signs containing the route markers are acceptable (25).

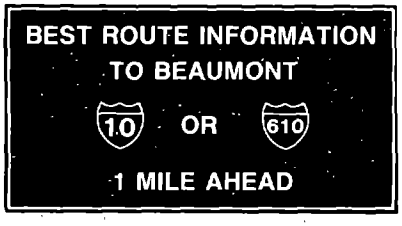


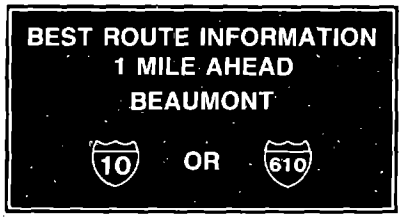




Although conventional freeway guide signs display the distance on the bottom line, many drivers prefer to have the distances placed immediately following **BEST ROUTE INFORMATION** on advance signs (25).

## D. Diversion of Thru Traffic to a Freeway Loop

As discussed in earlier Chapters, the advisory CMS should tell drivers which route to take. Thus, the advance sign should prepare them for the "best route" information. Laboratory studies indicate that the following messages and formats for the advance sign are acceptable (25):




Although conventional freeway guide signs display the distance on the bottom line, many drivers prefer to have the distance placed immediately following **BEST ROUTE INFORMATION** on advance signs (25).

The following are some additional guidelines (25):

- The first message line should be the nature of the information--"Best Route" Information. This is more precise than "Traffic Information," "Traffic Condition," or "Traffic Advisory."

- The second message line may be either the distance to the Advisory CMS, the destination (motorists who should observe the message), or the route markers of the alternate routes.

- The destination should be indicated by the first major city (preferably the control city) after the alternative routes reunite.

- If there is no major city immediately beyond the location where the routes reunite, then the cardinal direction may be used by itself in place of a destination city (e.g., **FOR POINTS EAST**).

- The cardinal direction may be included with the destination (e.g., **BEAUMONT AND POINTS EAST**).

- If the word **INFORMATION** is omitted from the sign, many drivers will feel that either route is acceptable and that the interchange is the distance shown on the advance sign (e.g., **1 MILE AHEAD**).

- Use of the route markets is highly preferred over the written message "I-10" or "I-610."

## 7. GUIDE SIGNS (TRAILBLAZERS) FOR ARTERIAL ALTERNATE ROUTES

### A. Introduction

Trailblazers are used for three specific intracity incident management/route diversion cases:

- Diversion to major generators
- Diversion to a specific highway
- Diversion around incidents

In addition, trailblazers can be used for intercity diversion.

Trailblazer signing along an alternate route can take on several designs. The design objective for trailblazers is to insure high target value and ease of recognition. This is accomplished by employing colors, shapes, and sometimes logos and symbols.

The message on trailblazer signs should be as simple as possible, providing two essential elements:

- Destination affirmation
- Route affirmation and direction

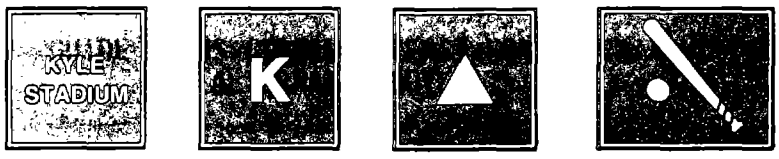
### B. Trailblazers for Diversion to a Major Generator

#### B.1 Designs

**B.1.1 Single Destinations**--Because of the permanence of a route as a viable alternate, several effective message options are available. These include the use of:

- Destination name
- Logo
- Symbol
- Silhouettes

Examples are as follows:



Pictorial silhouettes are a useful technique for guiding unfamiliar drivers to special events. A baseball and bat, for example, is a self-explanatory symbol for a ball park.

**B.1.2 Multiple Destinations**--Some situations may dictate the need to simultaneously divert traffic going to two or more separate destinations. When the beginning segment of the diversion routes overlap, geometric-shaped symbols should not be used for trailblazing to the multiple destinations (25).

---

**DO NOT USE TWO OR MORE ABSTRACT SYMBOLS (GEOMETRIC SHAPES) AS A TECHNIQUE FOR DIRECTING TRAFFIC TO MULTIPLE DESTINATIONS OFF THE FREEWAY. USING THE DESTINATION NAMES WHICH DO NOT REQUIRE LEARNING IS A SIMPLER AND MORE EFFECTIVE METHOD OF GUIDANCE TO MULTIPLE DESTINATIONS.**

---

## B.2 Arrows

Trailblazers containing a destination name, logo, or symbol should be accompanied by an arrow. The arrow can be placed on a separate sign blank mounted below the trailblazer, or it may be incorporated on the same sign face. Examples are shown in Figure 7-1.

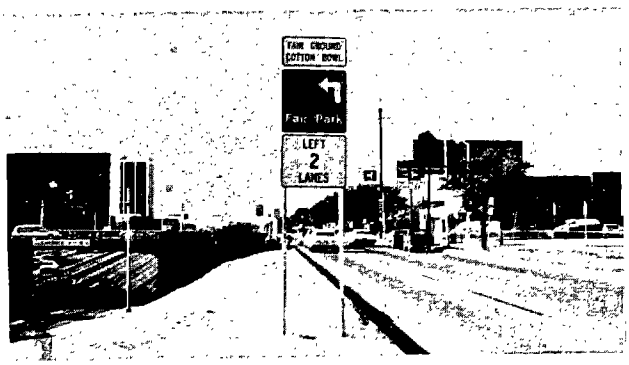
When an arrow assembly is used, the preference is to use the same color combinations as for the trailblazer (i.e., the arrow should be the same color as the trailblazer legend and the sign background colors should be the same).

## B.3 Ramp/Service Road Junction

Normally, as soon as drivers leave the freeway, they must maneuver through a major signalized intersection. Because of the relatively high exit speed and the loaded conditions of the drivers (due to high volume traffic and the short time available to make critical decisions as soon as they leave the freeway), good signing at the ramp/service road (or arterial street) junction is exceptionally important.

As soon as drivers leave the freeway they will be searching for information about the

- destination,
- turning movements, and
- lane assignments.





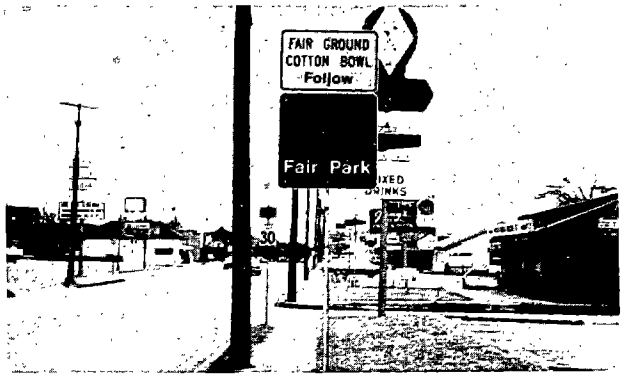







Figure 7-1. Trailblazers Used in Dallas

Since destination is of utmost importance, drivers will immediately be searching for information about the destination.

---

**THE FIRST TRAILBLAZER SIGN OR SIGN ASSEMBLY MUST CONTAIN THE DESTINATION NAME. THE DESTINATION NAME MUST BE IDENTICAL TO THAT USED ON THE FREEWAY CMS.**

---

Trailblazers containing the destination name obviously satisfy the destination requirement. When logo or symbol trailblazer signs are used, an additional sign assembly containing the destination name must be placed above the trailblazer. An example is shown in Figure 7-1, Sign 2.

It is recommended that the upper destination panel be of a reverse color to the trailblazer. For example, if the trailblazer is white-on-brown, the destination assembly should be brown-on-white.

The sign should be located on the left side of the service road upstream of the intersection to allow adequate time for the drivers to read the sign and enter in the appropriate lane(s). Care must be exercised so that the sign is not placed too close to the ramp/service road intersection.

Because of the heavy driver work load, it may in some cases be necessary to enlarge the size of the sign, place an additional sign on the right, or both.

When a right turning movement is required, it is recommended that a minimum of two signs be used--one on the left and the other on the right side of the service road.

Sometimes it may be desirable to allow left (right) turns from two service road lanes. An additional sign panel will then be necessary for the service road sign assembly. One approach is to use the sign assembly shown in Figure 7-1, Sign 1.

### B.4 Pull Thru Signs

---

**DRIVERS MUST BE "PULLED THRU" THE BUSY SERVICE ROAD/ARTERIAL STREET INTERSECTIONS.**

---

Because drivers are under considerable work load at the service road/arterial street intersection, they must be "pulled thru" the intersection with a trailblazer assembly that is easily recognized. It is recommended,

therefore, that an additional sign with an arrow pointing in the direction of the turn movement should be placed at the intersection. (See Sign 2, Figure 7-1.)

If a left turn is necessary at the intersection, drivers will immediately be confronted with another busy intersection on the other side of the freeway. Again, a "pull thru" trailblazer is necessary. (See Sign 3, Figure 7-1.)

### B.5 Trailblazer Code Explanation

Whenever a special type of trailblazer containing a logo or symbol code is used, the code must be explained to drivers. The code explanation should not be given when the driver is overloaded. After the drivers are pulled thru the busy intersections, they can be transitioned into following the trailblazer sign. At locations along the route where traffic conflicts are at a minimum, the transition can be made using the Sign 4 assembly shown in Figure 7-1. Two such signs should be used at successive locations.

The key factor to remember in transitioning from the freeway sign to any type of route guidance marking is that no doubt should be left in the driver's mind that the two signs go together. Whether the common elements are route names, destinations, or events, they should be easily detectable and recognizable.

### B.6 Route Confirmation

Following this transition, the remaining signs would merely use the trailblazer with an arrow.

Advance turn signs are advisable upstream of intersections where turning movements are required.

Forks or Y-intersections along the alternate route are particularly confusing to unfamiliar drivers (20). At such locations, special attention should be given to sign placement and number. A slanted arrow (left or right) should be used.

### B.7 Location of Trailblazer Signs

---

**TRAILBLAZERS SHOULD BE LOCATED AT EVERY POINT WHERE DRIVERS MAY BECOME CONFUSED.**

---

The important point to remember is that many drivers will be taking the alternate route for the first time. Also, drivers expect that turning

movements, if required, will be made at major intersections. Unfamiliar drivers, therefore, consider every major cross-street or highway as a potential leg on the alternate route, and must decide on the appropriate course of action.

A general rule of thumb to follow is that a trailblazer is needed at intersections where drivers have to make decisions. Thus, trailblazers should be located at every major intersection where the alternate route traffic is controlled by a traffic signal or stop sign, in addition to locations where the road forks.

Where a wide major road (particularly a freeway) passes over or under the alternate route, trailblazers are recommended both in advance of and just beyond the interchange. The second trailblazer provides reassurance to drivers that they have not missed a turn and are headed in the proper direction.

It is recommended that at least one supplementary trailblazer be installed between major intersections whenever the major intersections are spaced 1 mile (1.6 km) or more apart (20).

Each alternate route exhibits its own unique characteristics. It is advisable to personally travel the route to inspect the locations where confusion might arise to identify where the trailblazers are needed. One may want to get an unfamiliar person to drive the route and help identify potential problem locations.

Adequate visibility of the trailblazers is important. Trailblazers may be mounted either on the near of far side of the intersections depending upon where best visibility is achieved. Be consistent along the entire stretch of the alternate route. Experience has indicated that placement within 100 feet (30.4 m) of the intersection is satisfactory (20).

## B.8 Supplementary Information

**B.8.1 Distance to Generator**--Questionnaire studies (20) conducted to evaluate a trailblazer system in Dallas on an alternate route over four miles (6.44 km) long indicated that some drivers became concerned and would have liked to know how much farther they had to travel to reach the major generator. Although not necessary for route following, consider the possible addition of a mileage sign panel mounted below one or more trailblazers located at intermediate points. When used, these mileage and trailblazer sign assemblies should be placed at locations away from major intersections.

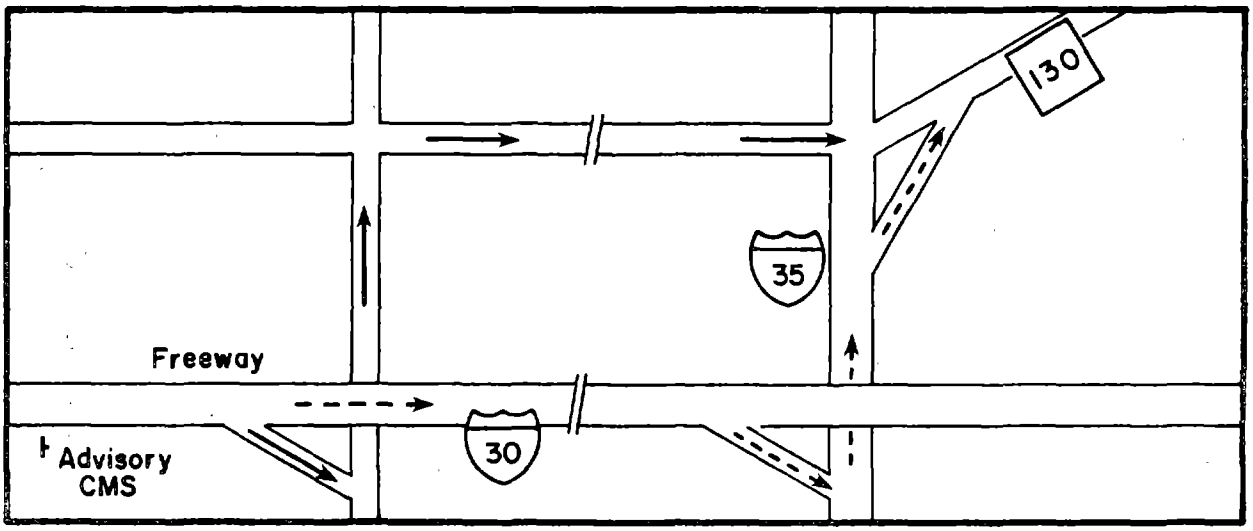
**B.8.2 Parking**--One major concern of drivers will be the availability and location of parking facilities (20). Where public off-street parking is available, supplementary panels similar to Sign D.4.1 shown in the MUTCD should be mounted below the trailblazers near the parking facility. The

arrows on the Parking Sign Panel must be in concert with those on the trailblazer.

Generally, drivers begin to seek parking facilities, either on- or off-street, well before reaching the major generator. Therefore, it is advisable that Parking sign panels be used with the alternate route trailblazers well in advance of the major generator parking area to assist the drivers. The parking panels should be used with each subsequent trailblazer leading to the parking area.

## C. Trailblazers for Diversion to Another Major Highway

The example below illustrates a typical diversion situation that might arise when it is necessary to divert traffic destined to another major highway off the primary route to an alternate arterial route.



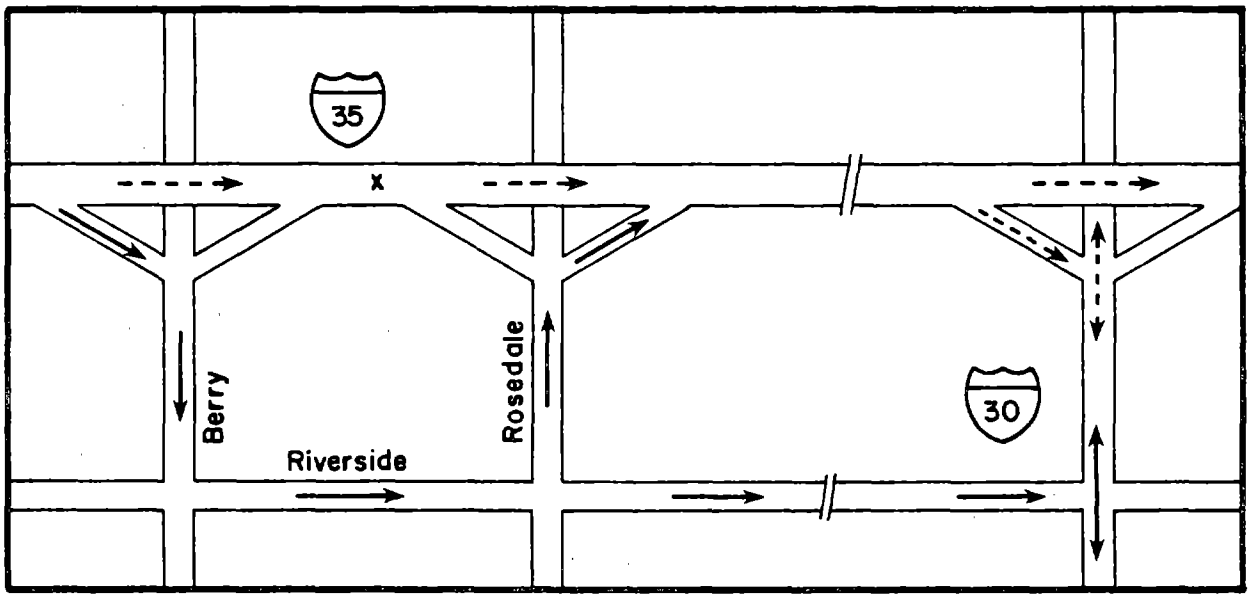

Eastbound I-30 traffic destined for S.H. 130 in this illustration would normally take I-35 to S.H. 130. Because of incident problems on the critical segments of I-30 and I-35, an alternate route can be permanently established along the arterial diversion route. The objective of the freeway CMS message is to intercept the S.H. 130 traffic and redirect it along the designated arterial.

In this case, no special designs are necessary for the trailblazers. Standard trailblazer route markers and auxiliary route marker assemblies can be used. An example is shown on the following page.


Design principles presented in Sections B.1 through B.8 should be reviewed and followed.

## D. Trailblazers for Diversion Around Incidents

The example below is a typical diversion situation around a freeway incident.




X = incident

Message design for trailblazers used to route traffic along arterials around an incident and back to the primary freeway presents unique problems. In this latter situation, the trailblazer designs discussed in Sections B and C cannot be used because they display contradictory information to drivers.

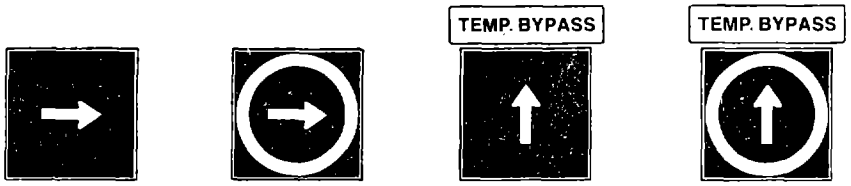
Research has not progressed to a point where real-world data are available to validate the adequacy of trailblazer sign designs for managing traffic around incidents along arterial routes. The recommendations presented

in this section are based on human factors laboratory studies and represent the best judgment of the authors.

## D.1 Situations Using Diversion Route Names

When the freeway CMS displays a name for the alternate route such as **TEMPORARY BYPASS**, then the alternate route must be trailblazed using a design that will be quickly read and understood by diverting drivers, yet will not confuse other drivers traveling on the arterial. These conditions must be met regardless of whether the trailblazers are permanently installed or are placed in position by an incident response team only during major incidents.

Simple designs for the basic trailblazer could be an arrow on a rectangular sign similar to those shown below:




One important feature is that drivers not destined for the freeway are not likely to become confused because the sign does not present any contradictory information. In fact, it presents no information at all to those drivers not in the diversion population. The sign will be meaningful to diverting drivers, however, once they are "transitioned" into it.

## D.2 Situations Using Street Names

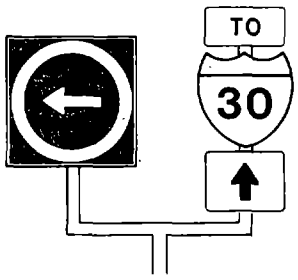
When the freeway driver is told before leaving the freeway the exact sequence of streets to use to bypass the incident--such as **TAKE BERRY/TO RIVERSIDE/TO ROSEDALE** or **USE RIVERSIDE/TO ROSEDALE**--then the designs shown in Section D.1 would not be applicable.

Normally, street names are given only when the audience is primarily familiar drivers who would know the approximate location of "Riverside" and "Rosedale." Although trailblazers along the alternate route are not essential, it is recommended that a street (road) name sign pointing the direction to the parallel street be placed at the intersection of the ramp or frontage road and the cross-street that drivers should take to the parallel street. An example is illustrated below:

### D.3 Multiple Destination Signs

On occasion, an incident diversion route might occur immediately upstream of a busy major interchange, and a significant part of the traffic might be planning to take a route to the right from the interchange rather than continuing through the city. An example of this situation is given in the schematic shown at the beginning of Section D. Rather than direct the traffic destined for eastbound I-30 back to I-35 and through the interchange, it would be better for this traffic to continue on Riverside to I-30.

The sign assembly shown below is an example of an assembly that could be placed near the intersection of Rosedale and Riverside.



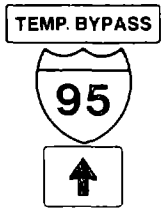

## E. Trailblazers for Intercity Diversion

### E.1 Designs

The trailblazer for intercity diversion should be different from that used for intracity diversion. The diversion route should be given a name depending upon the type of facility.

As indicated previously, the name given the diversion route on the freeway advisory CMS should be used consistently along the bypass route. Thus, if the CMS advises to **USE I-95 TEMP. BYPASS**, then the trailblazer signs should use the same language.

Example:



## E.2 Route Assurance

Drivers expect that the bypass route will rejoin the primary route eventually, and it may be desirable to use a route assurance sign at intervals along a lengthy bypass route. The point of return in this situation may be given in miles ahead.

The route assurance message: **TEMP. BYPASS RETURNS TO I-95 AT (Return City)** is a clearer explanation than would be signs indicating **TO 95 NORTH** or **TO (Destination City)** when in fact the bypass route involves traveling in a direction away from I-95 or perpendicular to I-95 (25).

## E.3 Forgiving Signing

Wherever traffic is traveling on a temporary bypass and a left- or right-hand turn to another intersecting roadway is required to return drivers to the original route, some drivers may inadvertently fail to see or comprehend the return signs. To prevent them from traveling a considerable distance before discovering their error, a "forgiving sign system" may be employed. Missing a turn-off is especially troublesome when the route leads away from the bypass route so that the only solution is to turn around and drive back to the correct turn-off.

Erring drivers require three sets of information:

- An advisory that they have gone past the correct route for return to the interstate.
- An advance guide sign which informs them that there is a designated return route and that the next exit or turn will lead them to the route.
- A set of guide signs at intersections which trailblaze the route.

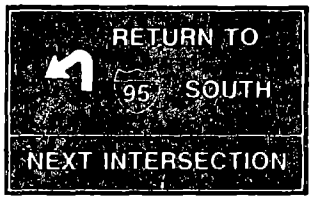
Designs for signs to supply the above information are provided in the next three subsections.

**E.3.1 Forgiving Advisory Sign**--Although seldom used in traditional signs, use of an active tense, rather than a passive tense, may attract the driver's attention better, especially in static signs. Research findings (25) support the following advisory message:

**DO NOT: USE THE WORD "TURN-AROUND" INSTEAD OF "RETURN" (25).**

If the temporary bypass was marked by a trailblazer symbol which motorists had been keying on, the symbol would be used instead of the interstate shield and number.

**E.3.2 Forgiving Advance Guide Signs**--The second message should be as follows:

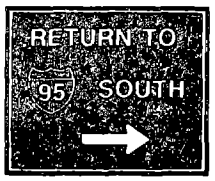



**USE AN ARROW WHICH RESEMBLES A "U" TURN ARROW. (THE RETURN ROUTE MAY NOT INVOLVE GOING BACK ON THE OPPOSITE LANE OF THE PRESENT ROUTE AS WOULD BE IMPLIED. THE RETURN ROUTE COULD INVOLVE TAKING A FRONTAGE ROAD OR EVEN AN ARTERIAL AS THE SITUATION DICTATES.)**

This message should convey three kinds of information:

- The driver is being led to a return route.
- The driver must reverse his direction to get back to the bypass route.
- The next exit (or turn) will get him started on the route, so he must transition into the appropriate lane.

**E.3.3 Forgiving Guide Signs**--The guide signs should be simple trailblazers at each intersection along the return route. They should carry the same message as the forgiving advance guide sign with an appropriate set of left, right, or forward directional arrows. An example is shown below:



# 8. GUIDELINES FOR MESSAGE LENGTH, EXPOSURE TIME AND DISPLAY FORMAT

## A. Introduction

**Reading time** is simply the time it actually takes a driver to read a sign message. **Exposure time** or available viewing time is the length of time a driver is within the legibility distance of the message. That is, it is the maximum time available to the driver to read a message. Thus, exposure time must always be equal to or greater than the critical reading time selected for design purposes.

Exposure time is directly related to message legibility distance and driving speed.

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**THE DESIGNER HAS SOME CONTROL OVER THE MINIMUM EXPOSURE TIME OF A MESSAGE.**

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For a given operating speed, exposure time will increase with increasing legibility distance (assuming the message is continuously displayed). For example, an overhead sign message legible at 650 feet (197.6 m) will be exposed to drivers traveling at 55 mph (88.6 km/hr) for approximately 8 seconds. With a legibility distance of 1,000 feet (304 m), the message will be exposed for about 12 seconds. Once exposure time requirements have been determined based on the operating speed and the longest message, sign design and placement criteria can be established to fulfill message legibility requirements.

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**IN AN EXISTING SYSTEM, REQUIRED EXPOSURE TIMES DICTATE THE MAXIMUM LENGTH OF MESSAGE THAT CAN BE DISPLAYED.**

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For a given legibility distance, exposure time will reduce with increased speeds (assuming the message is continuously displayed). For example, an overhead sign message legible at 650 feet (197.6 m) will be exposed to drivers traveling at 40 mph (64.4 km/hr) for approximately 11 seconds. At 55 mph (88.6 km/hr), the same message will be exposed for about 8 seconds. Once a sign is installed, the maximum exposure time is firmly established. This will control the maximum message length that can be displayed.

Driver reading times and consequently, minimum exposure times of CMS messages normally associated with incident management/point diversion, have not been fully researched in a real-world environment. However, some

laboratory research on reading times for both static and CMSs have been reported. This research, coupled with limited incident management/point diversion field experiences, enables the authors to provide some preliminary guidelines.

## B. Factors Affecting Reading Time

At a given driving speed, several factors affect driver reading time of signs having similar legibility distances. These include:

- Driver work load
- Message load
- Message length
- Message familiarity
- Display format

Design guidelines to account for those factors are presented in the following sections.

It makes no difference what communication mode is used (visual or audio), one cannot tell everything to the drivers in the limited time available. So, discipline must be exerted to prune the message down to the basics alone. Real-time displays can, at most, register up to only two ideas:

- What is the condition
- What should be done

Brevity is not only the soul of wit, it is the heart of effective signing. Remember: people will be moving when they see the message. They must therefore also devote time to the traffic and roadway situations, as well as distractions while driving. Thus, they can only absorb a few words. These words must communicate the basic information.

To cope with the moving, busy, and oftentimes distracted driver, outdoor advertisers recommend that words be kept short and to the point. They suggest that outdoor advertising ideas should register in about 6 seconds. Similar principles hold true for real-time driver information displays.

## C. Driver Work Load

One important consideration in establishing adequate message exposure times is the need of drivers to time-share their attention to the roadway and traffic with sign reading. Adults can read quite fast while sitting on a recliner reading a novel or newspaper or while sitting in a stopped car reading a sign or billboard. While traveling, drivers cannot always devote full attention to sign reading. Drivers must share their attention between information necessary for the driving task which they receive from the roadway

and traffic on the highway with the information displayed on signs. Because of this time-sharing, it will take longer to read a sign than if the drivers could devote all their attention to the sign.

Drivers search the environment for information needed to perform the various subtasks and shift attention from one information source to another by a process of load-shedding (26). As the complexity of the driving task increases due to extremes in geometrics, heavier traffic volumes, traffic conflicts, or climatological conditions, load-shedding is required. Drivers will attend to those information needs that they feel are most important to them. The demands on the driver result in less time available to read the sign messages. Thus,

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**THE MESSAGE MUST BE LEGIBLE AT A DISTANCE THAT ALLOWS SUFFICIENT EXPOSURE TIME FOR DRIVERS TO ATTEND TO THE COMPLEX DRIVING SITUATION AND GLANCE AT THE SIGN A SUFFICIENT NUMBER OF TIMES TO READ AND COMPREHEND THE MESSAGE.**

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## D. Message Load

Message load refers to the informational "load" in the message.

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**THERE IS EVIDENCE THAT NO MORE THAN THREE UNITS OF INFORMATION SHOULD BE DISPLAYED ON ONE SEQUENCE WHEN ALL THREE UNITS MUST BE RECALLED BY DRIVERS (7, 13). FOUR UNITS OF INFORMATION MAY BE DISPLAYED WHEN ONE OF THE UNITS IS MINOR AND DOES NOT HAVE TO BE REMEMBERED BY DRIVERS IN ORDER TO TAKE APPROPRIATE ACTION TO THE ADVISORY MESSAGE.**

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**A UNIT OF INFORMATION MAY BE DISPLAYED ON MORE THAN ONE LINE ON THE SIGN. HOWEVER, A SIGN LINE SHOULD NOT CONTAIN MORE THAN TWO UNITS OF INFORMATION.**

---

## E. Message Length

Message length refers to the number of words in a message. Although message length is somewhat interrelated with message load,

**THERE IS EVIDENCE THAT AN 8-WORD MESSAGE (ABOUT FOUR TO EIGHT CHARACTERS PER WORD) EXCLUDING PREPOSITIONS SUCH AS "TO", "FOR", "AT", ETC., IS APPROACHING THE PROCESSING LIMITS OF DRIVERS TRAVELING AT HIGH SPEEDS (8, 13).**

## F. Message Familiarity

Another factor that influences sign reading time is driver expectancy and familiarity with what will be displayed. Commuters, having seen several messages displayed on the CMS, develop expectations of message classes and types. Based on previous experience, they tend to gloss over familiar elements of the message and concentrate on those elements that change from one situation to another. (This assumes that standard message formats are used consistently.) For example, once commuters establish expectancies that a portion of the message will read **ACCIDENT AT (location)**, they quickly identify the form of the word **ACCIDENT** and concentrate on the "location" information. Thus, their reading times reduce with repeated exposure to standardized messages.

Unfamiliar drivers, on the other hand, seeing the message and perhaps the sign for the first time, must read the entire message. Their reading times will thus be longer than that required for familiar drivers (with respect to the sign and messages).

### F.1 Reading and Message Exposure Times for Familiar Drivers

While traveling, drivers must glance from the road to read a sign and back to the road. Forbes (27) states that during this glance the maximum amount of copy which can be read by the ordinary person is three to four familiar words. Mitchell and Forbes (28) recommend that 1.0 second be adopted as the time necessary for a single minimum glance to guarantee adequate time to read the sign twice, unless they are distracted or their vision is obstructed. The relationship between the minimum reading time available and the number of words on a sign are shown in Figure 8-1.

Also shown is the relationship recommended by the British Road Research Laboratory (RRL).

The two relationships are plotted in Figure 8-1 to identify some minimum reading times that should be used for displays. Messages must be legible and exposed to drivers for a period of time not less than that shown in Figure 8-1. Desirably, longer viewing times should be used.

The following examples serve to illustrate driver reading times of selected messages measured in instrumented vehicle studies conducted by Mast and Ballas (29). The data are for familiar drivers (i.e., drivers who had

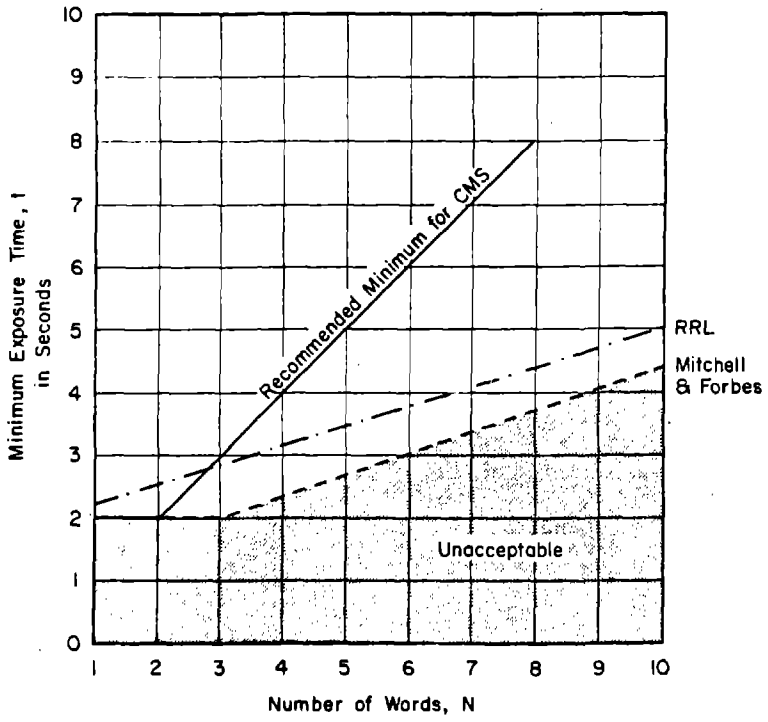


Figure 8-1. Minimum Reading and Message Exposure Times for Short Word Messages

previously viewed similar signs and messages and were thus familiar with the types of signs and messages to expect while traveling on a rural freeway. Reading time distributions for the three selected messages are shown in Figure 8-2.

Sign A contains two units of information composed of five words and numbers. The 85th percentile reading time for familiar drivers traveling on a rural freeway was 2.3 seconds, or slightly more than 1 second per unit of information. The 2.3 seconds reading time is somewhat consistent with the guidelines of Mitchell and Forbes (See Figure 8-1). Note that the message on Sign A is "balanced" vertically and horizontally.

The 85th percentile reading time for the 6-unit message on Sign B consisting of thirteen words was 6.7 seconds. An examination of the message shows that the top two lines of the sign (**TRAFFIC CONDITIONS/NEXT 2 MILES**) actually is a descriptive title for the bottom two lines displaying problem and action messages. The authors speculate that the "familiar" drivers in the study were concentrating on reading the last two lines. Assuming that the test drivers were only reading the bottom two lines, the 85th percentile reading time for the 4-unit, 8-word message (excluding **ON**) was about 1.7 seconds per unit of information (0.8 seconds per word). This reading time is longer than that suggested by Mitchell and Forbes and the RRL shown in Figure 8-1.

| | | Number of Words* | Number of Message Units | 85th Percentile Reading Time (Seconds) |
|---|---|---|---|---|
| A. | Heavy Congestion<br>2 Miles Ahead | 5 | 2 | 2.3 |
| B. | Traffic Conditions<br>Next 2 Miles<br>Disabled Vehicle on I-77<br>Use I-77 Bypass Next Exit | 13 | 6 | 6.7 |
| C. | Traffic Conditions on I-91<br>Normal on I-91 North<br>Accident on I-91 South<br>Use I-91 South Bypass | 13 | 7 | 9.8 |

* Excluding prepositions

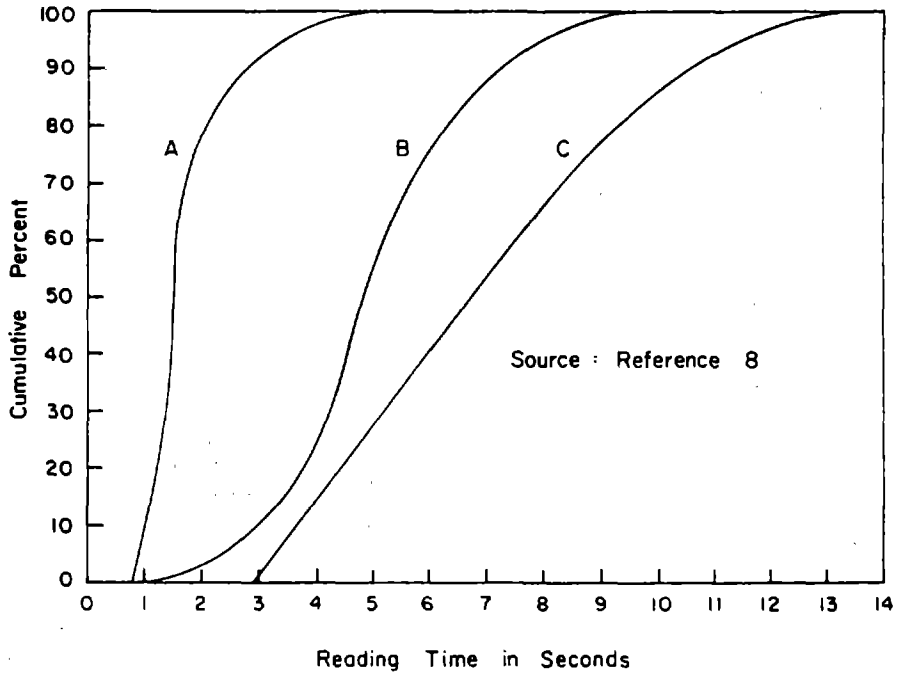


Figure 8-2. Reading Times for Selected Messages

The 85th percentile reading time for the 7-unit, 13-word message shown on Sign C was 9.8 seconds. Assuming that the title on the first line was learned by the test subjects by previously viewing similar signs, the sign message reduces to 5 information units consisting of 10 words. The 85th percentile reading time for the 6-unit, 10-word message was 2.0 seconds per unit of information (about 1 second per word).

It is important to note that all of the instrumented vehicle studies were conducted in very light traffic in a rural area where the drivers were in

relatively "unloaded" situations. The reading times would increase under "loaded" driving conditions. Also, the test subjects knew exactly when a sign message was going to be displayed (when they heard the click of the slide projector), and they read a message that was close to them rather than one at a distance. These latter two factors tend to indicate that reading times in a real-world setting would be higher than that resulting from the instrumented vehicle studies (30).

### F.2 Reading and Message Exposure Times for Unfamiliar Drivers

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**RESEARCH (7, 8, 20, 31) HAS INDICATED THAT A MINIMUM EXPOSURE TIME OF ONE SECOND PER SHORT WORD* (FOUR TO EIGHT CHARACTERS) OR TWO SECONDS PER UNIT OF INFORMATION, WHICHEVER IS LARGEST, SHOULD BE USED FOR UNFAMILIAR DRIVERS. ON A SIGN HAVING 12 TO 16 CHARACTERS PER LINE. THIS MINIMUM EXPOSURE TIME WILL BE TWO SECONDS PER LINE.**

---

***Excluding prepositions**

Four-line CMSs designed to display 13 to 20 characters per line are capable of accommodating about eight short words (not counting prepositions) of the type normally associated with incident management/route diversion situations. When it is necessary to display long words such as destination or street names, these words should be counted as two short words.

Field experience (20, 31) has suggested that when an 8-word message is broken into two phrases and the two phrases are sequenced (alternated) an a 2-line display, the guideline of two seconds per message line works satisfactorily. Allowing two seconds per line results in a display time of four seconds per phrase, or a total of eight seconds for the entire message. Since it takes about eight seconds for drivers to travel 635 ft. (193 m) (the legibility distance of 18" [46 cm] lamp matrix sign), eight seconds of exposure time is available.

It is not known how long messages of more than eight words displayed all at once on a 4-line sign should be exposed to the drivers within the legibility distance. Human factors laboratory studies (8) strongly indicate that long messages displayed on one sign tend to overwhelm drivers, so they cannot scan the message quickly. Thus it may take them longer to read the entire message than if it were separated into two smaller phrases.

## G. Display Formats

Equally important to the length and exposure time of a message is the display format. Display format is distinguished from message format in that

display format refers to the manner in which a message is displayed, while message format is the arrangement of the message elements. There are three basic display formats to be considered: discrete, sequential, and run-on.

- A discrete display is one in which the entire message is displayed at once.
- A sequential display is one in which the message is broken into parts and displayed one part at a time.
- A run-on, or moving display, presents a message by moving the message continuously across the sign from right to left. Run-on messages are not recommended because they take longer for drivers to read.

The appropriate format for a particular situation depends on the type of display, the length of message, and the traffic conditions in which the driver must read the sign. Although not all of the variables associated with display requirements can be quantified, this section provides some guidelines for enhancing the effectiveness of the display.

Loading refers to the work load under which a driver must perform. For purposes of simplicity, two categories of loading will be considered: 1) urban area peak period driving (loaded), and 2) urban area off-peak or suburban driving (unloaded). The following descriptions of formats may include references to the loading condition. This is not to suggest that there is some magic cut-off point to the amount of message presented, but rather to indicate that one should give consideration to the loading conditions as the length of message increases.

## G.1 Discrete Display Formats

Most of the types of real-time displays available use the discrete format where the entire message is displayed at one time. (In some cases, certain lines on the sign may be flashed on and off.) These displays are typically one to four lines in length. Following is a description of various displays and the recommended minimum exposure time necessary for proper reading of each. Under loaded conditions, the exposure time should be higher than that shown.

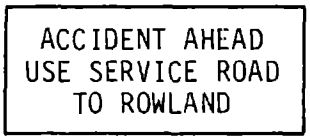
- A one-line display would appear as follows:

| ACCIDENT AHEAD | **Minimum 2.0 seconds exposure** |
|---|---|

- A two-line display would appear as follows:


**Minimum 4.0 seconds exposure**

- A three-line sign, as follows:




**Minimum 6.0 seconds exposure**

- A four-line sign, as follows:


**Minimum 8.0 seconds exposure**

## G.2 Sequential Display Formats

Sequential displays are those in which parts of the message are displayed in sequence. The message sequence is normally repeated (cycled) several times. There are several ways to display messages sequentially. The one best suited to a particular installation will depend on the length of message, the number of lines on the sign, and the length of the words in the message.

There are several possible format configurations for a one-line sign. The corresponding recommended minimum message exposure, sequence element exposure, blank and cycle times, are shown on the next two pages. The recommendations for the exposure times are based on data collected in laboratory studies (8). Adjustments to the exposure times may need to be made in the field to fit specific installation requirements.

The first type of one-line sign format configuration is a one-word (up to eight characters) per line format.


**Minimum 2.0 seconds exposure**


**Minimum 3.0 seconds exposure (1.5 seconds/sequence element, no star time required)**
**Cycle = 3.0 seconds**

If a driver first sees the second part of a two-element sequential message, the message should normally be intelligible without delineating the end of each message sequence.

However, when the number of sequence phrases or elements is three or more, the message would not be as intelligible without delineating the end of a message sequence.

---

**WHEN A MESSAGE IS CHUNKED INTO THREE OR MORE PHRASES OR ELEMENTS THAT ARE SEQUENCED OR CYCLE ON A SIGN, 3 OR MORE "STARS" OR ASTERISKS SHOULD BE DISPLAYED ON A FRAME AT THE END OF THE CYCLE TO POSITIVELY SEPARATE SUCCESSIVE REPETITIONS OF THE MESSAGE. IT IS RECOMMENDED THAT THE ASTERISKS BE DISPLAYED FOR 0.5 SECOND WITH A 0.25 SECOND BLANK TIME BEFORE AND AFTER THE ASTERISKS (7).**

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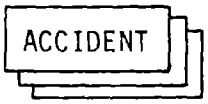
An alternative to the stars is to have a blank time of 1 second delineate the end of message before the sequence is repeated and no more than 0.25 second between sequences (8, 32). Research (7) indicated that the stars are more effective than using a blank time.

A question often arises as to whether the message should be displayed at a slow rate so that it is displayed once while the driver is in the legibility zone, or whether the message should be displayed at a faster rate and exposed twice to the driver. Proving ground studies (7) indicate that on 2-sequence messages, up to 4 words or 2 units of information per sequence can be displayed at rates as fast as 0.5 second/word without loss of recall. The driver can see the message cycle twice. Messages longer than 4 words or 2 units should be cycled at a speed of at least 1 second/word. One second per word with repetition is recommended.

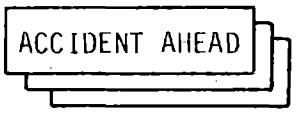
Another feature which must be considered for a sequential message with three or more elements is that many drivers will enter the sign legibility zone and begin reading the sign in the middle of a message sequence. In some cases, the information may not be intelligible unless the drivers read the message from beginning to end. Increasing the "normal" minimum exposure time requirements insures that the sign letter size selected will be large enough to enable most drivers to read the message in a logical order, thus enhancing driver understanding. Until more field experience dictates otherwise, the authors are recommending that at least 3 seconds of added time be used.

| Optional | | Recommended |
|---|---|---|
| **Minimum 9.5 seconds exposure (0.75 seconds/ sequence element, plus 1.0 second star time (twice), plus 3.0 seconds added time) Cycle = 3.25 seconds** |   | **Minimum 8.5 seconds exposure (1.5 seconds/sequence element, plus 1.0 second star time, plus 3.0 seconds added time) Cycle = 5.5 seconds** |
| **Minimum 11.0 seconds exposure (0.75 second/ sequence element, plus 1.0 second star time (twice), plus 3.0 seconds added time) Cycle = 4.0 seconds** |   | **Minimum 10.0 seconds exposure (1.5 seconds/sequence element, plus 1.0 second star time, plus 3.0 seconds added time) Cycle = 7.0 seconds** |

Research (7, 8) has shown that 4-word messages can be displayed satisfactorily in the above format (one word at a time). However, it has been shown that 8-word messages are too long for this type of format. In the absence of evidence to suggest otherwise, the authors recommend that the sequencing of single words be limited to four sequences, and thus four words.

For one-line signs having 20 characters per line, the following guidelines are recommended:

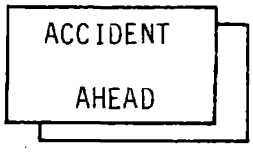
| Optional | | Recommended |
|---|---|---|
| |   | **Minimum 2.0 seconds exposure** |
| **Minimum 4.0 seconds exposure (1.0 seconds/sequence element (twice), no star time required) Cycle = 2.0 seconds** |   | **Minimum 4.0 seconds exposure (2.0 seconds/sequence element, no star time required) Cycle = 4.0 seconds** |



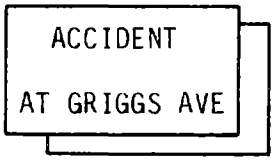

**Minimum 10.0 seconds exposure (2.0 seconds/sequence element, plus 1.0 second star time, plus 3.0 seconds added time)**
**Cycle = 7.0 seconds**

Recommended minimum exposure times for 2-line signs having up to 8 and 16 characters per line are as follows:

**Minimum 4.0 seconds exposure (1.0 seconds/sequence element (twice), no star time required)**
**Cycle = 2.0 seconds**




**Minimum 4.0 seconds exposure (2.0 seconds/sequence element, no star time required)**
**Cycle = 4.0 seconds**




**Minimum 8.0 seconds exposure (4.0 seconds/sequence element, no star time required)**
**Cycle = 8.0 seconds**

## H. Required Legibility Distance (Side-mounted Signs)

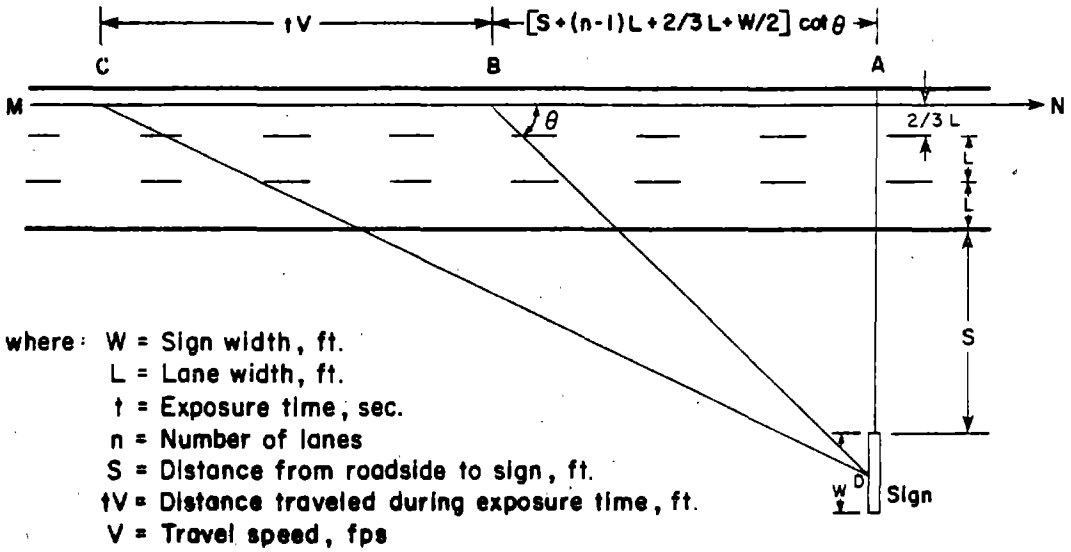
The previous section provided guidelines for message exposure time. The minimum required legibility distance for overhead sign messages can be determined by simply multiplying the operating speed and the minimum exposure time. For side-mounted signs, however, the required legibility distance can be significantly greater than the product of the speed and minimum exposure time. This is true because drivers cannot necessarily read the message when they are near the sign.

Mitchell and Forbes (28) found that when a sign is greater than $10^{o}$, measured horizontally from the center of the driving lane, the driver's ability to read the sign message is severely diminished. King (33) provides a rather complete development of this concept with respect to lateral sign placement. Figure 8-3 serves to illustrate the effect sign lateral placement has on the nearest distance at which the sign is visible.

In Figure 8-3, point C is the location where drivers can begin to read the message; point B is the location where the message can no longer be read by drivers in the inside lane because the sign falls outside the normal field of vision. The distance at which the sign must become legible is CD which can be expressed for tangent highway sections as:

For a 20 ft. (6.1 m) wide CMS, this equation becomes:

$$CD = \sqrt{\{tV + [S + (n - \frac{1}{3})L + \frac{20}{2}]5.67\}^2 + [S + (n - \frac{1}{3})L + \frac{20}{2}]^2}$$




where: W = Sign width, ft.
L = Lane width, ft.
t = Exposure time, sec.
n = Number of lanes
S = Distance from roadside to sign, ft.
tV = Distance traveled during exposure time, ft.
V = Travel speed, fps

Figure 8-3. Geometry of Sign Location and Horizontal Displacement on a Tangent Section

Table 8-1 provides values for the term inside the brackets. Values for tV, the distance traveled during exposure time, are given in Figure 8-4.

TABLE 8-1

SOLUTION TO THE FUNCTION: $[S + (n - \frac{1}{3})L + \frac{20}{2}]$*
FOR 12 FT. (3.6 m) LANES

| n \ S | 10 | 20 | 30 |
|---|---|---|---|
| 2 | 40' | 50' | 60' |
| 3 | 50' | 60' | 70' |
| 4 | 65' | 75' | 85' |
| 5 | 75' | 85' | 95' |

*Note: Assumes 20-ft. (0.6 m) wide sign.

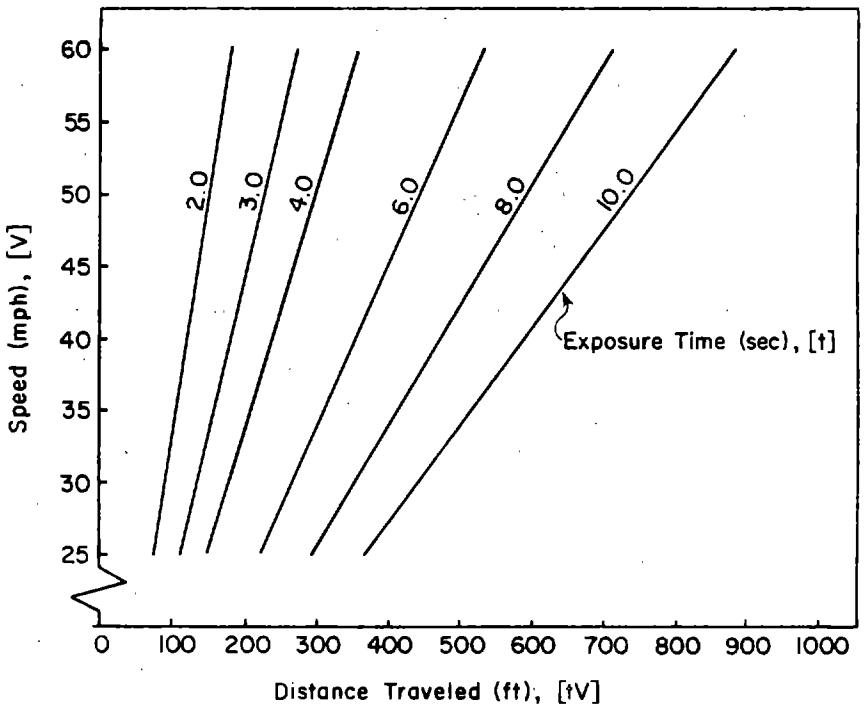



Figure 8-4. Exposure Times for Various Speeds and Distance Traveled

The following example serves to illustrate the use of Table 8-1 and Figure 8-4.

> Assume the operating speed is 55 mph (88 km/hr) and the required exposure time is 8.0 seconds. If a 20 ft. (6.1 m) sign is placed 20 ft. (9.1 m) away from the outside lane on a 4-lane freeway, the required legibility distance becomes:

$$CD = \sqrt{\{645 + [75]\ 5.67\}^2 + [75]^2}$$

$$CD = 1{,}073 \text{ ft. } (326.2 \text{ m})$$

Note that distance CD is the actual required legibility distance. However, the distance parallel to the freeway will normally be the distance most convenient to measure. The difference between the two distances is negligible. Thus, the computed distance CD can be used to measure required legibility distance parallel to the freeway.

# 9. LEVELS OF ADVISORY SIGN MESSAGES FOR INCIDENT MANAGEMENT

## A. Introduction

Previous Chapters have presented guidelines for the various elements of message design. Chapters 9 and 10 incorporate these guidelines into advisory sign message recommendations for application to specific incident management/route diversion situations.

Two classes of advisory sign messages are presented (when applicable):

- General messages
- Specific diversionary messages

General messages are those which do not give specific diversion instructions. Some voluntary diversion would be expected by familiar drivers (31). This class of messages is necessary when:

- A "better" alternate route does not exist, or
- Surveillance data are not yet available to allow one to decide whether to divert traffic to another route.

Specific diversionary messages give specific diversion instruction.

An important note is that example messages are given. Variations can be developed to serve your specific needs by reviewing Chapters 3 through 8.

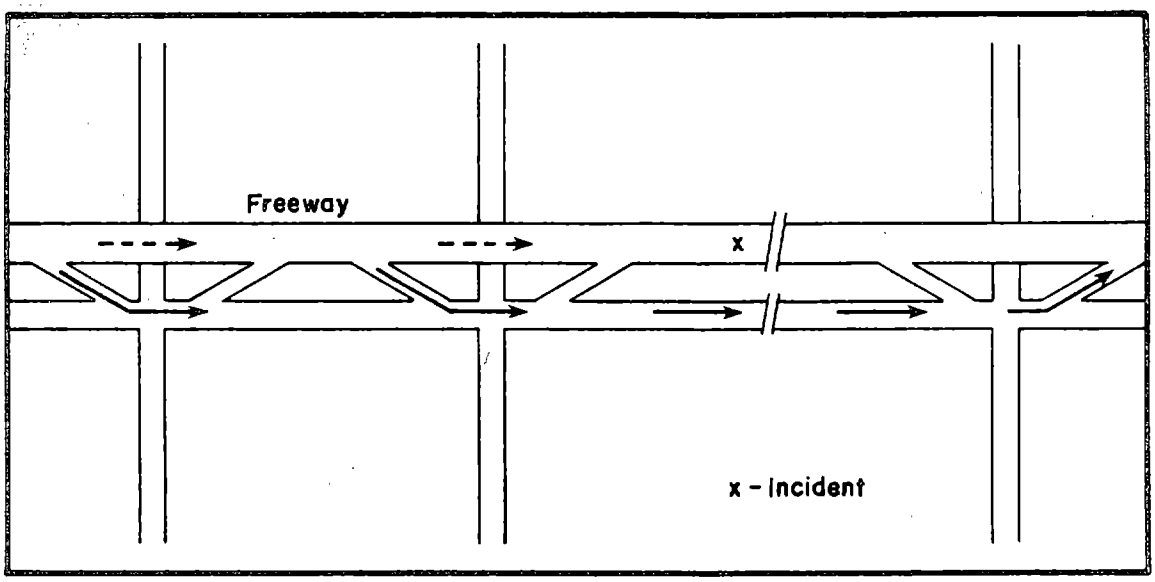
It is recognized that various types of sign hardware and sizes will be used throughout the country to satisfy individual needs. However, in order to have a consistent form in the Manual for illustrating the messages, the authors have elected to use two combinations of message lines and alphanumeric character lengths. These are as follows:

- 4 lines per sign, 20 alphanumeric characters per line
- 2 lines per sign, 20 alphanumeric characters per line, sequencing capabilities

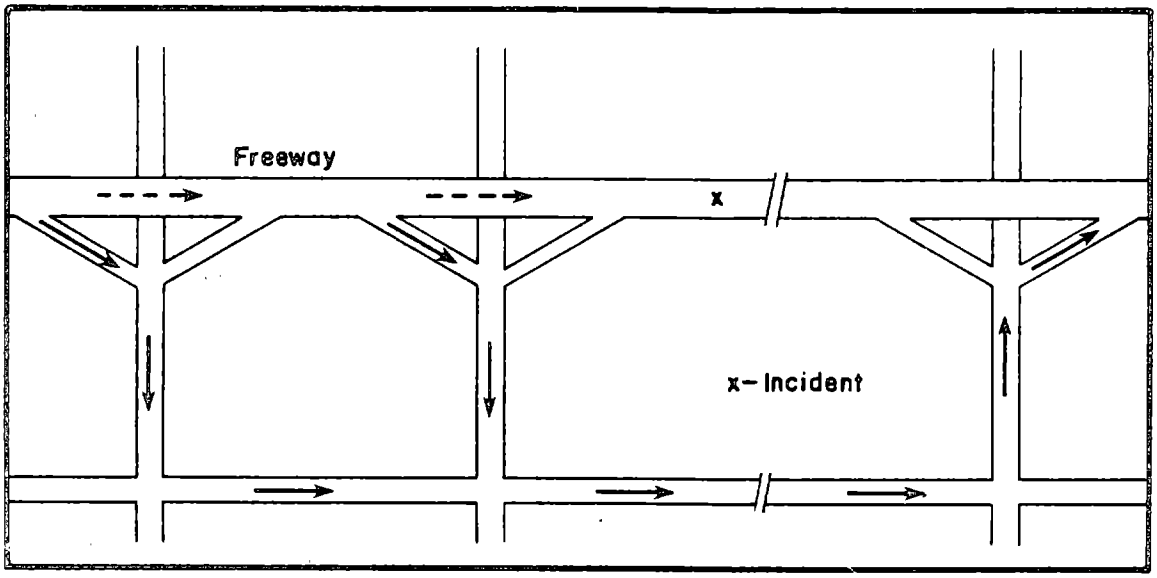
Most 4-line messages can be "chunked" into phrases that can be sequenced on 2-line signs having this capability.

## B. Basic Situations

Figure 9-1 illustrates two basic incident management situations.




Situation 1--Diversion to a Frontage Road




Situation 2--Diversion to an Arterial Bypass

Figure 9-1. Basic Incident Management Situations

The messages and considerations for diverting traffic along arterials around a freeway incident are essentially the same as for when a frontage road is used with two major exceptions:

- When drivers are diverted along an unknown route, the route must be given a name. The name found to be most commonly associated with this type of route is **TEMPORARY BYPASS.** The word **TEMPORARY** may be abbreviated **TEMP.**

- Since drivers are diverted away from the freeway and various diversion routes are possible (not all of these good), special consideration must be given to the use of trailblazers.

## C. General Messages

### C.1 Incident Description

Other than the message warning drivers of slow traffic, the simplest message is to let the drivers know that an incident has occurred.



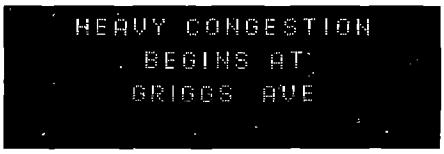
### C.2 Incident Description and Location

A better message would include the location of the incident to aid the drivers in deciding where to leave the freeway if they decide to divert. Examples of messages for familiar and for unfamiliar drivers are as follows:

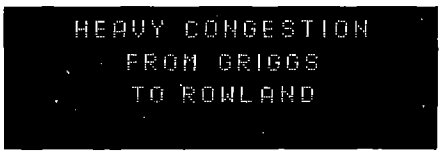


These messages are appropriate when the freeway is still the better route for the longer trips. The message is displayed to preserve system credibility and will result in significant voluntary diversion (31).

As a minimum, it is desirable to tell drivers the nature of the problem and the appropriate location of the incident. This requires specific visual surveillance capabilities. If television surveillance is available, the problem and location of the problem can be quickly identified. With other types of surveillance systems, there may be a considerable time interval after the incident occurs and before specific information about the incident is known. During this time lag it is desirable to display a message to preserve credibility--but the message displayed must be credible. One approach is to display traffic state information. It might also be desirable to present the location of the end of congestion so that drivers could estimate the length of the problem.




or



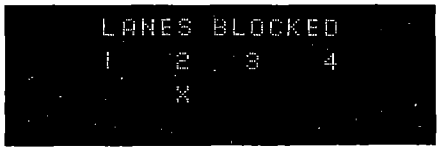

## C.3 Incident Description, Location, and Lane Blockage

Although the previous incident message will elicit voluntary diversion, drivers remaining on the freeway indicate they desire information about which lanes are blocked (or open) (25). Thus, on 2- or 3-lane freeway sections, the following message format is recommended:



Freeway sections having four or more lanes require that either two signs or a single 3- or 4-line sign having message sequencing capabilities by used. **Note that the message cannot be sequenced on a 2-line sign.** An appropriate message combination is as follows:


Sign 1 or first sequence




Sign 2 or second sequence

The reason is that it is difficult to describe in words when there are four or more lanes.

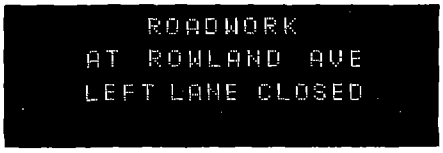
## C.4 Incident Description, Location, and Traffic State

Another message that will encourage voluntary diversion by some familiar drivers is to include a traffic state descriptor. Examples are as follows:



## C.5 Roadwork

As a minimum, messages for maintenance operations should include the incident descriptor, the location of the closure, and the lane(s) affected. An example of the simplest message for 2- or 3-lane freeway sections is as follows:




For freeway section with four or more lanes, the lane closure messages shown below are recommended:


Sign 1 or first sequence


Sign 2 or second sequence

When the maintenance operation requires that the lane be closed for a considerable distance, the preferred method of signing is to tell the drivers the cross-streets between which the lane is closed. For example:


## D. Specific Diversion Message

### D.1 Incident and Diversion Route Description

The simplest message for communicating diversion instructions to drivers in incident management situations is one which briefly describes the problem and advises the drivers what action they should take initially to avoid the problem.

Example:


---

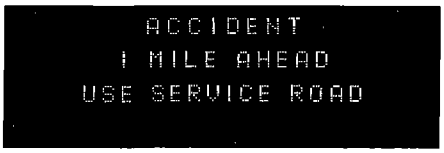
**DRIVERS NEED TO KNOW AS A MINIMUM WHAT THEY SHOULD DO AND ONE GOOD REASON FOR DOING IT.**

---

The "action" is an essential message statement at all levels of diversion signing. It is the statement that drivers will most likely attempt to recall. In addition, field studies revealed that the messages with the action message statement **USE SERVICE ROAD** will result in greater diversion than those not displaying the action statement (31).

### D.2 Basic Diversion Messages

Although the preceding "simplest" message can be used, the recommended simplest diversion message includes the following units of information: 1) incident description, 2) location of incident, and 3) action to be taken.

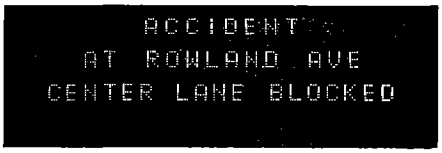




Situation 1

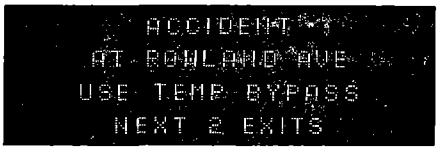
These three units of information (incident description, incident location, and alternate route directive) form the base of recommended specific diversion messages. Other information units can be added to the base as needed.

## D.3 Basic Diversion and Lane Blockage Messages

Lane blockage information can be added to the base diversion message without exceeding the maximum information unit criteria. The format for the message is as follows:




Sign 1




Sign 2

Situation 2

On freeway sections having four or more lanes, the following message formats are recommended and must be displayed on two signs or a sequencing sign having three or more lines.


Sign 1 or first sequence


Sign 2 or second sequence

If the recommendation is to divert, this information takes priority over lane blockage or delay.

## D.4 Basic Diversion and Traffic State Descriptor Messages

Traffic state descriptor messages can be incorporated into the display to convince drivers that using the frontage road will be better than remaining on the freeway. Many drivers have indicated a need to know about the conditions on the freeway (2, 3, 4). Two alternative messages are:



Displaying traffic state descriptor messages for Situation 2 must be done at the expense of omitting information about the location of the incident when the entire message is displayed on one sign.


Traffic state descriptor messages may be displayed in terms such as minutes of delay. Field studies (20) indicate that these messages will not result in higher percentages of diversion than the qualitative descriptors shown previously. Examples of the quantitative traffic state descriptor messages for Situations 1 and 2 are as follows:



Situation 1



Situation 2

The preferred method for Situation 2 is to maintain the basic diversion message and to incorporate the traffic state descriptor message element by using two signs as follows:


Sign 1


Sign 2

## D.5 Basic Diversion and Diversion Route Return Messages

One major concern drivers have is whether the frontage road is continuous beyond the incident (23). Even commuters will not be familiar with frontage roads and will thus be concerned about getting trapped on a discontinuous road. Therefore, it is desirable to tell drivers the point of return to the freeway, and thereby imply a continuous frontage road at least to this point. An example is as follows:



Note that the point of return in the first message also indirectly communicates the length of the diversion route.

## D.6 Diversion and Exit Designation Messages

Telling drivers to use the next exit or that they can use the next two or three exits prior to encountering congestion is desirable. Examples of this signing approach are given below:


## D.7 Message Combinations

The messages discussed in the previous Sections identify several distinct types of information desired by the driving population. Specific information includes:

- Incident descriptor
- Incident location
- Lane blockage information
- Traffic state descriptor
- Diversion route directive
- Diversion route return
- Exit designation

Not all drivers require the same information to make diversion decisions. It is desirable, however, to satisfy the needs of as many drivers as possible to insure that sufficient numbers will divert to improve operations in the corridor. Obviously there are limitations on the amount of information displayed on a sign that drivers can read and recall. Note that the messages in the previous Sections, as a rule, approach the recommended 8-word, 4-information unit maximum. Thus, when combination messages are displayed, two CMSs will be necessary.

---

**BECAUSE OF THE LIMITATIONS ON THE AMOUNT OF VISUAL INFORMATION DRIVERS CAN READ AND RECALL, IT IS PREFERRED TO EXCLUDE LANE BLOCKAGE INFORMATION AND INCLUDE DIVERSION INFORMATION WHEN COMBINATION MESSAGES ARE DISPLAYED.**

---

Since the basic objective of the signing system is to divert freeway traffic to balance demands in the corridor when incidents occur, the authors believe diversion information will be much more useful than lane blockage information.

**D.7.1 Basic Diversion, Traffic State, and Diversion Route Return**--When combination messages exceed the maximum signing criteria, a compromise solution is to display the total message on two signs with the incident information on the first and the traffic state severity and diversion instructions on the second. Drivers are told on the first sign that they will be advised later to divert and information where to divert is upcoming. Examples are illustrated below:


Sign 1


Sign 2

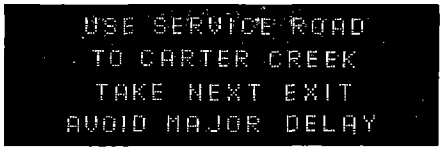
### D.7.2 Basic Diversion and Diversion Route Return Messages


Sign 1


Sign 2

### D.7.3 Basic Diversion, Traffic State, Diversion Route Return, and Exit Designation Messages


Sign 1




Sign 2

## E. Arterial Bypass Messages--No Trailblazers on Arterial

The previous sections dealt with freeway signing when the diversion route was an arterial bypass marked with trailblazers. There may be instances when it is necessary to divert traffic to arterial routes not previously marked with trailblazers. There is evidence from laboratory studies that unfamiliar motorists can follow simple arterial routes consisting of either a "]" or "[" pattern (25).

The messages for unfamiliar drivers differ from those described in Sections C and D in the following respects:

- The diversion route must be described in terms of the name of the parallel arterial which will be followed and the name of the return route. The name(s) of the street(s) leading to the parallel arterial

are desirable for unfamiliar drivers and may be omitted to meet signing space constraints.

- Two signs are required and the diversion route is defined as a **TEMPORARY BYPASS** or **BYPASS** on the first sign.
- Since the critical information are the names of the streets, the message should not include traffic state descriptor messages which would compete with the critical information.

## E.1 Basic Diversion Message

The simplest diversion message for this situation is one which consists of two signs. The message on the first sign will be identical to the basic diversion message for arterial diversion with trailblazers. The second sign will repeat the key work **BYPASS** and will include route guidance information.


Sign 1


Sign 2

## E.2 Aid to the Unfamiliar Driver

There may be some unfamiliar drivers who do not know whether the parallel arterial (**GREENVILLE** in the above example) is to the right or to the left of the freeway. This information cannot easily be displayed on the CMS without risking overload (four or more units of information). One approach to aiding unfamiliar drivers would be to use a sign located at the first cross-street they encounter which points out the direction to the parallel arterial. An example of such a sign is as follows:

# 10. LEVELS OF ADVISORY SIGN MESSAGES FOR POINT DIVERSION TO MAJOR GENERATORS

## A. Introduction

Major generators may be conveniently classified into those for:

- Special events (e.g., ballgames, parades, etc.), and
- Employment centers (e.g., downtown).

Special events attract many unfamiliar drivers, whereas commuters, who i many cases are familiar with the surrounding street system, are destined to the employment centers during the peak traffic periods. This distinction is important to recognize when designing messages for major generator traffic.

## B. Relative Effectiveness of Messages

The relative effectiveness of the specific messages for special event traffic is, in part, dependent upon whether the activity at the major generator has a:

- Specific and set starting time, or
- Variable starting time.

Ballgames, parades, shows, etc., have specific scheduled starting times. The traffic demands are concentrated in a relatively short time period, and drivers are concerned with arriving on time. At the other extreme, events such as a state fair have no set starting times, so demands are distributed over a greater period of time (except for certain major special events at the fair), and as a rule, no set arrival time is required. One would expect greater driver response to messages displayed prior to events with set starting times (20).

No field experience is available to indicate driver response to messages during peak periods for point diversion to major generators. The recommendations provided in this chapter are predicated on limited field studies dealing with driver response to incident management messages (discussed in Chapter 9) and human factors laboratory studies.

## C. Basic Situations

Figure 10-1 illustrates the basic diversion situations discussed in this chapter for special events and for commuter traffic:

- Indirect arterial diversion route perpendicular to the freeway,
- Indirect arterial diversion route parallel to the freeway, and
- Direct arterial diversion route.

The messages recommended for all three situations are essentially the same. There is one major exception: for Situation 2, because the primary arterial does not cross the freeway, drivers must exit at another cross street en route to the parallel arterial.

Figure 10-1b illustrates that Kent Ave., not Oxford, is the primary parallel arterial to the major generator. This is a different condition than Situations 1 and 3 where the cross-street at which traffic exited was itself the primary arterial to the generator.

The essential difference in the messages for the freeway signs for Situation 2 is the wording for the action message statement. The recommended action message statement is:

TAKE OXFORD EXIT or EXIT AT OXFORD

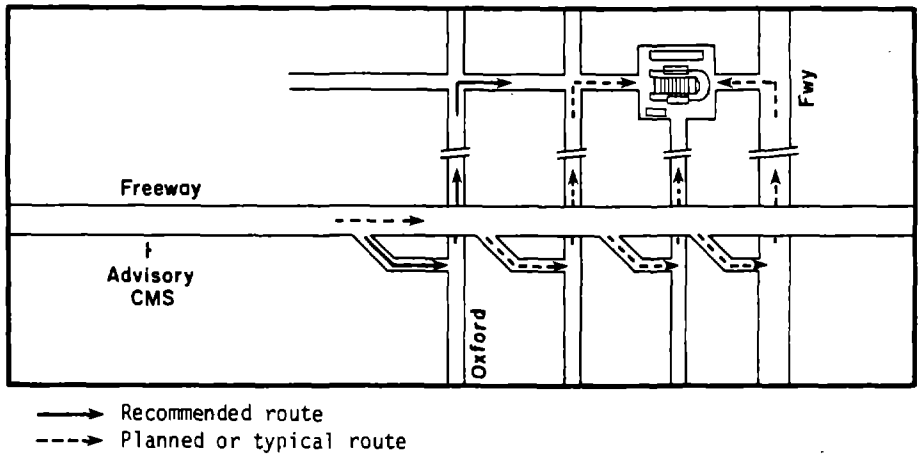
## D. Non-Incident Conditions

### D.1 Simplest Diversion Message

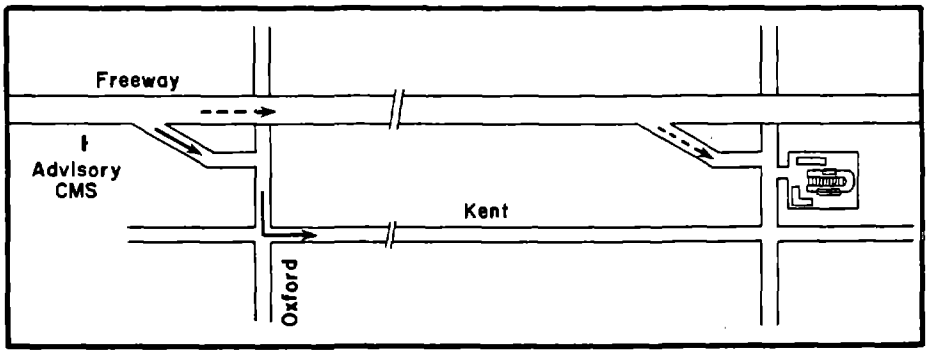
For special events, the simplest approach to signing for diversion onto an indirect perpendicular arterial route is to use one CMS displaying the following elements:

- Best route (to)
- Audience or destination (location, special event, etc.)
- Action to be taken (use arterial given)

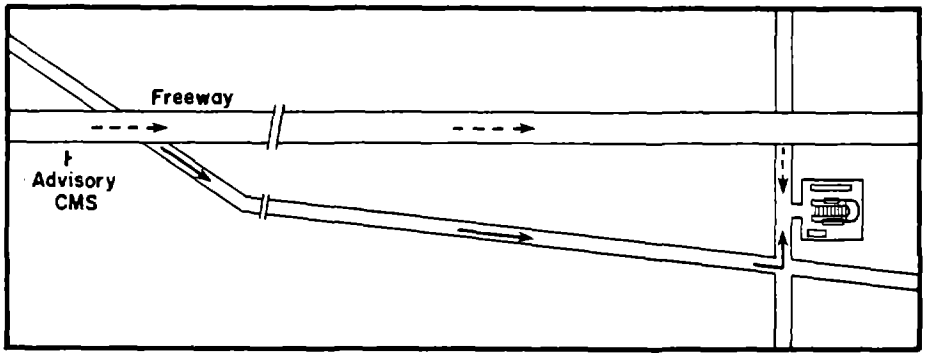
In this instance, the expression **BEST ROUTE** is intended to inform drivers that the traffic condition on the freeway route constitutes a "problem" (e.g., is degraded due to congestion); the simplest message attempts to imply this without actually stating it.




a. Indirect Arterial Diversion Route Perpendicular to Freeway




b. Indirect Arterial Diversion Route Parallel to Freeway




c. Direct Arterial Diversion Route

Figure 10-1 Basic Diversion Situations

For commuters:

---

**THE BASIC OPERATIONAL PHILOSOPHY RECOMMENDED IS THAT DURING THE PEAK PERIOD MESSAGES BE DISPLAYED ONLY WHEN UNUSUAL CONDITIONS EXIST DUE TO AN INCIDENT. SIGNS SHOULD NOT BE USED IN ATTEMPTS TO BALANCE TRAFFIC DEMANDS DURING NORMAL PEAK PERIOD OPERATIONS.**

---

## D.2 Diversion and Qualitative Traffic State Descriptor Messages

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**EXPERIENCE HAS SHOWN THAT FOR EVENTS AT MAJOR GENERATORS HAVING A VARIABLE STARTING TIME, DISPLAYING QUALITATIVE TRAFFIC STATE DESCRIPTOR MESSAGES (e.g., MAJOR DELAY, TRAFFIC JAM, ETC.) PRODUCES SLIGHTLY MORE DIVERSION THAN THE SIMPLE BASIC MESSAGE DISCUSSED IN SECTION D.1 (20).**

---

Although the basic message discussed in Section D.1 can be effective if properly used, some drivers will not divert. The primary reasons cited by these non-diverting drivers in special research studies were:

- The drivers were not convinced the alternate was a better route. They believed that the alternate, because of the traffic signals and lower type facility, would not be as good as the primary freeway route. Many of these drivers wanted more specific information concerning the conditions on the primary freeway route.

- Several drivers were not certain that guidance was provided along the alternate, and they were afraid of getting lost.

Two alternative traffic state descriptor messages that address the first reason cited above and require minimum surveillance capabilities are:

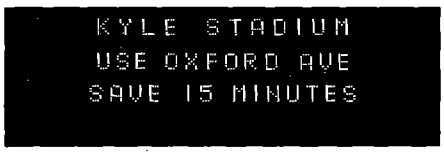

### D.3 Diversion and Quantitative Traffic State Descriptor Messages

---

**EXPERIENCE HAS SHOWN THAT FOR EVENTS AT MAJOR GENERATORS HAVING A VARIABLE STARTING TIME, DISPLAYING QUANTITATIVE TRAFFIC STATE DESCRIPTOR MESSAGES (TIME SAVED OR DELAY AVOIDED) PRODUCES SLIGHTLY MORE DIVERSION THAN THE BASIC MESSAGE DISCUSSED IN SECTION D.1. HOWEVER, THEY ARE NO MORE EFFECTIVE THAN THE QUALITATIVE TRAFFIC STATE DESCRIPTOR MESSAGES SHOWN IN SECTION D.2 (20).**

---

Alternative approaches when adequate surveillance is available for predicting travel times along the primary and alternate route are:


Note: Time in 5- or 10-minute increments

### D.4 Messages Concerning Guide Signs on Alternate Routes

Some non-diverting drivers in special field studies (20) stated they wanted assurance prior to leaving the freeway that guidance would be provided along the alternate route. The message shown below was therefore field tested but did not produce any better results than the **BEST ROUTE** message shown in Section D.1.


## E. Incident Conditions

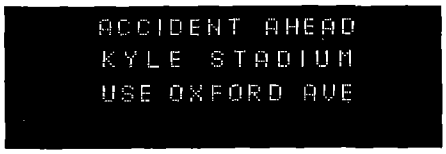
### E.1 General

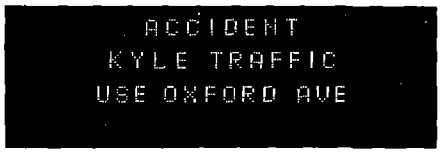
The messages suggested in Sections D.1 through D.4 have been used successfully in diverting traffic for special events when heavy congestion due to demand-capacity imbalance adversely affected the primary freeway route. Drivers are aware that traffic accidents will impair the operations even more,

so it is advisable that "stand by" messages be available. No real-world data are available validating the success of accident messages specifically for special event traffic. However, it follows from research on the effects of incident messages (31) that accident messages will elicit a higher degree of diversion.

## E.2 Simplest Diversion Message

The simplest diversion message includes an attention statement, an action statement, and one good reason for responding (problem statement). The simplest diversion messages for special events are as follows:

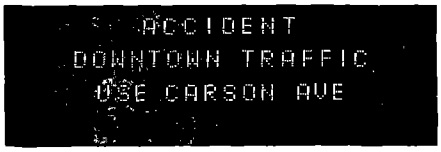



Note: when AHEAD is omitted, the word TRAFFIC must follow KYLE (STADIUM).

Another variation to the previous messages is to include the location of the accident in terms of miles away from the sign. Four lines of message will be required to abide by the principle of having only one unit of information per line of message. An example is as follows:


For commuters:


The preferred method is to include the location of the incident. Familiar drivers are knowledgeable about major cross-streets and desire to know the location of the accident in these terms.


Note: in the above examples and in the examples that follow, the recommendation is that the destination name should appear before the action message statement so that drivers going to the destination will attend to the recommended action.

## E.3 Diversion and Qualitative Traffic State Descriptor Messages

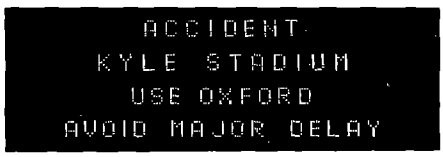
When the user desires to display qualitative traffic state descriptor information in addition to the basic diversion message for special event traffic, the following messages may be displayed on a 4-line sign:

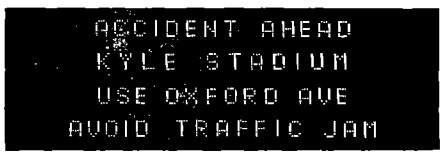


Note: four units of information displayed simultaneously may overload the drivers. Preferably, the message should appear on a 2-line, 2-sequence display or on two signs.

When the traffic condition descriptor--such as **MAJOR DELAY, TRAFFIC JAM, HEAVY CONGESTION,** etc.--applies specifically to the primary facility, then this descriptor should immediately follow the problem message statement (as previously shown) since it too applies to the primary facility.

Traffic state descriptors that imply a comparison between the primary and alternate route should follow the information about the alternate route. For example, the above general traffic state descriptors might be changed to read **AVOID MAJOR DELAY, AVOID TRAFFIC JAM, AVOID HEAVY CONGESTION,** etc. Thus, the message format would be as follows:



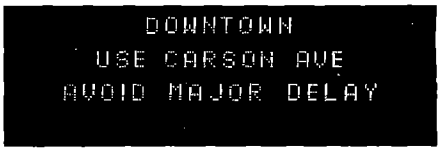
When the user desires to display qualitative traffic state information for commuters on one sign, it must be done at the expense of omitting the location of the incident. Examples are as follows:



Note: again, four units of information displayed simultaneously may overload the drivers. Preferably, the message should appear on a 2-line, 2-sequence display or on two signs.

One method is to include the accident location by using two signs. Examples of acceptable message formats are as follows:


Sign 1




Sign 2


Sign 1


Sign 2

When the traffic condition descriptor--such as **MAJOR DELAY, TRAFFIC JAM, HEAVY CONGESTION,** etc.-- applies specifically to the primary facility, then this descriptor should immediately follow the **ACCIDENT** descriptor (as previously shown) since it too applies to the primary facility.

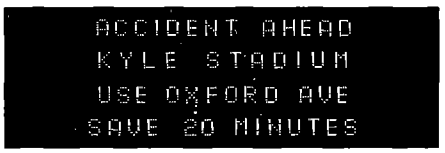
Traffic state descriptors that imply a comparison between the primary and alternate route should follow the information about the alternate route. For example, the above general traffic state descriptors might be changed to read **AVOID MAJOR DELAY, AVOID TRAFFIC JAM, AVOID HEAVY CONGESTION,** etc. Thus, an example message format would be as follows:


Sign 1

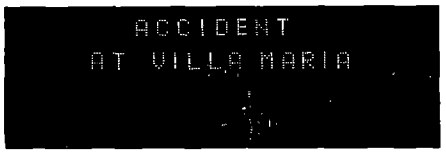

Sign 2

## E.4 Diversion and Quantitative Traffic State Descriptor Messages

The descriptors **MAJOR DELAY, TRAFFIC JAM, HEAVY CONGESTION,** etc., may be replaced with more specific quantitative traffic state descriptors when surveillance and prediction capabilities are available. Examples are as follows:


And for commuters:




Sign 1


Sign 2

# 11. VISIBILITY AND LEGIBILITY CRITERIA

Before a sign can communicate its intended meaning, it must be perceived under a wide variety of viewing conditions. This chapter will focus on factors affecting the target value and legibility of signs such as brightness contrast, color contrast, character size and spacing, and coding.

## A. Light-Reflecting (Painted) Signs

There are two types of signs - those that reflect light and those that emit light. Light reflecting signs reflect some external light source such as the sun or headlights. Certain types of CMSs are light-reflecting, e.g., the rotating drum, fold-out, and disk matrix. Light-emitting signs generate their own light on or behind the viewing surface, e.g., lamp matrix, blank out, and fiber-optic signs. These signs will be discussed in Section 11.B.

### A.1 Brightness Contrast

Brightness contrast between legend and background on a sign influences the legibility of characters. Contrast between the sign and the roadside environment influences both its target value and its legibility. Daytime brightness is normally sufficient to read light-reflecting signs, but may not be sufficient to attract attention if there are other visual elements in the environment. Increased size of flashing beacons may be required to enhance target value. At dawn, dusk, or night, special high reflective sheeting or external illumination may be necessary for both detection and legibility.

The contrast ratio is computed as follows:

$$\text{Contrast } (\%) = (100)\left[\frac{R_B - R_L}{R_B}\right]$$

where $R_B$ is the reflectance of the background and R is the reflectance of the legend.

The smaller the letter size and/or the longer the viewing distance, the greater the amount of contrast necessary for visibility and legibility. For trailblazers and most static signs, a minimum of 30 percent is recommended (34).

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**CONTRAST RATIOS OF 40 PERCENT FOR DAYTIME AND 50 PERCENT FOR NIGHTTIME READING ARE RECOMMENDED (35).**

---

These contrast ratios are readily achieved using MUTCD recommended letters and backgrounds. If an agency chooses to use any other color combinations, they should use the percent reflectances in Table 11-1 and compute the contrast ratios.

TABLE 11-1

REFLECTANCE PROPERTIES OF MUTCD COLORS

| Color | Percent Reflectance* |
|---|---|
| Red | 9 |
| Black | 9 |
| White | 79 |
| Orange | 25 |
| Yellow | 51 |
| Brown | 6 |
| Green | 7 |
| Blue | 7 |
| Purple | 12 |
| Light Blue | 43 |
| Coral | 51 |
| Brilliant Yellow-Green | 43 |

* Relative to flat white magnesium oxide which is considered to have a reflectance of 100 percent.

Source: Reference 36.

As an example, an agency wishes to use an orange legend on a blue background for a trailblazer. Using Table 11.1, the contrast ratio would be $(100)\ \frac{(43-25)}{43} = 41.8$. This ratio exceeds the 40 percent daytime recommended contrast, but it is less than the 50 percent value recommended for nighttime use.

## A.2 Color Contrast

Table 11-2 shows other acceptable color combinations for day and night application based upon contrast ratios.

Adequate brightness contrast for legibility is only one criteria for color selection. Certain color code conventions are given in the MUTCD, which must not be violated in selecting colors.

For purposes of target value, a light colored sign should not be used against a light background such as the sky, nor should a dark colored sign be used against a dark surrounding. In general, a light green background such as used on U. S. Interstate signs appears to provide the best contrast with a variety of possible backgrounds.

Trailblazers and other light-reflecting signs should be reflectorized with sheeting or be externally illuminated.

## A.3 Letter Sizes

Letter size affects the legibility distance of a sign message more than any other single factor. "Rule-of-thumb" estimates, such as 50 feet of legibility distance for each inch of letter height, are not always valid. The legibility distance varies with the Letter Series (A through F) selected and whether or not the design legibility distance is considered. Design legibility takes into account nighttime viewing conditions and possible 20/40 visual acuity, rather than the ideal 20/20 vision. For Series B through F, design legibility distances vary from 15'/in. to 27'/in., as opposed to 33'/in. to 60'/in. for legibility distance.

In general, letter sizes of light-reflecting signs should be designed in accordance with MUTCD requirements and recommendations.

## A.4 Spacing of Letters, Words, and Lines

The MUTCD provides the following guidelines with regard to interline and edge spacing:

- Interline spacings--three-fourths the average of upper-case letter heights to adjacent lines
- Top and bottom borders--average of the letter heights of the adjacent line
- Side borders--width equal to the height of the largest letter

It should be noted that good spacing in all aspects will significantly improve the readability of the sign.

TABLE 11.2

ACCEPTABLE SIGN COLOR COMBINATIONS
BASED ON BRIGHTNESS CONTRAST

| Background Color \ Legend Color | Red | Black | White | Orange | Yellow | Brown | Green | Blue | Purple | Light Blue | Coral | Brilliant Yellow-Green |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red | | | | | | | | | | | | |
| Black | | | | | | | | | | | | |
| White | | | | | | | | | | D | | D |
| Orange | | | | | | | | | | | | |
| Yellow | | | | | | | | | | | | |
| Brown | | | | | | | | | | | | |
| Green | | | | | | | | | | | | |
| Blue | | | | | | | | | | | | |
| Purple | | | | | | | D | D | | | | |
| Light Blue | | | | D | | | | | | | | |
| Coral | | | | | | | | | | | | |
| Brilliant Yellow-Green | | | | D | | | | | | | | |

Legend:

- Acceptable for Day or Night
- D — Acceptable only for Day Application or Night w/External Illumination
- Not Recommended

Avoid these pitfalls:

- Using a letter size too small to do the job.
- Crowding letters and words together, but retaining good edge spacing to make use of an existing sign blank.
- Crowding a well-spaced message to the edge of a sign to make use of an existing blank.

### A.5 Letter Height and Stroke Width - Disk Matrix Signs

Most disk matrix CMSs used in practice are capable of displaying three lines of message with 18-inch (46-cm) high characters. The disk matrix sign can also be programmed to display oversized triple-line, blocked letters.

### A.6 Legibility - Disk Matrix Signs

Available data on the legibility of disk matrix signs are very limited. The results of a legibility study conducted on I-279 near Pittsburgh with 20 subjects viewing overhead disk signs while driving in traffic are presented in Table 11-3. (37).

## B. Light-Emitting (Internally Illuminated) Signs

This section describes basic considerations in the design and selection of light-emitting signs, including brightness contrast, letter heights and stroke widths, spacing, alphabet and font, and lamp replacement. All discussions relate to light-emitting signs to the extent that they are peculiar. Design practices that are common to both types of signs are included in the discussion of light-reflecting signs.

### B.1 Brightness Contrast

Unlike light-reflecting displays, brightness contrast is often critical when considering the daytime operation of light-emitting displays. This criticality is a result of glare from the sun striking the sign face and severely reducing the brightness contrast between the sign legend and background. To reduce this "wash-out" effect, special non-glare sun screens should be mounted on the sign face. The legibility of lamp matrix signs can be further improved by using special glare-retardant bulb fixtures.

Most light-emitting displays have good target value and legibility at night. However, during nighttime operations, the legend may appear too bright and may blur due to irradiation. To reduce irradiation, a step down or

TABLE 11-3

LEGIBILITY DISTANCES FOR 18-INCH
DISK MATRIX (DAYLIGHT)

| Character Style | Legibility Distance (ft) 50th Percentile | 85th Percentile |
|---|---|---|
| WORD, single-line single-stroke | 725 | 500 |
| NUMBER, single-line single-stroke | 600 | 475 |
| WORD, triple-line, blocked | 1,850 | 1,350 |
| NUMBER, triple-line, blocked | 800 | 475 |

variable photocell control of the power supply may be necessary to decrease the light intensity.

Colored lamps have been used as internal illumination in several displays (38, 39). In general, the ability of the eyes to detect sources of colored internal illumination depends directly on the brightness of the source. Thus, at longer viewing distances, the intensities of colored lights must be greater than that of white light for equal visibility. Darker colors, such as red, green, blue, etc., must have much higher intensities than lighter colors. In addition, some lighter colors, such as yellow, are easily confused with white unless they are considerably brighter. Generally, unless colored illumination is used in a display requiring relatively short viewing distances, such as on arterials and ramps, or as a coding technique where legibility of the colored illumination is not required, the use of colored lamps should be avoided. In other words, colored lamps may be used to present a word or diagrammatic message only if the viewing distance to the display is relatively short. At longer viewing distances, colored lamps should be used only as status indicators such that recognition of lamp color is not mandatory.

### B.2 Letter Height and Stroke Width

Letter height and stroke width requirements for light-emitting signs differ somewhat from those for light-reflecting signs. For those displays in which light must shine through cut-outs in an opaque surface (known as

transillumination), such as blank-out signs and some types of rotating tape signs, "irradiation" may be a problem. Irradiation is a phenomenon resulting from extremely high brightness contrast where the lighter surface appears to "bleed" onto the darker surface. Irradiation is more likely to be a problem at night than in the daytime. To alleviate the problem, reduce the intensity of the light source, decrease the stroke width, or increase the recommended spacings between characters by 20 to 40 percent. In any case, test view the display at night and at all expected viewing distances before putting the display into operation.

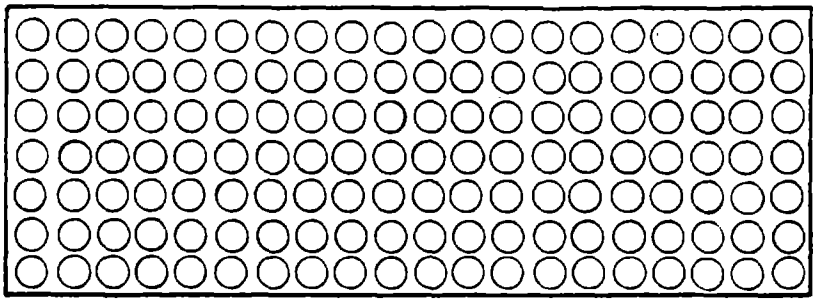
## B.3 Letter Height, Stroke Width and Legibility - Lamp Matrix Signs

In addition to sharing the irradiation problem with the above displays, lamp matrix signs possess other characteristics that merit consideration relative to design configurations. Lamp matrix signs generally consist of rectangular arrays of lamps individually surrounded by reflectors or shades. (Details of characteristics may be found in Chapter 13.) These lamp/reflector units are mounted adjacent to each other both vertically and horizontally to form a grid normally seven lamp rows high. The size of the lamp/reflector units and the spacing between them, if any, generally defines the height of the letter. As a single column or row of lamps is used to form the various parts of a letter, the stroke width of each character is essentially the width of the lamp/reflector unit. Although double-stroke characters (two lamp columns used to form vertical letter strokes) are available on some lamp matrix signs, their use should be avoided except when a single simple word is to be flashed.

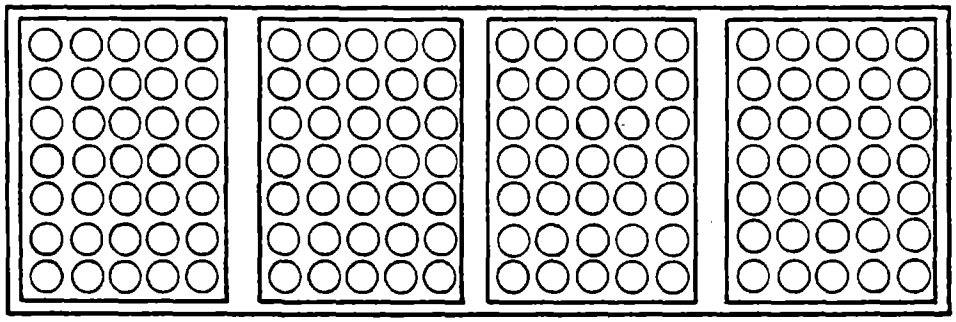
Lamp arrays used to form character lines can either be a continuous field of lamps or a fixed number of rectangular matrix modules (small banks of lamps separated by "lampless" areas). Typically, characters are formed by 7 lamp rows and 4 or 5 lamp columns (40). Various array designs are illustrated in Figure 11-1. These designs are well-suited to the formation of all alpha-numeric characters 10 inches or greater in height. Smaller letter heights require smaller, low wattage lamps that are not sufficiently bright for day-time use (41).

Available data on the legibility of matrix signs are very limited. The results of a legibility study conducted using a sign with 18-inch characters are shown in Table 11-4 (7, 8).

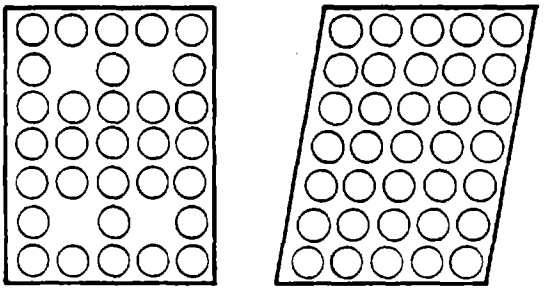
These data indicate a mean legibility distance of about 800 feet (243 m) and an 85th percentile legibility distance of about 650 feet (198 m) (36 feet of legibility distance/inch of letter height). In the absence of more definitive data, use 36 ft/in as a guide for determining required letter height.



Continuous Array



Modular Array (5 x 7 Rectangular Modules)



31-Bulb Figuregram

35-Bulb Slanted Module

Figure 11-1. Matrix Arrays

TABLE 11-4

LEGIBILITY DISTANCES FOR 18-INCH
BULB MATRIX CMS (DAYLIGHT)

| Character Style | Legibility Distance (ft) 50th Percentile | 85th Percentile |
|---|---|---|
| WORD, single-line, single-stroke | 850 | 700 |
| NUMBER, single-line single-stroke | 750 | 575 |
| NUMBER, single-line double stroke (thick/thin) | 850 | 700 |

As a general rule, follow these guidelines to determine matrix sign letter heights:

- Never use letter heights of less than 10 inches, as lamp brightness is not sufficient.
- For freeway applications, use letter heights of 18 inches or greater.
- For other than freeway applications, use letter heights between 10 and 18 inches based on 36 ft/in legibility distance.

### B.4 Spacing

The spacing requirements for light-emitting displays are the same as those for light-reflecting displays. Some matrix signs use modular construction or characters (See Chapter 13). That is, one 7 x 5 array of lamps is assigned to each potential character location. Some characters, such as "I," take less space than others, and thus have greater spacings between letters. As this concept generally results in greater overall spacings, its use is not discouraged.

## B.5 Alphabet and Font

Most matrix signs are limited in alphabet to upper-case letters. The arrangement of bulbs makes it difficult to form some of the parts of lower case letters. This is true especially for letters with loops, such as "g," "q,", or "y." In general, the practice of using upper case letter should be followed.

Font conventionally refers to the assortment of styles of letters. However, in matrix signs, font refers to the size of grid used to form the letters (7 x 5, 7 x 4, etc.), as well as the inclination (vertical, slanted) of the letters. Little research information is available on recommended grid sizes; however, operational experience indicates no appreciable loss in legibility by use of 7 x 4 for standard letters, rather than 7 x 5. The former allows for longer messages per line.

Some matrix signs use a slanted font for word messages. No research is known that supports improved legibility for slanted letters. However, the slanted font does require more horizontal space (up to several lamp columns) than a display of the same message in vertical font.

## B.6 Font Style

Overall, the 7 x 5 standard (rounded character) font style provides slightly superior legibility on a CMS sign to a 7 x4 character, a square character font style, or the Lincoln/Mitre character style. However, no single style would be expected to have a monopoly on the best design of all characters and numbers. An optimum composite font, based upon two criteria: legibility distance and minimizing character confusions, is presented in Figure 11-2 (7). The characters were selected from the four different styles based upon significantly better visual performance.

## B.7 Accentuation

In reading multi-lined CMS messages, drivers will typically read top-to-bottom even when there is limited time to scan the CMS. Experimentally, attempts have been made to alter the order of reading the lines by accentuating the second or third line via use of red lights, flashing lights, and double-stroke characters on one line only. In general, accentuation has been unsuccessful although red colored lights were more successful in directing attention than the other techniques (7).

## B.8 Lamp Replacement

The failure of lamps on a matrix sign directly affects the readability of the display. According to research findings with traffic-related words, the maximum tolerable percentages of random lamp loss are shown in Table 11-5.

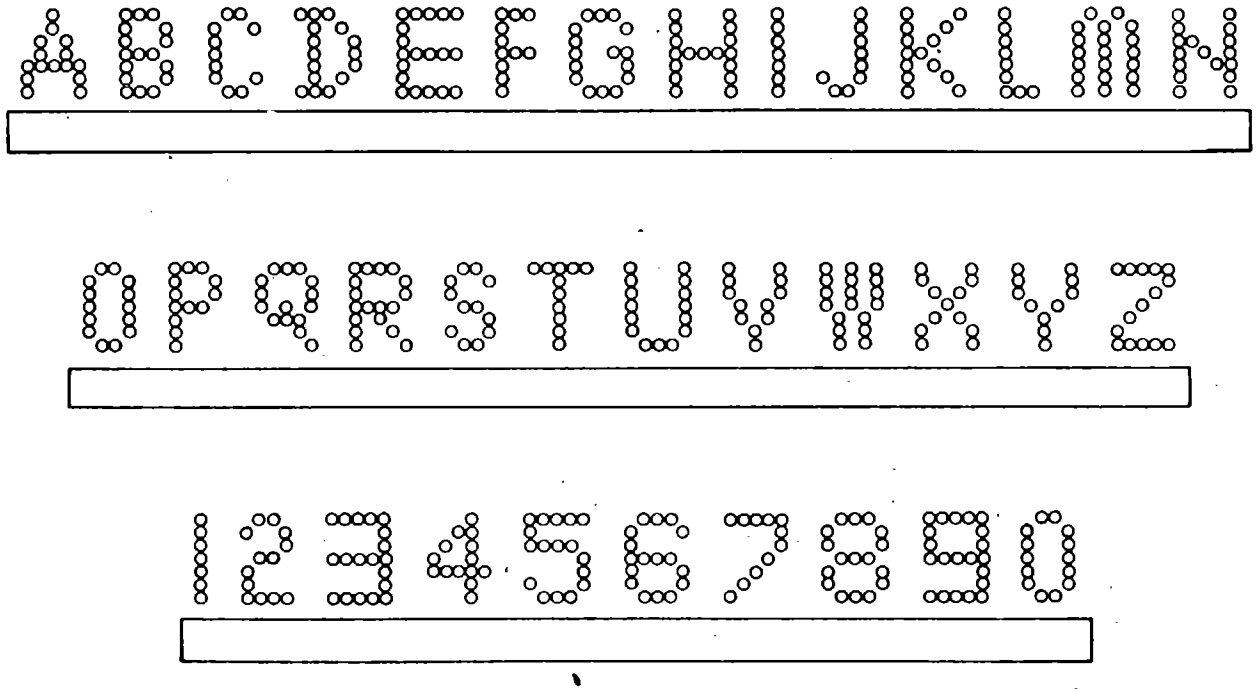



Figure 11-2. Optimum Composite Font Style

TABLE 11-5

MAXIMUM ALLOWABLE PERCENT BULB FAILURE

| Maximum State | Percent Correct Response | |
|---|---|---|
| | 95% Correct | 85% Correct |
| Unfamiliar | 8% | 18% |
| Average | 14% | 28% |
| Familiar | 28% | 44% |

Unfamiliar drivers are those who had not previously seen the words in a legible form at the time of testing. Familiar drivers had seen the words previously and the task was one of recognizing them when displayed in a degraded form.

However, lamp failure will generally degrade the appearance of the display to an unacceptable level before readability is seriously impaired.

A national sign manufacturer recommends that all lamps be replaced at or before 10 percent failure levels (normally 9 to 12 months). Adherence to this practice will suffice in maintaining adequate readability.

## C. Coding of Information on Signs

There are a variety of coding techniques such as color, geometric shapes, pictorial silhouettes, and diagrammatics. Standard codes for colors and shapes have been adopted and are dictated by MUTCD. Agencies should consult this standard whenever coded information is presented on a new sign.

## 12. GUIDELINES FOR ADVISORY SIGN LOCATION IN URBAN AREAS

### A. General Location Guidelines

There are at least two current practices in signing. These are to:

- Install a small system to address a specific problem location, and
- Install an overall system on a long stretch of freeway.

Regardless of which approach is used, there are some general location guidelines, some of which are obvious, that should be given particular attention.

---

- **LOCATE ADVISORY CMSs UPSTREAM OF BOTTLENECKS AND HIGH ACCIDENT LOCATIONS.**
- **MAKE SURE ADVISORY CMSs ARE UPSTREAM OF MAJOR "DECISION POINTS" (RAMPS AND INTERCHANGES THAT WILL BE USED FOR DIVERSION).**
- **FREEWAY-TO-FREEWAY INTERCHANGES ARE MAJOR DECISION POINTS. CONSIDER LOCATING CMSs IN ADVANCE OF THESE MAJOR INTERCHANGES.**

---

Other general location guidelines emphasize some things that should be avoided.

---

- **CMSs SHOULD NOT BE LOCATED WITHIN A MAJOR INTERCHANGE.**
- **AVOID USING CMSs LOCATED UPSTREAM OF A FREEWAY-TO-FREEWAY INTERCHANGE TO DIVERT TRAFFIC TO RAMPS DOWNSTREAM OF THE INTERCHANGE.**

---

### B. General Spacing Guidelines

#### B.1 General

Two factors affect the initial spacing requirements of CMSs used for incident management and diversion to major generators. Unfortunately, the factors result in conflicting requirements for sign spacing. First of all, cost considerations dictate the need to space the signs as far apart as possible. Secondly, long messages must be "chunked" and displayed on two signs. Ideally, the two signs should be close to each other so that the

drivers can relate the message on the second sign to that on the first sign. Also, driver recall of the message may be affected if the signs are too far apart.

No field or laboratory data is available that indicates the spacing requirements for optimum driver recall. However, reported operational experience from two installations may provide some insight into the sign spacing dilemma. The two installations are the Los Angeles Area Freeway Surveillance and Control Project (LAAFSCP) and the experimental project in the City of Dallas.

Although not conclusive, the information reported thus far seems to indicate that, from an operational standpoint, a spacing of at least 3/4 mile (1.2 km) seems to work well when addressing a bottleneck area. Since the Dallas study did not include longer spacings, it is not certain whether longer spacings would have been acceptable. The LAAFSCP experience established that 3/4 mile (1.2 km) spacings were too close for an overall signing system. The results from the two sites indicate that a 3/4 mile (1.2 km) spacing may be acceptable upstream of bottleneck areas within the city when diversion (action) messages are displayed, whereas longer spacings should not be used downstream of bottleneck areas and in outlying areas where no diversion messages are displayed. Also, exit ramp spacing may be more of a factor in deciding what spacing to use when actual diversion messages are displayed.

### C. Location with Respect to Exit Ramps and Advance Guide Signs

Advisory CMSs are not used in isolation, but become a part of the existing signing system. Existing Exit Direction Signs and Advance Guide Signs (or Interchange Sequence Signs) provide drivers with advance notice of specific exits (See Sections 2E-21 through 2E-32 in the MUTCD [14]). Thus, the placement of the CMS must be integrated with those existing static signs when- ever a specific exit ramp is used for traffic diversion.

---

**THE ADVISORY CMS MUST BE LOCATED UPSTREAM OF THE EXIT DIRECTION SIGN OF THE RAMP USED FOR DIVERSION.**

---

When the CMS tells drivers to use a specific ramp, it must be located upstream of the Exit Direction Sign for that ramp. Otherwise, drivers will not have enough time to change lanes and prepare to exit. Also, erratic and hazardous driving maneuvers are likely to be made by familiar drivers. Unfamiliar drivers will most likely miss the exit.

**WHEN THE EXIT RAMP HAS BOTH 1-MILE (1.6 KM) AND 2-MILE (3.2 KM) ADVANCE GUIDE SIGNS, THE RECOMMENDED LOCATION FOR THE ADVISORY CMS IS BETWEEN THE TWO ADVANCE GUIDE SIGNS (SEE FIGURE 12-1).**

This will better prepare the drivers for the exit maneuver to that ramp. (Note: the preceding recommendation applies to the location with respect to the nearest exit ramp that will be used for diversion. The CMS can also be used to divert traffic to ramps farther downstream.)

**IN URBAN AREAS WHERE THE ADVANCE GUIDE SIGNS ARE PLACED CLOSER TO THE EXIT BECAUSE OF CLOSELY SPACED INTERCHANGES, THE ADVISORY CMS CAN BE LOCATED BETWEEN THE TWO ADVANCE GUIDE SIGNS, PROVIDED THE ADVANCE GUIDE SIGN CLOSEST TO THE RAMP IS AT LEAST 1/2 MILE (0.8 KM) FROM THE RAMP. WHEN QUEUEING IS ANTICIPATED UPSTREAM OF THE RAMP, THE ADVISORY CMS SHOULD BE LOCATED UPSTREAM OF THE TWO ADVANCE GUIDE SIGNS (SEE FIGURE 12-2).**

It is important to remember that drivers are not anticipating changing routes until they read the message on the CMS. Thus, the group of drivers to whom the message applies may be distributed somewhat uniformly across all lanes. The drivers in the inside lane must have ample opportunity to read the message and change lanes for exiting.

**WHEN INTERCHANGE SEQUENCE SIGNS ARE USED FOR CLOSELY SPACED INTERCHANGES IN URBAN AREAS, THE ADVISORY CMS SHOULD BE LOCATED UPSTREAM OF AT LEAST TWO ADVANCE INTERCHANGE SEQUENCE SIGNS FOR THE RAMP USED FOR DIVERSION (SEE FIGURE 12-3).**

### D. Spacing Between the Advisory CMS and Advance Guide Signs

**THE RECOMMENDED MINIMUM SPACING BETWEEN THE ADVISORY CMS AND A DOWNSTREAM ADVANCE GUIDE SIGN IS 1,000 FEET (300 M).**

The MUTCD recommends an 800-ft. (240 m) minimum spacing between guide signs. Due to longer decision-reaction times associated with diversion messages, greater distances are required for drivers to make decisions. The authors believe that at least 1,000 feet (300 m) is needed for drivers to make this unexpected decision and then to read the upcoming Advance Guide Sign.

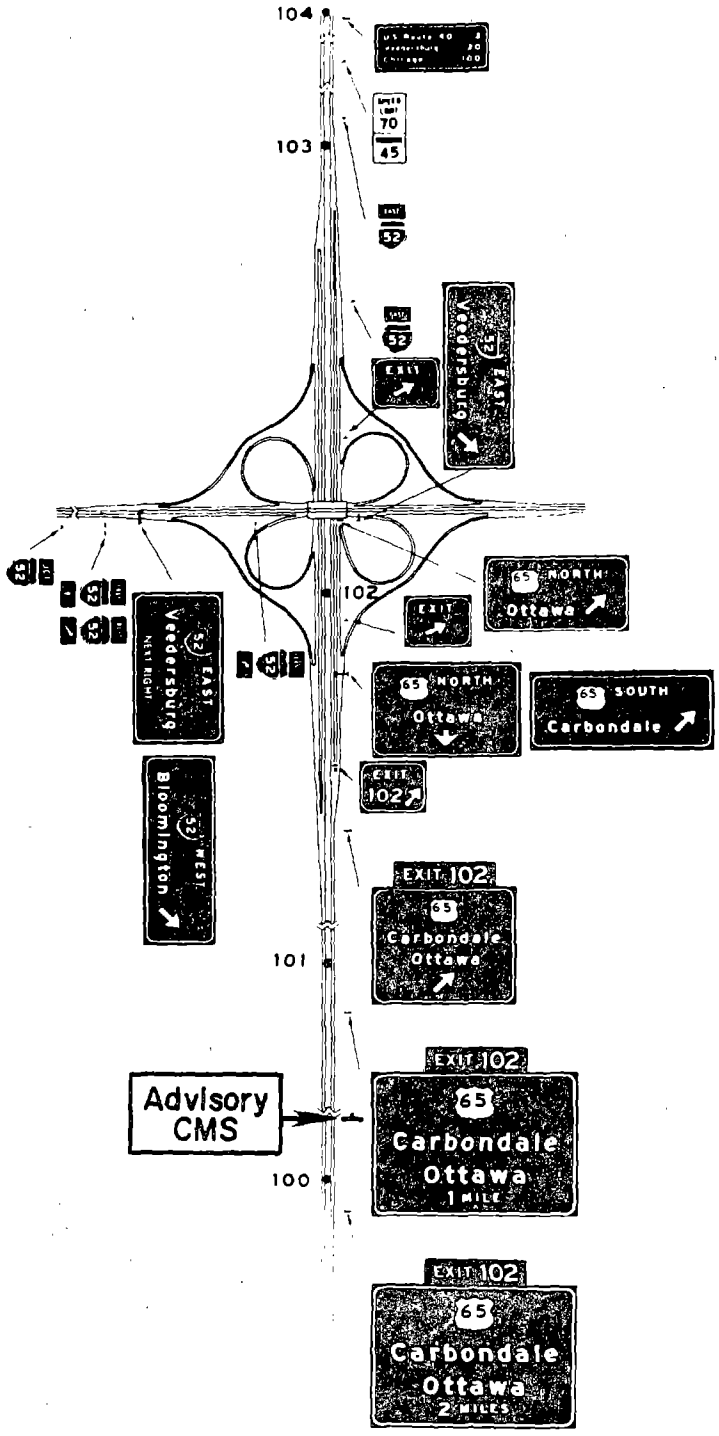



Figure 12-1. Recommended Advisory CMS Location When 1-Mile and 2-Mile Advance Exit Signs Are Available

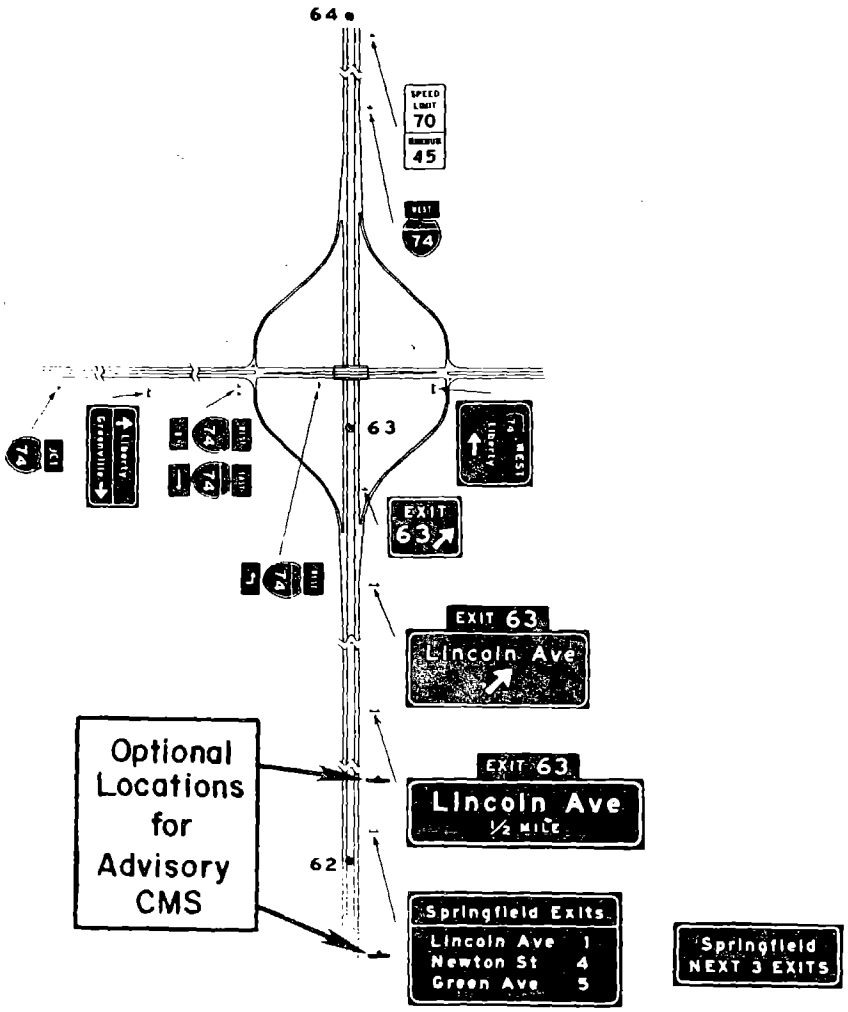



Figure 12-2. Recommended Advisory CMS Locations When Advance Exit Signs Are Close to Ramp

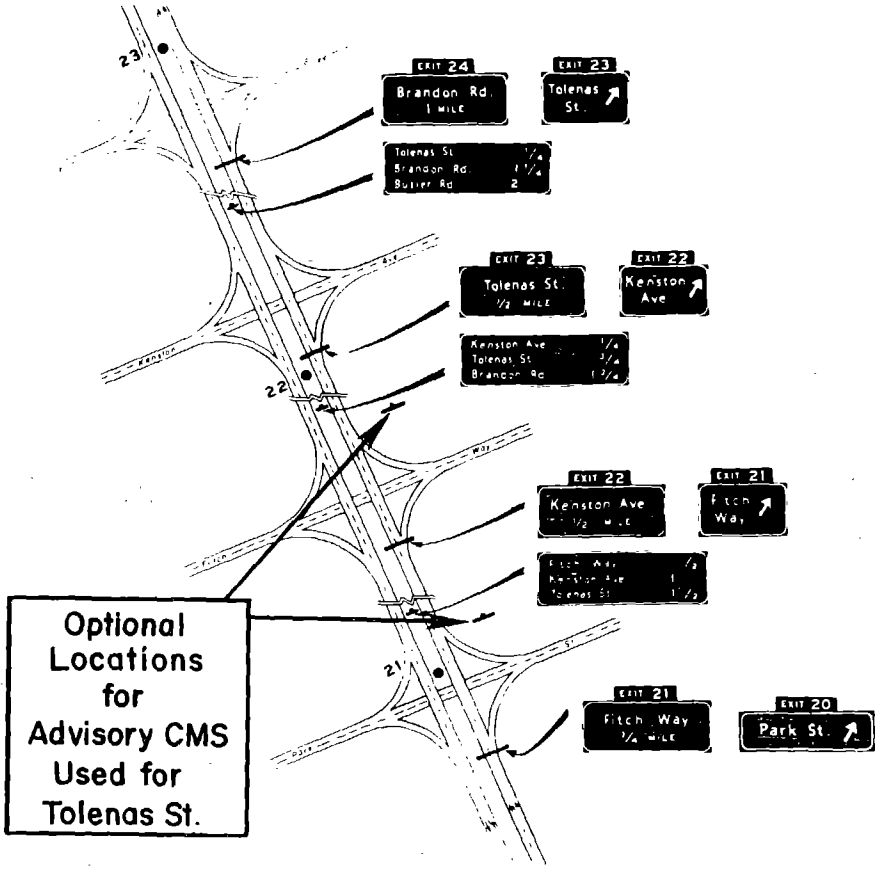



Figure 12-3. Recommended Advisory CMS Location When Interchange Sequence Signs Are Used

**RECOMMENDED MINIMUM SPACING BETWEEN THE ADVISORY CMS AND AN UPSTREAM ADVANCE GUIDE SIGN WILL DEPEND UPON SEVERAL FACTORS, INCLUDING MESSAGE LENGTH, MESSAGE FORMAT, AND OPERATING SPEED. RECOMMENDED MINIMUMS ARE PROVIDED IN TABLE 12-1 FOR A 55 MPH (88.5 KM/HR) OPERATING SPEED AND A 20-FOOT (6.1 M) SIGN PLACED 20 FEET (6.1 M) FROM THE EDGE OF THE SHOULDER LANE.**

The minimum distance between the CMS and an upstream Advance Guide Sign is composed of the three elements illustrated in Figure 12-4:

- Minimum message exposure distance
- Distance from the point where the CMS is out of clear vision to the location of the CMS
- 350 ft. (106.4 m) additional visibility distance

The sum of the minimum exposure distance (determined from minimum message exposure time) and the "dead space" is the minimum required message legibility distance. Chapter 8, Section G discusses the procedure for calculating minimum legibility distance.

The third component shown in Figure 12-4 is 350 ft. (106.4 m) of additional visibility distance. The additional visibility distance is added to allow the drivers time to recognize that the sign is displaying a message and, in the case of unfamiliar drivers, to recognize the existence of the CMS. It is important that drivers recognize that the CMS is displaying a message before they are within the legibility distance of the message. The use of 350 ft. (106.4 m) provides drivers with about four seconds of viewing time before they begin to read the message.

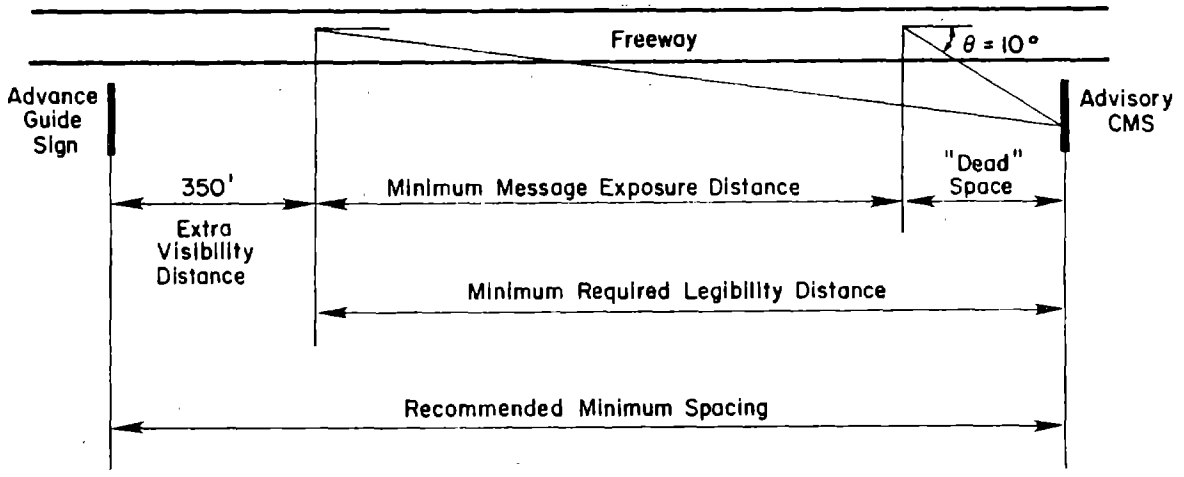



Figure 12-4. Spacing Between CMS and Upstream Advance Guide Sign

Table 12-1 presents recommended minimum spacing between side-mounted CMSs and upstream Advance Guide Signs for freeway operating speeds of 55 mph (88.5 km/hr). The distances shown are the sums of the three components previously discussed. Minimum exposure distances for various message exposure times are given in Table 12-2. Table 12-3 presents the approximate distance at which side-mounted signs are out of the driver's clear vision. The data were computed from the equation shown in Chapter 8, Section G. The distances presented in Table 12-4 are the sums of the minimum exposure distances (Table 12-2) and the distances at which the signs are out of the cone of clear vision (Table 12-3), and represent the required minimum CMS legibility distances. Adding 350 ft. (106.4 m) to those values results in the minimum spacing distance shown in Table 12-1.

TABLE 12-1

RECOMMENDED MINIMUM SPACING BETWEEN SIDE-MOUNTED ADVISORY CMSs AND UPSTREAM ADVANCE GUIDE SIGNS FOR AN OPERATING SPEED OF 55 MPH (88.5 KM/HR)

| Number of Freeway Lanes (One Direction) | Minimum Spacing (ft.) | | |
|---|---|---|---|
| | Required Minimum Message Exposure Time | | |
| | 4 seconds | 6 seconds | 8 seconds |
| 2 | 950 | 1100 | 1250 |
| 3 | 1050 | 1200 | 1350 |
| 4 | 1100 | 1250 | 1400 |

1 ft. = .304 meters

Notes:

Distances are for side-mounted signs 20 ft. (6.1 m) wide placed 20 ft. (6.1 m) from the shoulder lane.

Values in Table 12-1 are the sums of the following distances:

- Minimum message exposure distance (Table 12-2)
- Distance at which the CMS is out of cone of clear vision (Table 12-3)
- 350 ft. (106.4 m) additional visibility distance

The sum of the minimum message exposure distance and the distance at which the CMS is out of cone of clear vision is equal to the required minimum legibility distance (Table 12-4).

## E. Spacing on Freeways with No Advance Guide Signs

In cases where no Advance Guide Signs are in place, such as in the case of older freeways where signing has not yet been updated to present standards,

drivers must rely solely on the Exit Direction Sign for exiting information. The MUTCD specifies that the Exit Direction Sign should be located approximately 1/4 to 1/2 mile in advance of the gore point. When Advance Guide Signs are in place, these distances should, as a rule, be adequate. However, in the absence of Advance Guide Signs, these may not always be adequate for incident management/route diversion situations.

TABLE 12-2

MINIMUM EXPOSURE DISTANCE FOR 55 MPH (88.5 KM/HR) OPERATING SPEED

| Required Minimum Exposure Time (Seconds) | Minimum Exposure Distance (Feet) |
|---|---|
| 4 | 320 |
| 6 | 480 |
| 8 | 640 |

1 ft. = .304 m

TABLE 12-3

APPROXIMATE DISTANCES AT WHICH SIDE-MOUNTED SIGNS ARE OUT OF CONE OF CLEAR VISION

| Number of Freeway Lanes (One Direction) | Distance From Sign at Which The Sign is No Longer in Cone (ft) |
|---|---|
| 2 | 280 |
| 3 | 350 |
| 4 | 420 |

1 ft. = .304 m

Note: Assumes a 20-ft. (6.1 m) sign placed 20 ft. (6.1 m) from outside edge of traveled way.

TABLE 12-4

REQUIRED MINIMUM CMS LEGIBILITY DISTANCES FOR SIDE-MOUNTED SIGNS, OPERATING SPEED 55 MPH (88.5 KM/HR)

| Number of Freeway Lanes (One Direction) | Required Minimum Legibility Distance (ft.) | | |
|---|---|---|---|
| | Required Minimum Message Exposure Time | | |
| | 4 seconds | 6 seconds | 8 seconds |
| 2 | 600 | 750 | 900 |
| 3 | 700 | 850 | 1000 |
| 4 | 750 | 900 | 1050 |

1 ft. = .304 m

Data assumes a 20-ft. (6.1 m) side-mounted sign placed 20 ft. (6.1 m) outside the edge of the traveled way.

Research has shown (42, 43) that a 1/4 mile spacing of the Exit Direction Sign from the gore when Advance Guide Signs are not available does not allow drivers sufficient time to change lanes, decelerate to exit speed, and make the exit maneuver.

---

**WHEN THE EXIT DIRECTION SIGN IS TOO CLOSE TO THE EXIT RAMP GORE, THE ADVISORY CMS MUST ENCOURAGE DRIVERS TO BEGIN THEIR LANE CHANGE MANEUVERS.**

---

An example of a message that might be used is as follows:


Tables 12-5 and 12-6 present the required minimum spacing between the Exit Direction Sign and the gore for letter sizes of 20 and 16 inches (51 and 41 cm) computed using lane change distance data from Table 12-7 and a deceleration distance of 250 ft. (76.0 m) based on an initial speed of 55 mph (88.5 km/hr) to a final exit speed of 30 mph (48.3 km/hr) from Table 12-8.

TABLE 12-5

MINIMUM SPACING BETWEEN EXIT DIRECTION SIGN AND GORE-- PRINCIPAL URBAN ARTERIAL (20-INCH LETTERS)

| Number of Freeway Lanes (One Direction) | Minimum Spacing (feet) |
|---|---|
| 2 | 830 |
| 3 | 1405 |
| 4 | 1930 |

1 ft. = .304 m

TABLE 12-6

MINIMUM SPACING BETWEEN EXIT DIRECTION SIGN AND GORE-- INTERMEDIATE URBAN ARTERIAL (16-INCH LETTERS)

| Number of Freeway Lanes (One Direction) | Minimum Spacing (feet) |
|---|---|
| 2 | 935 |
| 3 | 1510 |
| 4 | 2035 |

1 ft. = .304 m

When the Exit Direction Sign is less than the distance shown in Tables 12-5 and 12-6, the advisory CMS must display a message that encourages drivers to change lanes into the shoulder lane.

TABLE 12-7

DISTANCES REQUIRED BY DRIVERS TO MOVE FROM THE MEDIAN LANE TO THE SHOULDER LANE UNDER HEAVY FLOW CONDITIONS

| Number of Freeway Lanes (One Direction) | Distance in Feet |
|---|---|
| 2 | 850 |
| 3 | 1425 |
| 4 | 1950 |

1 ft. = .304 m

TABLE 12-8

DISTANCE IN FEET REQUIRED TO DECELERATE FROM AN INITIAL TO FINAL SPEED

| Initial Speed | Final Speed, mph | | | | | |
|---|---|---|---|---|---|---|
| | 50 | 40 | 30 | 20 | 10 | 0 |
| 60 mph | 130 | 240 | 320 | 380 | 420 | 430 |
| 55 | 60 | 170 | 250 | 310 | 350 | 360 |
| 50 | 0 | 110 | 190 | 250 | 290 | 300 |
| 45 | | 50 | 130 | 190 | 230 | 240 |
| 40 | | 0 | 80 | 140 | 180 | 190 |
| 35 | | | 40 | 100 | 140 | 150 |

1 ft. = .304 m  1 mph = 1.61 km/hr

Deceleration rate: 9 $fps^2$

A question that may arise is: "How far upstream of the Exit Direction Sign should the CMS be placed?" No data are available to indicate the maximum distance that the CMS can be located upstream of the exit without drivers failing to recall the action message statements. Experience in Dallas (20), however, reveals that the CMS can be located at least 2 miles (3.2 km) upstream of the exit ramp.

# 13. TYPES AND CHARACTERISTICS OF CHANGEABLE MESSAGE SIGNS

This chapter provides a summary of the types and characteristics of available CMSs. Emphasis is placed on the characteristics that relate to the human factors aspects of the various CMSs. Special considerations, such as hybrid displays and transportable signs, are also discussed.

## A. Characteristics of Various Types of CMSs

As might be expected, the selection of the appropriate visual display is a complex task requiring trade-offs between display capability to fulfill a specific need and cost. Further complicating the selection process is the large number of signing techniques, each possessing quite different design and operating features. This section of the Chapter summarizes pertinent features of various types of CMSs with emphasis on human factors considerations. More detailed information on display types can be obtained by contacting sign manufacturers or agencies which have installed real-time information systems. A list of some of the agencies and their signing experience as of 1978 is presented in Reference 1. The reader is also encouraged to review a report entitled, "Variable Message Signing for Traffic Surveillance and Control" (44).

It should be noted that technology in the field of real-time signing hardware is increasing rapidly. One should be alert to improvements in existing hardware and development of new signing techniques subsequent to the publication of References 1 and 44.

## A.1 Static Sign

**Appearance**

- Static signs are used in support of real-time information displays. From an appearance standpoint, static signs have the same characteristics as conventional highway signs.

**Message Display**

- One and only one fixed message is continuously displayed.

**Message Storage**

- To alter the message displayed on a static sign, the sign face must be replaced or repainted.

**Uses**

- Static signs are typically used as advance or guidance signs. A special guidance usage of static signs is the "trailblazer" sign.
- Flashing beacons can be used in conjunction with static signs to produce dual status displays. The dual status capability is applicable to real-time advisory and advance signing under some conditions.

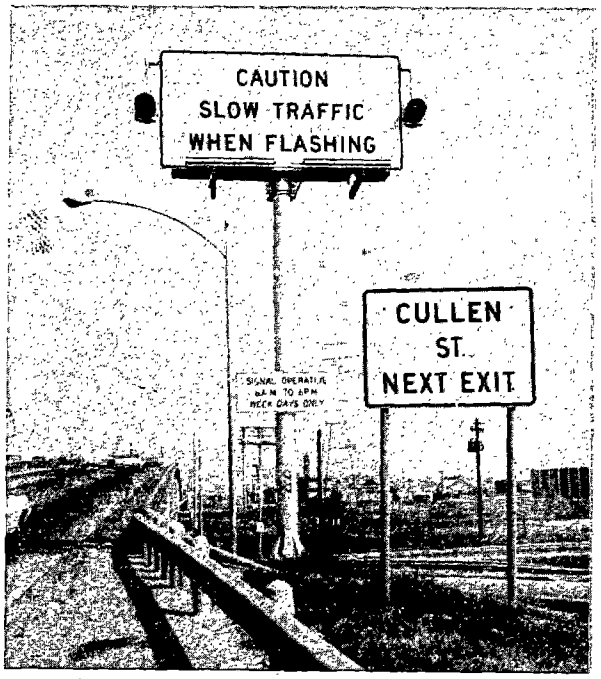



Figure 13-1. Flashing Beacon Sign in Houston, Texas


Figure 13-2. Special Event Trailblazer Sign in Dallas, Texas

## A.2 Fold-out (Flap) Sign

**Appearance**

- A fold-out sign is a conventional highway sign with a hinged viewing face. When the hinged face is opened, drivers view the front of the sign face. When closed, only the back side of the hinged section is visible.
- Any color can be incorporated into the message(s) or background.
- Exact shaped and standard lettering types can be displayed.

**Message Display**

- Individual messages are statically displayed.
- Message changing can be affected manually or by a motor-driven assembly.
- Time required to change messages varies from one to several seconds. However, under normal applications, message change time may not be critical.

**Message Storage**

- Two separate messages can be displayed on a fold-out sign (one message may be a blank sign face).
- To alter one or both of the messages, the sign face must be replaced or repainted.

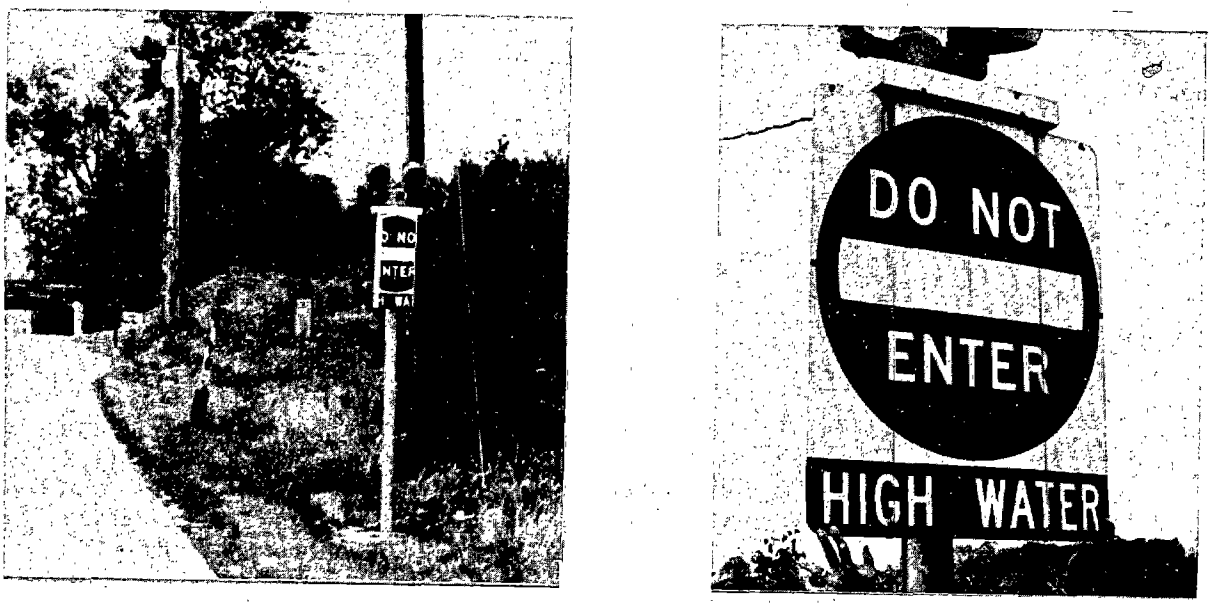



Figure 13-3. Electromechanically Operated Fold-Out Sign at High Water Crossing

## A.3 Blank-Out Sign

### Appearance

- The viewing faces of the various blank-out sign designs are somewhat different in appearance. Various design configurations include:

  1. Formed neon-type clear gas tubing on a painted background.

  2. Grid-type gas tubing behind a "cut-out" legend.

  3. Fluorescent lamps behind a "cut-out" legend.

  4. A single fluorescent lamp behind an alzak reflector.

- Any color combination may be employed on the viewing face.

- Exact shapes may be displayed on most designs.

### Message Display

- A message is displayed only when the sign (or a portion of the sign) is illuminated (on-off operation). Otherwise, the viewing face is blank.

- Message changing is instantaneous. All or part of the sign message can be illuminated at one time, depending on sign design.

### Message Storage

- Fixed messages are printed or formed onto the sign face at the time of sign fabrication. Only these messages can be displayed.

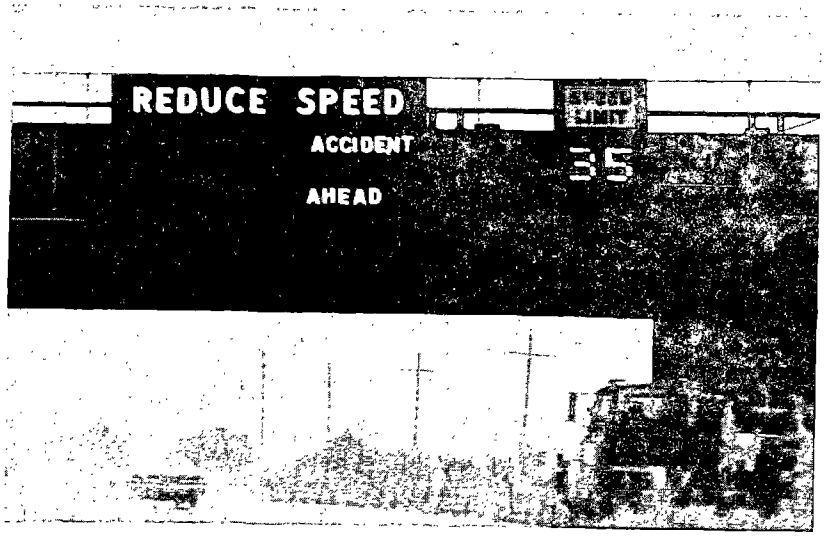



Figure 13-4. Neon-Type Blank-Out Sign on the New Jersey Turnpike

## A.4 Rotating Drum Sign

### Appearance

- Typically, the viewing face is similar in appearance to that of a conventional highway sign. Most designs use either raised sheet metal letters on a painted aluminum background or spray masked lettering on a painted wood, aluminum, or translucent plastic background to form messages.
- Messages may be back illuminated if desired.
- Any color may be incorporated into the message or background.
- Exact shapes and standard lettering types can be displayed.

### Message Display

- Messages are displayed by rotating the drum(s) to the appropriate viewing position. An individual message line or "blank" can be displayed on each drum side.
- Drums can be rotated singularly or in unison.
- Drum rotating speeds range from 1 to 10 rpm. Therefore, approximately 2.0 seconds would be required to rotate a triangular drum to a new message position at the fastest rotating speed (10 rpm).
- In the process of drum rotation, undesired messages may become visible for a short period of time.

### Message Storage

- The number of stored messages is theoretically equal to the product of the numbers of sides per drum. For example, a four-drum sign with triangular drums could display 81 (3 x 3 x 3 x 3) unique messages.
- Typically, rotating drum signs have no more than four drums and display up to 12 unique messages. Triangular and square drums are most common.
- If desired, drum-face panels can be manually removed and replaced with newly fabricated panels. This allows changing of stored messages.

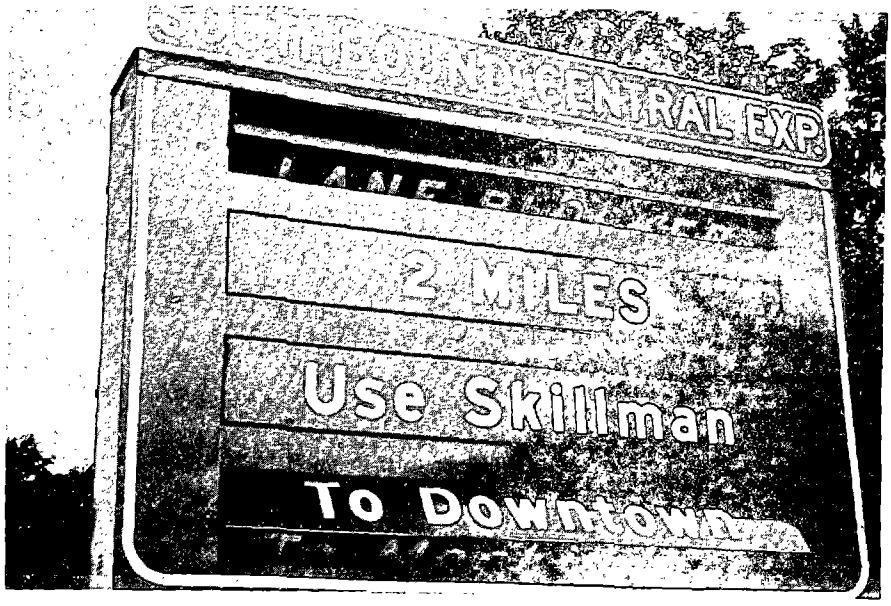



Figure 13-5. Rotating Drum Sign in Dallas, Texas

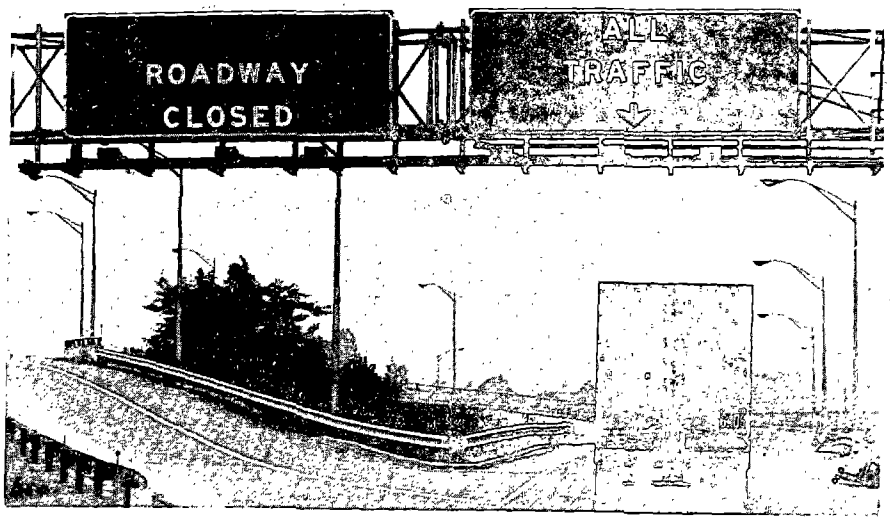



Figure 13-6. Rotating Drum Signs of the New Jersey Turnpike

## A.5 Rotating Tape (Scroll) Sign

### Appearance

- The viewing face is formed by flexible cloth or plastic material stretched between rollers on which messages are printed using a silk screen or spray masking process.
- In many instances, the material is translucent, permitting back illumination.
- Any color may be incorporated into the message or background.
- Exact shapes and standard lettering types may be displayed.

### Message Display

- Messages printed on the tape are displayed by rotating the tape to the appropriate viewing position. If desired, a blank space may be left on the tape so that no message is visible when the tape is rotated to that position.
- Tapes can be vertically or horizontally rotated, depending on sign design.
- At least 1.0 second is required to rotate the tape (change messages) to an adjacent message or blank space.
- In the process of tape rotation, undesired messages may become visible to drivers. To correct this problem, some designs employ a curtain device during message changing.

### Message Storage

- Depending on the sign design, anywhere from 2 to 30 printed messages can appear on a tape.
- Typically, no more than 12 messages are printed on a tape. With a larger number of messages, the time to change to a message located at a distant point on the tape becomes unreasonable for some applications.
- Message storage changes require tape replacement or alteration.


Figure 13-7. Scroll Sign Mounted at the Portal of the Lincoln Tunnel in New York


Figure 13-8. Rotating Tape Signs on I-70 near Dillion, Colorado

## A.6 Bulb-Type Matrix Sign

### Appearance

- The viewing face is formed by an array of incandescent light bulbs affixed to a dark background surface. The light bulb array can either be a continuous field of bulbs or a fixed number of matrix modules (small banks of bulbs with "bulbless" areas between banks).

- Use of color is normally limited to a two-color combination. Typically, the bulbs are white and the background surface is flat black.

- Exact shape presentation or the display of lower case lettering types is not possible.

### Message Display

- Messages can be displayed statically, flashed on and off, sequenced, or run-on. In its simplest form, the bulb-type matrix sign can be operated as an on-off "blank-out" sign.

- Changing of messages is almost instantaneous. All or part of a message can be changed at one time.

- Typical displays currently used on highways have up to 4 lines of copy; the number of alphanumeric characters per line ranges between 12 and 20. Character heights from 12 to 18 inches (30-46 cm) have been used, although larger letters are available.

### Message Storage

- Storage is effected in one of two ways, depending on design.

    1. Messages are pre-coded onto printed circuit boards using Programmable Read-Only Memory units (PROMs), Read-Only Memory units (ROMs), or Erasable Programmable Read-Only Memory units (EPROMs). The number of available messages is fixed. Replacing one of the existing messages requires removal and replacement of an existing PROM, ROM, or EPROM, or reprogramming of an EPROM.

    2. Storage can be accomplished by inputting desired messages into the memory banks of an on-line computer utilizing conventional software (punch cards, teletype, magnetic tape, etc.).

- Current operational systems have maximum storage capacities ranging from 10 (method 1) up to 160 (method 2) messages.


Figure 13-9. Bulb-Type Matrix Sign in Los Angeles, California


Figure 13-10. Bulb-Type Matrix Sign in Houston, Texas

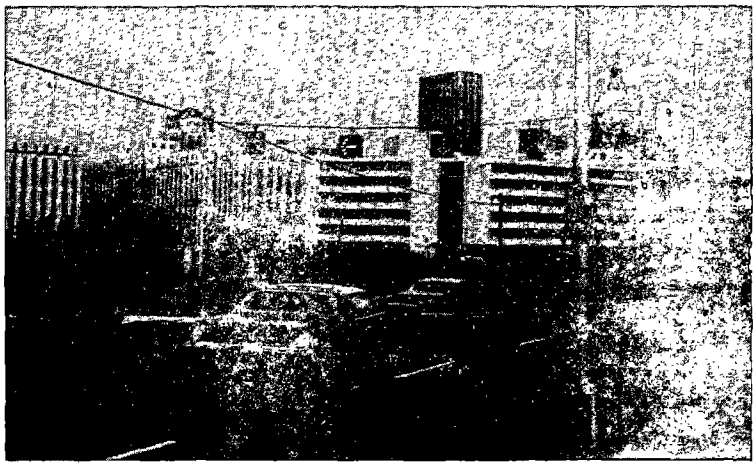


Figure 13-11. Bulb-Type Matrix Lane Control Signals in Atlanta, Georgia

## A.7 Disk-Type Matrix Sign

### Appearance

- The viewing face is formed by an array of permanently magnetized, pivoted, disk-shaped indicators inset on a dark background surface. By electromagnetically actuating appropriate disks (they rotate to reveal a brightly colored side), messages are displayed.
- Modular array designs are most common.
- Use of color is normally limited to a two-color combination. Typically, disks are brightly colored on one side (white or yellow) and flat black on the other.
- The matrix array of disks prohibits exact shape presentation and the display of lower case lettering types.

### Message Display

- Messages can be displayed statically or flashed on and off using a simulated flashing mode.
- Message change is effected by sequential writing across the sign face. One of two methods is employed:

  1. Module-by-module/line-by-line writing.
  2. Column-by-column writing.

- The first method requires about 1.0 second to change a 20 character line. The second method is considerably faster, but requires much more control hardware.
- With either method, portions of both the old and new messages are visible during the change phase unless the sign is blanked before writing the new message. Blanking, however, increases write time.
- Character heights from 12 to 18 inches (30 to 46 cm) are common on designs applicable for highway use.

### Message Storage

- Storage considerations are the same as those discussed in the description of bulb-type matrix signs.

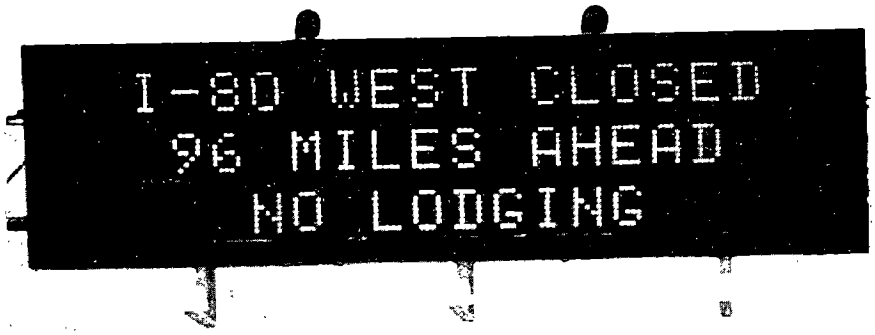



Figure 13-12. Modular Disk-Type Matrix Sign in Cheyenne, Wyoming

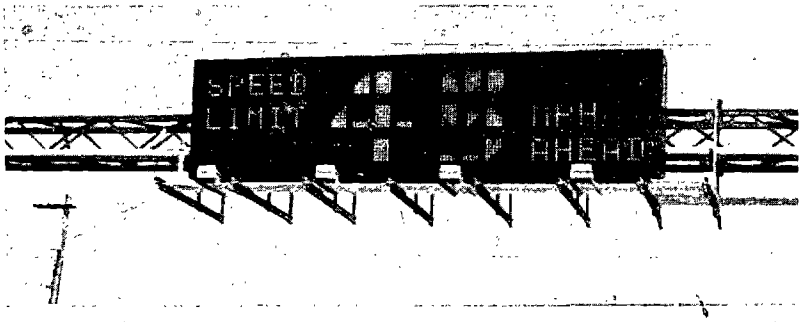



Figure 13-13. Disk-Type Matrix Sign near Pittsburgh, Pennsylvania

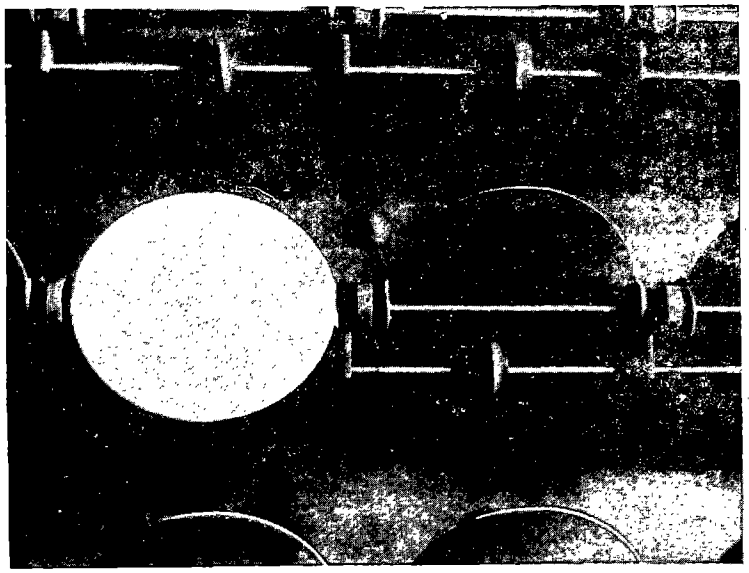


Figure 13-14. Close-Up View of Reflectorized Disk Indicators

## A.8 Electrostatic Vane Matrix Sign

### Appearance

- The viewing face consists of a number of modules closely fitted such that no separation between modules is apparent; each module contains many iridized aluminum vanes. Each vane is electrostatically moved to one of two positions (up or down) and, depending on vane position, one of two colors is visible.

- Exact shapes cannot be displayed, but newer designs employ 0.5 square-inch vanes which permit fairly accurate shape representation.

### Message Dispaly

- Normally, messages are statically displayed; however, some designs permit a flashing mode.

- Changing of messages is usually accomplished by sequential column-by-column writing.

- Depending on the control system, message change times vary from 50 milliseconds to 45 seconds; typical displays applicable for highway use require 30 seconds to change an entire message.

- Letter heights ranging from 2 1/2 to 18 inches (6 to 46 cm) are available.

### Message Storage

- Message storage capabilities are similar to those discussed in the section on bulb-type matrix signs.

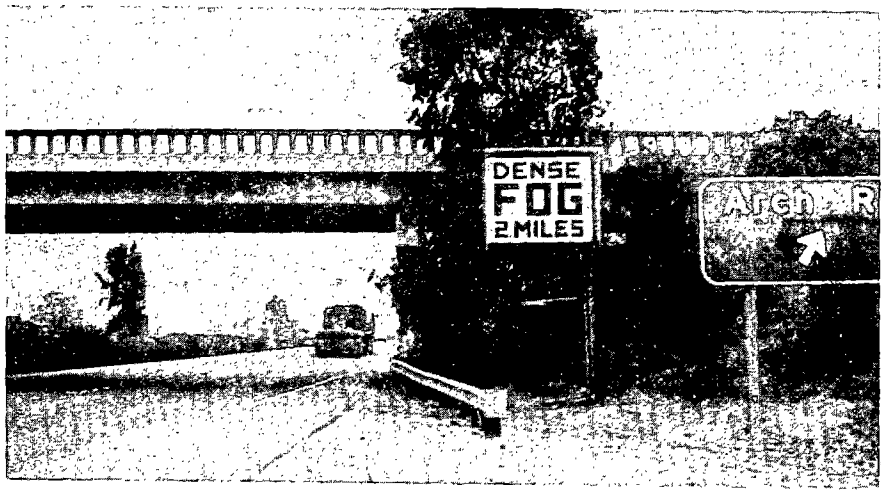



Figure 13-15. Electrostatic Vane Matrix Sign Installed on Highway 99 near Stockton, California

## A.9 Flap Matrix Sign

### Appearance

- The viewing face is formed by a matrix arrangement of electromechanically actuated flaps.
- Current designs are modular, employing 5 x 7 modules or 31 flap figure-grams.
- Flaps have two positions, up or down, and reveal one of two colors.
- A white-on-black color combination is typically utilized.
- Exact shape presentation or display of lower case lettering types is not possible.

### Message Display

- Normally, messages are statically displayed.
- Module-by-module/line-by-line writing is employed to change messages on current designs.
- At least 2.0 seconds are required to change a complete line of copy. Up to 10 seconds are required to change the entire message.
- Unless blanked prior to changing messages, parts of the old and new messages will be visible during the message changing process.
- Character heights from 14 to 18 inches (36 to 46 cm) are available.

### Message Storage

- Like other matrix signs, storage depends on the type of control. However, the few flap matrix signs in operation are "hardwired" for up to 10 messages per line.

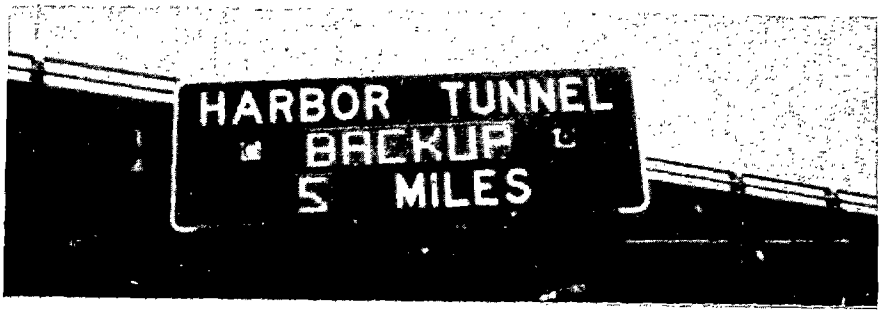



Figure 13-16. Electromechanical Flap Matrix Sign Installed on King Avenue Overpass in Baltimore, Maryland

## A.10 Fiber Optic Sign

### Appearance

- Light radiated from an internal point source is directed to the sign's viewing face through a bundle of optically polished glass fibers. On the sign face, these light-emitting glass fibers can be arranged in a matrix array (alphanumeric character formation).

- Through the use of individual color filters, any color combination can be utilized. However, normally only two colors are employed in traffic signing applications.

### Message Display

- A message is displayed only when the internal light source(s) is (are) activated.

- Messages can be displayed statically of flashed on and off. Normally, fiber optic displays are operated as on-off "blank-out" signs.

- Message changing is almost instantaneous.

### Message Storage

- All stored messages are "hardwired" with each message requiring an individual light source and fiber bundle. Generally, the maximum storage capacity is around 15 separate "hardwired" messages.

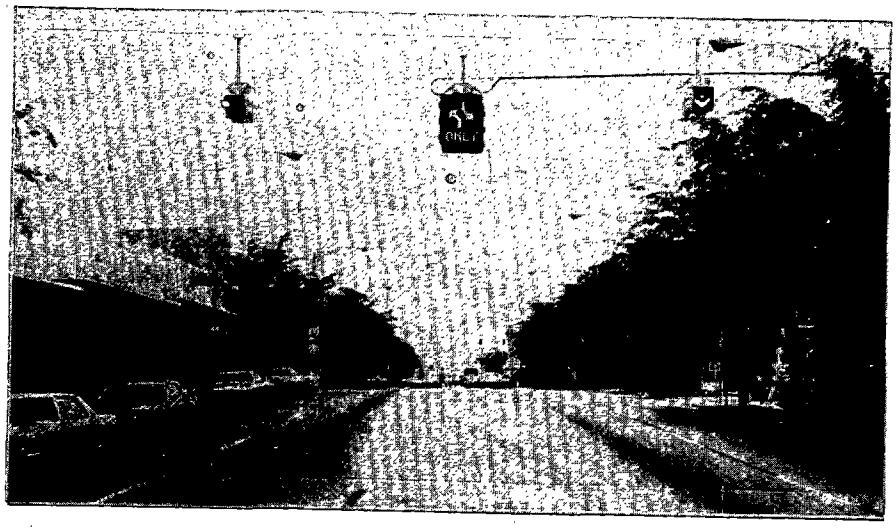


Figure 13-17. Fiber Optic Signs Installed on 7th Avenue in Miami, Florida

## A.11 Tri-Color Sign

### Appearance

- The viewing face is formed by a matrix of 2 1/2 inch square rotating tri-color elements.
- The elements reveal one of three colors (e.g., white, black and fluorescent yellow; thus, several color combinations of letters and backgrounds can be displayed.
- A typical freeway mounted sign may contain 2,430 elements (27 rows x 90 columns).

### Message Display

- Normally, messages are statically displayed.
- Control codes are available to change font size, shape, color, and spacing.
- Font size can be changed to range from 4 wide to 6 wide and 5 high to 9 high. Thus, the following character sizes can be displayed: a) 4 lines of text with 4 x 5 font, b) 4 lines with 4 x 7 font, c) 3 lines with 5 x 7 font, d) 2 lines with 5 x 9 font, and e) double stroke.
- The font fields can be adjusted by the sign operator so that different fonts can be mixed on the same line of text.
- The sign elements can be rotated quickly to provide a pseudo flashing message.

### Message Storage

- Storage considerations are the same as those discussed for the bulb-type matrix signs.

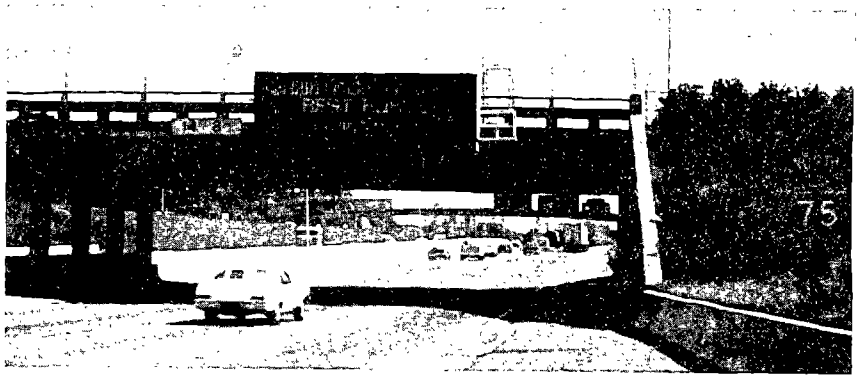



Figure 13-18. Tri-Color Sign in Detroit, Michigan

## B. Special Considerations

### B.1 Hybrid Displays

A hybrid display results when two or more of the signing techniques discussed in the previous section are incorporated in a single display. Hybrid signs typically, though not always, employ a combination of static and changeable elements. Under some circumstances, this combination affords certain advantages:

- Some CMSs require one or two lines of copy or a part of a line or lines which do not vary with the message being displayed. By using a static (conventional sign) element for the fixed portion of the message, cost savings related to materials, fabrication, maintenance, and power consumption can be achieved.

- Some CMSs (e.g., bulb and disk matrix signs, fiber optic signs, etc.) have limited shape and color display capabilities. Therefore, a static (conventional sign) element on which desired shapes and colors are displayed can be used in combination with these CMSs.

Hybrid signs also have drawbacks in some applications:

- Invariably, the use of a fixed message element with a changeable message element will reduce the message flexibility of the changeable element and the display as a whole.

- If an internally lighted changeable message element is used with a static (conventional sign) element, the static portion may be washed-out by the intense, internal light source.

Figure 13-19 illustrates typical hybrid displays currently in operation.

### B.2 Transportable Signs

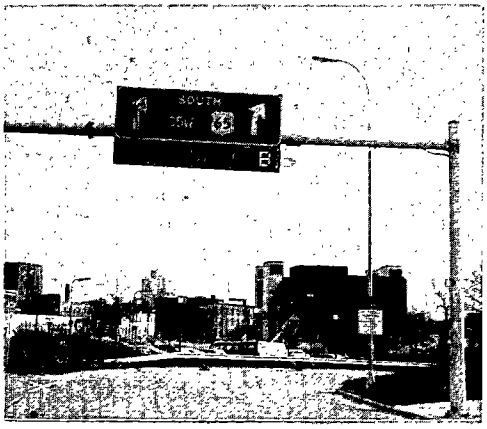
In some situations, it may be desirable to utilize transportable signs to display real-time information. Types of transportable signs include the following:

- Truck- or trailer-mounted signs

- Pick-up signs (leg-supported signs which can be placed in a truck or trailer, hauled to a site, and set out on the roadside)

- Ground-mounted signs with removable, transportable message panels.

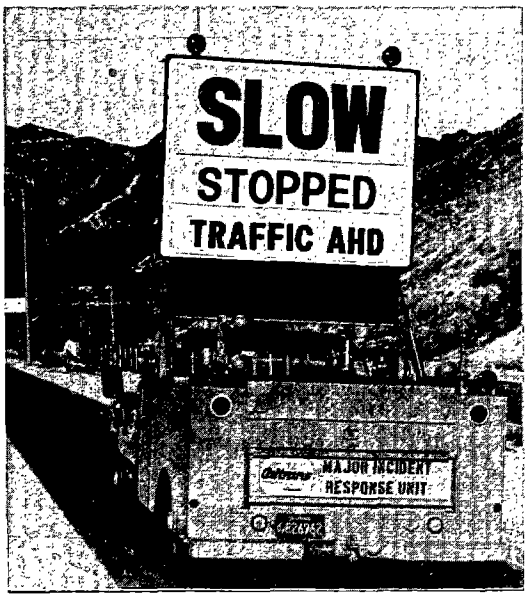
Examples of the use of truck-mounted signs in response to major incidents are the Caltrans Major Incident Response Units (Figure 13-20). The message




Bulb-Type Matrix and Static Sign Elements
Used in Combination in Minnesota


Hybrid Display in Philadelphia, Pennsylvania

Figure 13-19. Typical Hybrid Displays



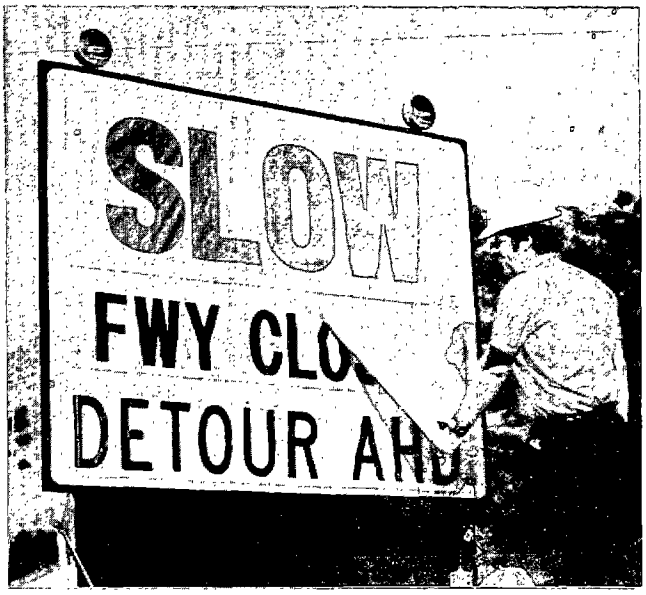





Figure 13-20. Truck-Mounted Cloth Sign and Matrix Sign, Caltrans

inserts are signs mounted on a rigid-frame support. A library of message inserts is stored on each truck, and messages are displayed in various combinations as dictated by the situation. The Caltrans response team also utilizes bulb-type matrix signs mounted on the back of pick-up trucks to manage traffic during incident conditions. The response team is on call at all times, thus reducing response time to a minimum (45).

Trailer-mounted signs are used by several Districts of the Texas State Department of Highways and Public Transportation. Although these signs have the capability to respond to unexpected incidents of considerable duration, their primary function is in response to recurring or scheduled events. Figure 13-21 illustrates one of these signs displaying a message that was used prior to major maintenance activities on a freeway in Houston, Texas. A message displayed several days in advance of scheduled work activities permits regular freeway users to plan alternate routes or adjust their time of freeway travel. The trailer on which the sign is mounted is designed to permit easy parking of the sign on the separation area between the main lanes and the service road.

Another example of a trailer-mounted sign is the bulb-type matrix sign shown in Figure 13-22. This sign has almost unlimited message capabilities and can be moved to virtually any location where power is available. It is shown here in a closed U-turn lane on an expressway overpass. This type of trailer-mounted sign may have limitations with respect to response time, size, and power requirements; it is best suited to predictable events.

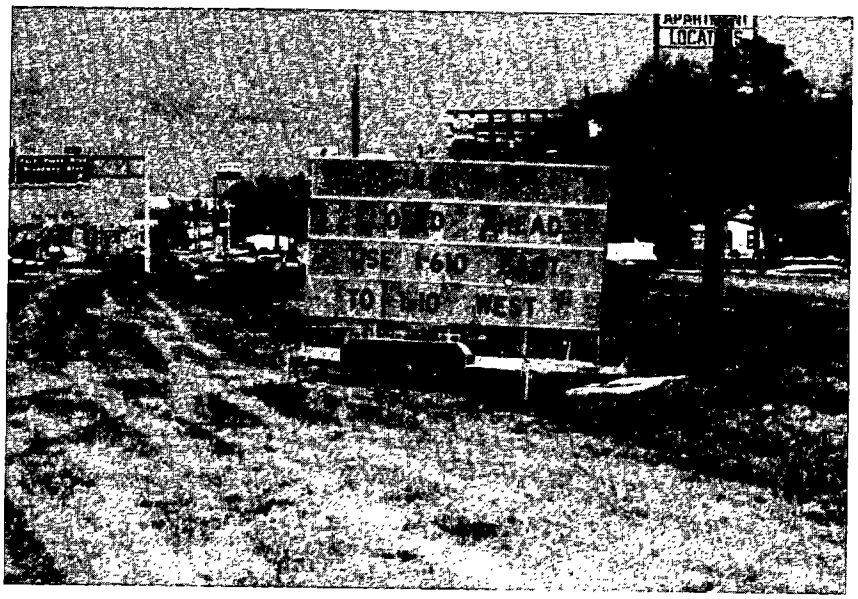


Figure 13-21. Trailer-Mounted Changeable Message Sign in Houston, Texas


Figure 13-22. Trailer-Mounted Bulb-Type Matrix Sign in Dallas, Texas

## 14. LANGUAGE STYLE AND MESSAGE FORMAT, LOAD, LENGTH, AND REDUNDANCY

### A. Language Style

In regard to language style, there are at least three ways of aurally presenting a message designed to influence the driver's choice of route. These styles are staccato, short form, and conversational.

---

**FOR MAXIMUM RECALL AND DRIVER ACCEPTANCE, AUDIO MESSAGES SHOULD BE PRESENTED IN SHORT OR STACCATO STYLE. AVOID THE CONVERSATIONAL STYLE WHEN A COMPLEX MESSAGE IS TO BE PRESENTED (13).**

---

HAR messages should be held to the minimum number of words necessary to communicate essential information. The language style should be concise. This is particularly important for diversion type messages especially where as many as 10 or more pieces of information must be recalled by drivers.

Drivers prefer short messages rather than long, wordy, conversational-style messages. They are also more likely to recall the important information if there are no "dead words" in the message.

#### A.1 Staccato

This is a spoken version of what might be termed "sign-ese," the language written on highway signs. The style is terse and telegraphic. An example of a correct concise message is as follows:

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC
- ACCIDENT AT ROWLAND AVENUE
- HEAVY CONGESTION
- USE SERVICE ROAD
- TO CARTER CREEK

#### A.2 Short Form

The short form or extended message is expressed in sentence format rather than brief phrases. The style is somewhat like that used for secondary headlines in newspapers, and is similar to that used in advertising messages on radio and television. An example of an acceptable extended message is as follows:

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC
- THERE IS AN ACCIDENT AT ROWLAND AVENUE
- THE CONGESTION IS HEAVY
- YOU ARE ADVISED TO USE THE SERVICE ROAD
- EXIT AT MONROE AND RE-ENTER NORTH OF CARTER CREEK

### A.3 Conversational

This is a spoken message much like drivers would hear on commercial radio or television. The message is correct English with appropriate arrangement of words and phrases into sentences as in the spoken language, but is unacceptably wordy. An example of an unacceptable wordy message is as follows:

- ATTENTION ALL TRAFFIC HEADED NORTH ON THE CENTRAL EXPRESSWAY
- AN ACCIDENT OCCURRED ON THE CENTRAL FREEWAY AT ROWLAND AVENUE
- YOU ARE ADVISED TO BYPASS THE CONGESTION BY USING THE SERVICE ROAD
- TAKE THE MONROE EXIT, USE THE SERVICE ROAD AND RE-ENTER THE CENTRAL FREEWAY AT A RAMP NORTH OF CARTER CREEK AVENUE
- PLEASE DRIVE SAFELY AND THANK YOU FOR LISTENING TO THE (State) HIGHWAY ADVISORY RADIO SYSTEM FOR TIMELY REPORTS

The above conversational message has many needless words and phrases. As previously seen, the attention statement can be shortened to eliminate unnecessary words (e.g., ALL, HEADED). The fact that the accident occurred on the Central Freeway should be obvious from the attention statement. The bypass instructions can be shortened without loss of understanding. Thanking the driver for listening sounds commercial and possibly annoying.

A distinction should be made between a wordy message and a long message. A wordy message uses many words to make only a few points (e.g., those points in the concise message above). A long message will also require many words, but it may also have a large number of important points that need to be communicated. Some HAR applications may require long messages (when HAR transmission zone permits) because a variety of information required by many, if not all, drivers needs to be transmitted (e.g., tourist information) (46).

## B. Message Format

Important issues related to the message include the format (ordering of message elements) and content.

The content of a message depends principally upon the particular situation in which it is broadcast, the composition of the driver population, the availability of trailblazers, etc.

The format of an audio message is also somewhat variable. However, there are several general principles for organizing audio messages for incident management and point diversion (13).

- The first statement in an audio message should be an attention statement alerting a facility user group or a particular destination group to attend to the message.

- The second message statement should give the problem (accident, construction, roadwork, etc.) and, in longer messages, the location of the problem followed by an effect on traffic (congestion, delay, lane blockage).

- The final message should be an action message statement advising drivers what they should do about the problem. Action message statements vary from simple to complex. A simple message statement, for example, may tell drivers to exit and use the service road, or exit and follow the marked route (marked with trailblazers). A complex message statement describes the route which should be followed.

- When the initial attention statement addresses the facility user group and the action message statement applies only to a select destination group, an additional attention statement addressing the destination group must be included prior to the action message statement.

Examples of three typical messages are illustrated below.

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC — Attention
  THERE IS AN ACCIDENT AT ROWLAND — Problem
  CONGESTION IS HEAVY — Effect
  YOU ARE ADVISED TO USE THE SERVICE ROAD
  EXIT AT MONROE AND REENTER NORTH OF CARTER CREEK — Action

- ATTENTION KYLE STADIUM TRAFFIC — Attention
  TO AVOID A MAJOR DELAY — Effect
  USE OXFORD AVENUE TO KYLE STADIUM — Action

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC — Attention
  THERE IS AN ACCIDENT AT ROWLAND — Problem
  CONGESTION IS HEAVY — Effect
  DOWNTOWN TRAFFIC — Attention
  IS ADVISED TO USE CARSON AVENUE — Action

---

**SINCE BROADCAST TIME IS AT AN ABSOLUTE PREMIUM, INFORMATION CONCERNING THE FACT THAT THE MESSAGE IS COMING FROM A CONTROL CENTER SHOULD BE OMITTED.**

---

This information is implied by either the advance sign directing drivers to the broadcast frequency or by the distinctive alerting signal at the beginning of the message.

## C. Message Load (Unit), Length, and Redundancy

The message **load** as used in the Manual refers to the informational "load" in the message expressed in terms of "units" of information. Message **length** refers to the number of words in the message and the associated pre- sentation time. The various language styles discussed in Section A were equivalent in message load yet varied in length.

The **information unit** refers to each separate data item given in a message which a motorist could recall and which could be a basis for making a decision. A unit usually consists of a noun and its modifiers, and may include a verb. The following example of the message shown in Section A.3 serves to illustrate the concept of information units:

| | Question | Info. Unit Required |
|---|---|---|
| 1. | Who is the message addressed to? | Northbound Central Freeway Traffic |
| 2. | What happened? | Accident |
| 3. | Where? | At Rowland Avenue |
| 4. | What effect on traffic? | Heavy Congestion |
| 5./6. | What is advised? | Use Service Road to Carter Creek |

Hence, the message contains six units of information. If the drivers are told to "turn left" or "go north," these are also informational units. For example, the following message contains 12 units of information:

- ATTENTION SOUTHBOUND INTERSTATE 75 TRAFFIC
- ACCIDENT AT POULSON ROAD
- TO BYPASS THE ACCIDENT, YOU ARE ADVISED TO
- EXIT AT KINGMAN ROAD
- TURN RIGHT ON KINGMAN
- LEFT ON ANDERSON
- AND LEFT ON RILEY
- BACK TO INTERSTATE 75

**Note that the action message statement contains eight units of information (underlined).**

**RESEARCH (13) HAS FOUND THAT DRIVERS TEND TO FILTER AUDIO INFORMATION (LOAD SHED) AND, IN LONG MESSAGES, WILL RECALL PROPORTIONALLY MORE OF WHAT IS MOST CRITICAL TO THEM: THE ADVISORY AS TO WHAT THEY SHOULD DO (ACTION MESSAGE STATEMENT).**

Diversion action message statements can be discussed in terms of the minimum number of units of information necessary to describe the route. Thus, an action message statement with a "]" pattern diversion route involves recalling exit location, the names of the three "legs" of the route, and three directions of turns. (The name of the primary freeway and the last turn back to the freeway should be well understood.) Therefore, the message will contain an 8-unit action message statement.

**Redundancy** is a concept which has been employed in several different ways. It is discussed in greater detail in Chapter 3, Section E. **External redundancy** is used in this Manual to describe a repetition of either the complete message or the key message elements, and in this sense is equivalent to an additional opportunity to learn the important message elements. **Internal redundancy** refers to repeating certain key words in a message immediately after they have been given the first time. As an example, "Turn right on Kingman and take Kingman to Anderson" would have internal redundancy for the street name Kingman.

**FOR MAXIMUM RECALL, DRIVERS MUST HEAR THE MESSAGE AT LEAST TWICE.**

There is a significant reduction in performance if drivers hear the message only once.

**INSTRUMENTED VEHICLE STUDIES (37) INDICATE THAT ABOUT 90 PERCENT OF UNFAMILIAR DRIVERS CAN FOLLOW A DIVERSION ROUTE DESCRIBED BY AN 8-UNIT ACTION MESSAGE STATEMENT CONSISTING OF STREET NAMES AND TURNING MOVEMENTS, PROVIDED THAT EITHER THE STREET NAMES ARE REPEATED WITHIN THE MESSAGE (INTERNAL REDUNDANCY) OR THE DRIVERS HEAR THE ACTION MESSAGE STATEMENT AT LEAST TWICE (EXTERNAL REDUNDANCY). EIGHT UNITS IS THE DESIGN LIMIT OF AUDIO RETENTION WHEN THE UNITS ARE CRITICAL TO ROUTE FOLLOWING. THEREFORE, KEEP THE DIVERSION ROUTE SIMPLE.**

The problem of following a "]" or a "[" pattern diversion route is not as difficult as might be supposed because: (a) the direction of turns, after the

first, can largely be anticipated, and (b) the task involves essentially recognition of street names on signs, rather than absolute recall.

Research (13, 47) indicates that drivers encounter some diffi- culty in being able to recall all elements of audio messages following some time delay after hearing it. However, information processing while driving on a highway is a less difficult type of memory task. It is a recognition pro- cess whereby drivers merely associate visual messages (i.e., street name signs) with previous audio messages. Studies (13, 37) have shown that, although drivers encounter difficulties in repeating the entire audio message, they perform much better when following a route given in an audio message. The better performance is attributed to the drivers' need to only recognize street name signs at intersections rather than to recall them.

A suggested approach is to

---

**REPEAT THE ENTIRE MESSAGE WHEN IT IS SHORT. FOR LONG MESSAGES INVOLVING DETAILED DIVERSION INSTRUCTIONS, IT IS ACCEPTABLE AND MORE PRACTICAL TO REPEAT ONLY THE ACTION MESSAGE STATEMENT (AND ATTENTION STATEMENT IF THE DIVERSION INFORMATION APPLIES ONLY TO A SELECTED PORTION OF THE FREEWAY DRIVERS HEADING TO ONE OR MORE SPECIFIC DESTINATIONS).**

---

An example of repetition of the action message statement is as follows:

- ATTENTION SOUTHBOUND INTERSTATE 75 TRAFFIC
  THERE IS AN ACCIDENT AT POULSON
  CONGESTION IS HEAVY
  TO BYPASS THE ACCIDENT, YOU ARE ADVISED TO
  EXIT AT KINGMAN ROAD
  TURN RIGHT ON KINGMAN
  LEFT ON ANDERSON
  AND LEFT ON RILEY
  BACK TO INTERSTATE 75

  I REPEAT:
  TO BYPASS THE ACCIDENT, YOU ARE ADVISED
  TO EXIT AT KINGMAN ROAD
  TURN RIGHT ON KINGMAN
  LEFT ON ANDERSON
  AND LEFT ON RILEY
  BACK TO INTERSTATE 75

While a message may be defined in terms of "load," the driver's success in retaining the information and using it in route following depends upon whether the information is truly new to him or whether it may be anticipated in part from his knowledge of the situation. Thus, commuters and other familiar drivers can recall substantially more of an audio route diversion

message than would an unfamiliar driver (37). Drivers who are familiar with the parallel arterial (Anderson) can follow a route presented in a shorter message that omits turning movements.

Example:

...TO BYPASS THE ACCIDENT, YOU ARE ADVISED
TO EXIT AT KINGMAN ROAD
TAKE ANDERSON
TO RILEY
AND RETURN TO INTERSTATE 75

---

**FOR COMPLEX DIVERSION ROUTES REQUIRING MORE THAN AN 8-UNIT ACTION MESSAGE STATEMENT (DIVERSION MESSAGE), TRAILBLAZERS MUST BE USED ALONG THE DIVERSION ROUTE (13,37).**

---

There are three basic audio message approaches when trailblazers are used along the diversion route:

- Give a detailed description of the diversion route and tell drivers to follow the marked route.
- Do not give a detailed description of the diversion route, but tell drivers where to exit and to follow the marked route.
- Do not give a detailed description of the diversion route, but tell drivers which route to use (e.g., use Fitzhugh Avenue).

---

**IT IS NEITHER NECESSARY NOR ADVISABLE TO GIVE A DETAILED DESCRIPTION OF THE DIVERSION ROUTE WHEN A TRAILBLAZER SYSTEM IS AVAILABLE.**

---

Giving a detailed description of the diversion route when trailblazers are available increases the length of the message. Also, research (13) has found that the simpler message telling the drivers to follow the marked route results in more drivers being able to follow the diversion route than if the full description of the diversion route were included in the audio message.

### C.1 Minimum Broadcast Distances

As previously indicated, **message length** refers to the number of words in a message. With audio messages, it is important that the action message

statement, as a minimum, be heard at least twice while the driver is still within the broadcast transmission area.

Added to the required message broadcast time is a period for the alerting signal and/or pause required each time the message is presented to delineate the beginning and end of the message.

Another factor that must be considered in determining the minimum time to broadcast a message, and consequently, the minimum broadcast distance, is the probability of drivers entering the radio zone after the beginning of a message. In this case, drivers would not hear the message twice for maximim recall. A practical solution is to add a period of time necessary to repeat one-half the message.

In summary,

---

**THE MINIMUM MESSAGE BROADCAST TIME IS THE SUM OF THE FOLLOWING COMPONENTS:**

- **TIME TO BROADCAST THE MESSAGE ONCE.**
- **TIME FOR AN ALERT SIGNAL AND/OR PAUSE TO DELINEATE THE BEGINNING AND END OF THE MESSAGE**
- **TIME TO REPEAT THE ACTION MESSAGE STATEMENT OR THE ENTIRE MESSAGE**
- **TIME FOR THE ALERT SIGNAL AND/OR PAUSE AFTER REPEATING THE MESSAGE**
- **TIME TO REPEAT ONE-HALF THE MESSAGE**

---

As an example: for a 14-second message with a 3-second alert signal and/or pause, the minimum message broadcast time would be 41 seconds (14 + 3 + 14 + 3 + 7 = 41) if the entire message was repeated rather than just the action message statement. As discussed in Chapter 17, a message of 35 to 40 words can be broadcast in 14 seconds at normal delivery speed.

Table 14-1 presents minimum transmission distances required to receive radio messages of various broadcast times as a function of the freeway operating speed. For the example in the previous paragraph, a minimum broadcast distance of about 3600 ft. (1097 m) would be required for drivers to hear the 14-second message 2 1/2 times at an operating speed of 60 mph (96.5 km/hr).

TABLE 14-1

MINIMUM BROADCAST DISTANCES (FEET)

| Minimum Message Broadcast Time (Seconds) | Operating Speed (mph) 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|
| 10 | 300 | 440 | 590 | 740 | 880 |
| 20 | 590 | 880 | 1180 | 1470 | 1760 |
| 30 | 880 | 1320 | 1760 | 2200 | 2640 |
| 40 | 1180 | 1760 | 2350 | 2940 | 3520 |
| 50 | 1470 | 2200 | 2940 | 3670 | 4400 |
| 60 | 1760 | 2640 | 3520 | 4400 | 5280 |
| 120 | 3520 | 5280 | 7040 | 8800 | 10560 |

1 ft. = .304 m

1 mph = 1.61 km/hr

## C.2 Techniques for Reducing Message Length

As a message designer you may be faced with a need to shorten the message or to improve the manner of presentation so as to meet broadcast time constraints. The following is a summary of guidelines for accomplishing this objective:

- Reduce the message content and load by displaying only the most critical information:

  a. Display only one effect of the problem, or delete the effect statement.

  b. In repeating the message, repeat only the action statement.

  c. Avoid redundant information such as the jurisdiction agency (control center) presenting the message.

  d. Limit the alert signal to 3 seconds.

e. In describing incidents, use one- and two-word generic descriptors (accident, roadwork) rather than highly specific descriptors.

- Employ an efficient manner of presentation:

  a. Use a terse language style rather than conversational.

  b. Talk at a radio speaker's rate of delivery (175 words/minute).

  c. Standardize the format or order of message elements so that listeners can anticipate the type of information coming next (e.g., the action statement).

  d. Limit the vocabulary used so that daily listeners can anticipate which of several words will be used and can more quickly process information given.

## C.3 Techniques for Improving System Design to Enhance Message Time

There are limits to the degree that a message may be shortened and still present the required information within the available broadcast time. However, there are several systems design improvements which will simplify the drivers' task and/or increase message transmission time. These are as follows:

- If possible, select a diversion route which is sufficiently simple that a listener can recall the instructions for negotiating the route. Unfamiliar drivers can recall and follow a route involving no more than three street names and associated turning movements if the message is repeated once. If a more complex diversion route is necessary, supplement the radio message with trailblazer signing.

- Provide an advance sign or sequence of signs on the highway upstream of the broadcast area. If effectively designed, the driver will be tuned to the correct frequency and ready to receive the message when it is first broadcast. This will give him an opportunity to hear the message the minimum number of times within the broadcast range.

# 15. DESIGN OF ATTENTION AND ACTION MESSAGE STATEMENTS

Advisory sign messages consist of the following elements:

- An attention statement which addresses a certain group or audience
- A problem statement (accident, roadwork, etc.)
- An effect statement (delay, heavy congestion, etc.)
- An action statement

Chapter 15 provides guidelines for the design of attention and action message statements in HAR displays.

## A. Attention Message Statements

### A.1 General

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**AN ATTENTION MESSAGE STATEMENT SHOULD ALWAYS APPEAR IN AN AUDIO MESSAGE.**

---

In contrast to a visual display that can only be read by freeway drivers in one direction of flow (in some cases by drivers entering the freeway), a message transmitted over HAR could possibly be heard by drivers in opposing traffic lanes should they be tuned to the station frequency. Therefore, an attention message statement should be used to identify the audience (facility user group) to whom the message applies. For example:

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC
- ATTENTION SOUTHBOUND INTERSTATE 95 TRAFFIC

---

**DURING NON-INCIDENT CONDITIONS FOR SPECIAL EVENT SITUATIONS WHEN THE ENTIRE MESSAGE APPLIES ONLY TO A SELECT DESTINATION GROUP, THE ATTENTION MESSAGE STATEMENT SHOULD ADDRESS ONLY THAT GROUP AND SHOULD PRECEDE ALL OTHER MESSAGE ELEMENTS.**

---

In non-incident point diversion situations (such as for special events) where only a select group is being diverted, the attention message statement should address only the select group. Other drivers in the traffic stream may

tune to the broadcast, but will immediately know that the action message statement does not apply to them. An example of a message is as follows:

- ATTENTION KYLE STADIUM TRAFFIC
  TO AVOID A MAJOR DELAY
  YOU ARE ADVISED TO
  EXIT AT ROWLAND AVENUE
  AND FOLLOW THE SIGNS TO KYLE STADIUM

---

**DURING INCIDENT SITUATIONS WHEN ONLY A SELECT GROUP OF DRIVERS IS BEING DIVERTED, TWO ATTENTION STATEMENTS ARE NEEDED. THE FIRST ATTENTION STATEMENT ADDRESSES THE ENTIRE FACILITY USER GROUP IN THE SPECIFIC DIRECTION OF TRAVEL AND APPEARS AT THE BEGINNING OF THE MESSAGE. THE SECOND ATTENTION STATEMENT ADDRESSES THE SELECT DESTINATION GROUP BEING DIVERTED AND COMES IMMEDIATELY BEFORE THE ACTION MESSAGE STATEMENT.**

---

When an incident occurs on the freeway, all drivers should be informed of the problem and its effects. The message must be specific as to who should react to the action statement. Examples of messages illustrating this principle are as follows:

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC
  THERE IS AN ACCIDENT AT ROWLAND AVENUE
  CONGESTION IS HEAVY
  DOWNTOWN TRAFFIC IS ADVISED TO
  USE CARSON AVENUE

- ATTENTION NORTHBOUND CENTRAL FREEWAY TRAFFIC
  THERE IS AN ACCIDENT AT ROWLAND AVENUE
  CONGESTION IS HEAVY
  THE BEST ROUTE TO KYLE STADIUM
  IS TO USE OXFORD AVENUE

### A.2 Use of the Word "Traffic"

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**THE USE OF THE WORD "TRAFFIC" AFTER A DESTINATION GROUP IS RECOMMENDED.**

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Since the audio message is not as constrained as are visual displays, the use of the word **traffic** after a destination group will add more clarity to the message without adversely affecting message length restrictions.

### A.3 City Destinations

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**NAMES USED FOR CITIES SHOULD BE IDENTICAL TO THOSE USED ON EXISTING STATIC SIGNING.**

---

City destinations displayed on the HAR should be consistent with existing signing practices. Nicknames should be avoided. For example, **San Antonio** is recommended rather than the nickname **Alamo City.**

### A.4 Major Generator Destinations

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**NAMES USED FOR MAJOR GENERATORS MUST BE SPECIFIC AND ADDRESS THE EXACT PLACE WHERE AN ACTIVITY TAKES PLACE.**

---

Many cities have large areas known locally by a single name, but which house smaller areas of wider general knowledge. An example is Fair Park in Dallas which contains the better known Cotton Bowl and the Texas State Fairgrounds. Caution should be used when signing for such areas so that the name displayed is consistent with the name used by drivers. If the anticipated audience contains non-local, unfamiliar drivers, the more general, lesser known destination name (Fair Park) would be confusing if the activity was being held at a specific, more widely known destination (Cotton Bowl or Fairgrounds) (20).

### A.5 Special Activity Destinations

---

**NAMES DESCRIBING CERTAIN SPECIAL ACTIVITIES SHOULD BE DISPLAYED RATHER THAN THE LOCATION WHERE THE ACTIVITY IS BEING HELD.**

---

Frequently, special activities such as parades and fireworks displays on July 4th attract large audiences, part of which are non-local, unfamiliar drivers. For these events, it is preferred to display the event (such as **parade** or **fireworks**) rather than the location of the event (such as **downtown** or **Kyle Stadium**) (20).

## B. Problem and Effect Message Statements

The HAR Problem and Effect Messages follow the same guidelines as CMS messages (Chapter 4, Section B).

## C. Action Message Statements

### C.1 General

General guidelines for HAR action message statements are the same as for CMS. The reader is referred to Chapter 5, Section B).

### C.2 Intracity Bypass Route Descriptors

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**REFERRING TO INTERSECTION TRAFFIC SIGNALS AND STOP SIGNS AND TO LANDMARKS WHEN DESCRIBING AN ARTERIAL BYPASS OR DIVERSION ROUTE ARE HELPFUL AIDS TO UNFAMILIAR DRIVERS. ALSO, ROUTE DIRECTIONS SHOULD BE GIVEN IN TERMS OF TURNS (LEFT OR RIGHT) AT DESIGNATED INTERSECTION NAMES.**

---

Laboratory and field studies with test subjects (13, 37) indicate that mes- sages with route descriptors are effective in describing a diversion route to unfamiliar drivers. Landmarks are very effective route descriptors. Traffic signals are also effective, but can result in driver confusion on long diversion routes or on routes which have a flashing signal.

While use of route descriptors may at times result in a message that exceeds the length of the maximum message that can be broadcast on a particular HAR system in most common situations, these guidelines are given for situations in which there is a large proportion of unfamiliar drivers and when message length is not a severe constraint.

- Route directions are given in terms of turns, left or right, at designated intersection names. Cardinal directions should be used only when the directions are to continue. Examples are "Turn left on Greenville," and "Go south on Fairmont."

- Landmarks such as shopping centers, gas stations, retail stores, restaurants, public buildings, or water towers that are prominent structures or have large commercial signs are good targets for drivers to key on. Landmarks in a message can be quite useful in at least two situations:

When the turn is at a road where the street sign is not easily visible at a distance. Example: "Turn left at Smith Street which is just past McDonalds Hamburgers."

When the leg of a route is several miles in length and the driver may need confirmation that he has not passed the turn intersection. Example: "Go south on Grand Avenue, past K-Mart, and turn right at the next traffic light, Young Street."

- Another way to describe an intersection, other than by name, is by the fact that it is at a traffic light or stop sign. Distance information on routes may also be given in terms of numbers of traffic lights. Example: "Go south on Texas Avenue to the third traffic light, University Drive."

- Side roads and unsignalized intersections may also be referenced to a traffic light. Example: "Turn left at the first street after the traffic light."

- Giving the length of a leg of a route in terms of miles or fractions thereof is not as descriptive as other methods in situations where there are signalized intersections and landmarks. Drivers are very poor at estimating distances accurately and do not normally refer to their odometer in driving. Distances in terms of miles are necessary only when the leg is a highway without signalized intersections or prominent landmarks.

Extreme care should be exercised when the number of traffic lights is used as a route descriptor. Traffic lights should not be used on long diversion routes or when one or more of the lights are flashing. Many drivers encounter difficulty with counting the number of traffic lights on long diversion routes. In addition, there is some confusion by drivers as to whether flashing traffic lights should be counted (37).

## 16. ADVANCE SIGNS

### A. Types

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**HAR SYSTEMS THAT REQUIRE DRIVERS TO TUNE TO A SPECIFIC RADIO STATION MUST HAVE AN ADVANCE VISUAL SIGN.**

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An advance sign is an essential part of an HAR system and makes the driver aware that the HAR service is available and provides useful information. Two types of broadcast operational approaches are used in practice.

1. Continuous broadcast - When a message is broadcast 24 hours each day static signs are normally used. Flashers are activated only when emergency messages are broadcast.

2. Emergency broadcast - Messages are broadcast only when an emergency exists. Three types of signs can be used. One is a static sign with flashing beacons. The sign contains the wording **When Flashing** as part of the sign message. The flashers are used to inform the driver that the HAR is operational.

   The second sign alternative is a changeable message sign. The sign is activated when a HAR message is broadcast. The message on some types of changeable message signs can be flashed to attract driver attention.

   Certain types of traffic control situations require the use of HAR for only a short period of time (e.g., 1 to 3 hours). One example is a sports event. A transportable advance sign can be used and covered with a drop-cloth or other material when a message is not on the air.

### B. Message Design

The message should include:

- A subject statement (what the sign is preparing drivers to receive on their radios)
- An action statement (tuning to a designated frequency)

The subject statement is generally given first to prepare the drivers and to convince them they should take the action recommended by the action statement.

In incident management and route diversion situations the messages that elicit the greatest degree of urgency for the drivers to respond are (13):

RADIO TRAFFIC ALERT
TUNE TO 530 AM

TRAFFIC ALERT
TUNE RADIO TO 530 AM

The following messages are considered by drivers to be moderately urgent:

RADIO TRAFFIC ADVISORY
TUNE TO 530 AM

TRAFFIC ADVISORY
TUNE RADIO TO 530 AM

The following messages are interpreted by drivers as least urgent:

RADIO TRAFFIC INFORMATION
TUNE TO 530 AM

TRAFFIC INFORMATION
TUNE RADIO TO 530 AM

Additional message design principles are as follows:

- The word **traffic** is essential so that drivers do not mistake the radio message to be about weather, news, or other items.
- The word **radio** is used to clarify the action statement, and is preferred to omitting the word.
- **Set dial to 530** and **tune dial to 530 AM** are acceptable, but are longer than the recommended message.
- It is recommended that **AM** be placed on the sign because many automobile radios are now equipped with FM. The driver may be listening to FM and may not remember to change to AM (37).
- **Radio route information** may imply that the HAR is broadcasting routing information for visitors.
- Avoid cluttering the action message statement with redundant words and phrases such as **on your dial** and **for information.**
- When the HAR is used to control traffic during a special event, either the special event or the name of the facility where the event is, whichever is more prominent, should appear on the first line of the advance sign. Examples are as follows (37):

OCTOBERFEST
RADIO TRAFFIC ADVISORY
TUNE TO 530 AM

ASTRODOME
RADIO TRAFFIC ADVISORY
TUNE TO 530 AM

- The type of information broadcast (e.g., traffic, weather, tourist, etc.) must be specifically stated on the sign (37). The driver needs to know what type of information is being broadcast.

- The word **INFORMATION** is now commonly abbreviated as **INFO** and no major reduction in understanding will result from use of the abbreviation (37).

## C. Location of Advance Signs

Gatling (48) has conducted a reaction-time study of the requirements for placing an alerting sign upstream of a broadcasting area. The study was based upon an investigation of the time required to read the sign and manually tune the radio to the designated frequency, assuming the radio was either initially ON or initially OFF.

With the radio initially ON, 95 percent of the subjects were able to read, react and tune to the frequency in about 6.0 seconds, which translates to about 530 feet (161 m) at 60 mph (96 km/hr.). When the radio was initially OFF, 95 percent of the subjects read, reacted and tuned to the frequency in about 53.3 seconds, which is about 4700 feet (1432 m) at 60 mph (96 km/hr.).

If the sign was placed to accommodate the reaction times of the "worst-case" drivers then the better drivers would be tuned to the station and wondering why there was no message.

The issue of where the advance sign should be located has not yet been resolved. Gatling recommends that the sign be located 1 mile (1.6 km) upstream of the beginning of the radio zone and an additional sign be erected on the roadside where the broadcast area begins. Brizell (4), based on experience with HAR systems in Philadelphia, recommends that the sign should be placed 1/2 mile (0.8 km) upstream of the radio zone. A further analysis of Gatling's data indicates that 3/4 mile (1.2 km) would cover the "worst-case" driver (radio OFF). For example, if one were to assume a 16-inch (41-cm) legend on the advance sign and a legibility of 50 feet/inch of letter height, a legibility distance of 800 feet (244 m) is obtained. Thus the advance sign could be placed 3900 feet (1189 m) (4700 minus 800) or about 3/4 miles (1.2 km) upstream of the beginning of the radio zone.

Placement 3/4 miles (1.2 km) upstream should allow sufficient time to turn on the radio and/or to select the indicated frequency. Some highway agencies believe that even 3/4 miles (1.2 km) is too far from the radio zone, particularly in urban areas where the speeds are much lower during peak periods. A distance of 1/2 mile (0.8) km appears to be a good guideline for urban areas.

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**THE ADVANCE SIGN MUST BE HIGHLY VISIBLE. DO NOT EXPECT THAT ALL DRIVERS WILL SEE THE ADVANCE SIGN THE FIRST TIME THEY PASS IT. IT MAY BE NECESSARY TO USE TWO ADVANCE SIGNS.**

---

The advance sign must be highly visible and conspicuous, particularly for unfamiliar drivers. Locally, familiar drivers passing an advance sign several times eventually become aware of the sign. One field study (37) found that only 58% of drivers passing a large advance HAR sign for the first time claimed in an interview that they had seen the sign even though it was favorably located.

It is desirable that a second sign with approximately the same message be installed at the beginning of the broadcast zone. The advance mileage on the second sign would be omitted. Some drivers may have missed the first sign or failed to see or remember the radio frequency. The second sign would be particularly necessary if a major entry ramp to the interstate existed downstream from the first advance sign.

# 17. TYPES AND CHARACTERISTICS OF HIGHWAY ADVISORY RADIO

## A. Introduction

Under conditions of heavy traffic moving at high speeds, or when visibility is poor, the amount of information that can be communicated to drivers in the few seconds that they may be exposed to wayside or overhead signs is extremely limited. Available audio signs and other concepts of audio communication are available alternatives that can serve as an integral part of a motorist information system. Four existing audio modes have potential in this capacity:

- Limited range roadside radio (Highway Advisory Radio)
- Two-way radio (Citizens Band)
- Telephone call-in system
- Commercial radio

Chapter 17 presents considerations for Highway Advisory Radio systems. Detailed discussions of two-way radio, telephone call-in systems, and commercial radio may be found in References 49, 50, and 51.

## B. Highway Advisory Radio (HAR)

### B.1 Background

HAR is a means of providing highway and driving-related messages to the driver using his existing AM radio receiver. Although the system can be designed to broadcast information on any available AM frequency, typically the service is provided at frequencies of 530 and 1610 kHz. These HAR frequencies are sufficiently close to the commercial AM broadcast band that the majority of existing AM receivers can tune to them. Use of these frequencies can be authorized by the Federal Communications Commission (FCC) on a developmental license or under FCC Rules and Regulations Part 15 without a license.

In operating under Part 15, the system is limited by power output and/or maximum field strength. In some applications those requirements are adequate for the operation of HAR; however, in other cases higher power output and/or maximum field strength are needed for a good quality intelligible broadcast. A developmental license is needed for the latter. Action by FCC has established this service in accordance with Docket 20509.

## B.2 Types

In addition to the distinguishing characteristics of power output discussed in Section B.1, HAR may be classified according to its antenna system. Currently, two types are available:

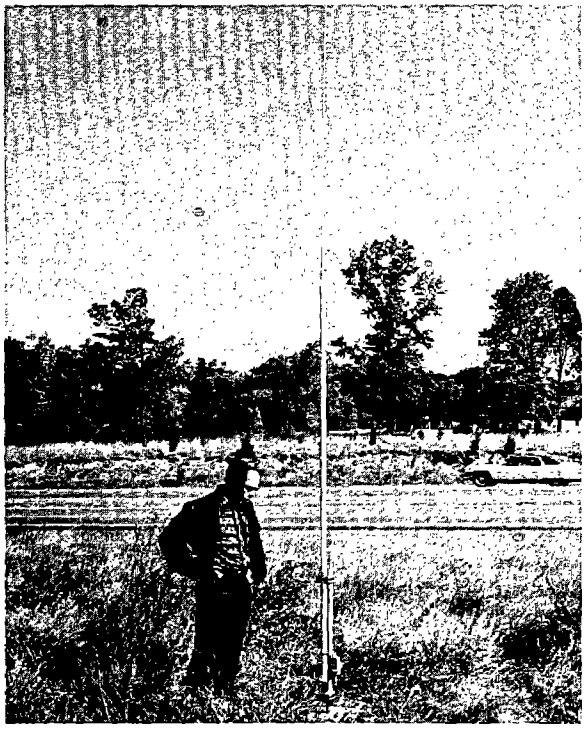
- Vertical "whip" antenna
- Induction or "lossy" cable antenna

Examples of the antennas are shown in Figure 17-1.

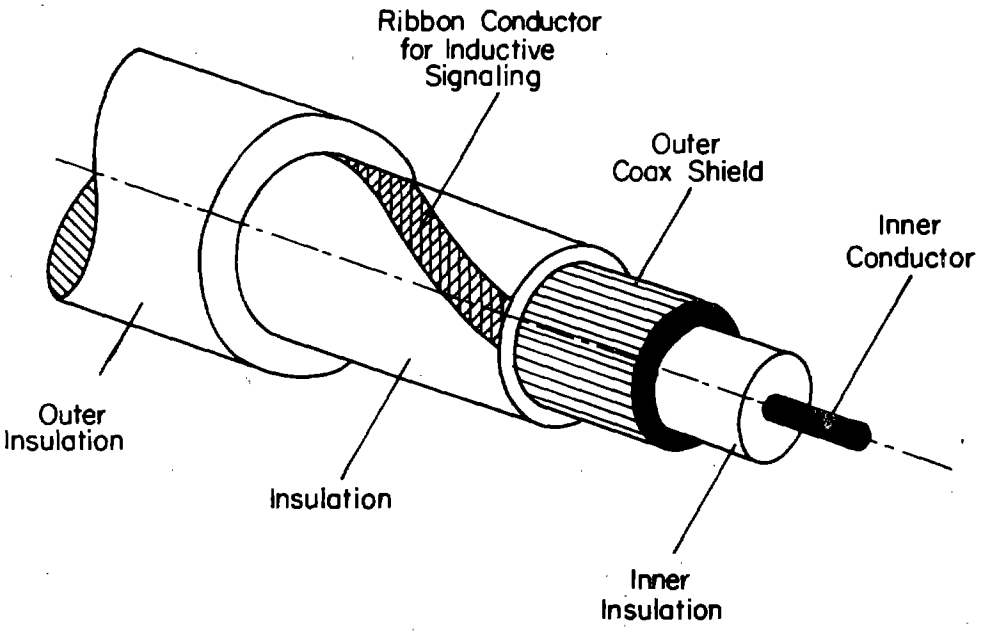
A single whip antenna may be used or several antennas can be spaced along the highway and electronically interconnected. Each antenna radiates a signal in all directions, thus forming a circular transmission zone. Some of the primary advantages and disadvantages of the whip antenna are a follows (52):

- It is physically small and can be installed in a relatively small space.
- It is relatively easy to install. It can be installed in a short time in various environments over earth or pavement, on a building tower, etc.
- It can be easily relocated.
- It will usually be visible, but can be partially camouflaged.
- It can be placed several hundred feet from the highway.
- It is subject to damage by weather, accident, or vandalism.
- It requires a matching network (or series inductance) that is efficient, stable, reliable, and easily tunable.
- It provides a circular zone of coverage that may interfere with other coverage zones on adjacent highways.
- The coverage zone extends well beyond the limits of the intended zone and thus may overlap with other coverage zones on the same highway.
- It will usually be less costly to purchase and install than a cable antenna.

The second method of broadcast utilizes a roadside cable instead of conventional vertical antennas. The radio signals are "narrow cast" by directional induction radio transmission and can thus be confined to the width of a multilaned highway.



Whip Antenna




Typical Induction Cable Antenna Schematic

Figure 17-1. Typical Antennas

One of the characteristics of the "lossy" cable is that a strong, but highly localized induction type radio signal can be produced within a short lateral distance (100-150 ft) [30.4-45.6 m] from the cable. This is sufficient to produce a good signal for the width of a modern, multilane highway while restricting the field. At a distance of several hundred feet from the cable, the field is below the effective response value of typical automobile receivers. This results in a relatively high degree of efficiency in the use of the radio spectrum for roadway communications, as the same carrier frequency may be utilized without interference on several highways in one area. Another feature is that the system can be designed such that different messages can be broadcast over two separate frequencies on the same cable. Thus, messages could be individualized by direction of travel (52).

Several advantages and disadvantages relative to the use of "lossy" cable antennas are as follows (52):

- It must physically extend the full length of the coverage zone.
- It may be placed above or below ground.
- It can provide continuous coverage through tunnels, in buildings, under overpasses, etc.
- If buried to deter vandalism, it is more costly to purchase, install, and relocate; however, it can be made virtually invisible.
- It is not easily installed in some areas already built up with concrete pavement and highway structures, such as through a highway interchange or intersection.
- The cable antenna is easily connected electrically and requires no matching network or tuning adjustment.
- The radiation zone is confined to within 100 feet (30.4 m) or less from the cable, and thus minimizes interference with nearby coverage zones.
- It must be placed close to the highway.
- If installed below ground, it is not subject to damage by weather or vandalism.
- The radiation is stable with temperature and weather and is relatively unaffected by the type of soil if buried.

The choice of the type of antenna depends on a consideration of such factors as (52):

- Permanency of installation.
- Practicality of installation along existing highway.
- Limitations on size of radiation zone of coverage.
- Costs of purchase and installation.
- Protection and concealment.
- Engineering considerations of radiation versus power.

### B.3 Transmitting the Message

Regardless of which antenna system is used, message transmission is accomplished by means of a roadside transmitter positioned adjacent to the highway. Broadcasts can be "live," but normally prerecorded messages on magnetic tapes are used. High quality cartridge-type tape recorder/player equipment that has been proven acceptable in several existing advisory radio systems is commercially available. Continuous loop magnetic tapes of various time durations inserted in cartridges allows the message to be continuously repeated.

The recorder/player can be used on-site or from a remote control center. Control of message transmission from a remote locations can be either by telephone line or radio connection.

### B.4 Broadcast Signal Strength (53)

The transmitter power, antenna configuration, and location should provide a reception zone with signal characteristics at least equal to a good quality AM broadcast station. Signal level within the zone (along the highway) should be free of noticeable fading. Available information suggests that a minimum field strength of 2mV/m at 530 kHz and 3mV/m at 1610 is necessary for consistently good reception. Organizations contemplating installation of HAR systems are encouraged to contact Federal Highway Administration, Office of Research,Development, and Technology, Systems Technology Division, HSR-10, Washington, D.C. 20590, for more detail and background on these items.

## C. Examples of Existing Systems

Operational or experimental audio systems have been installed at the following locations:

- Colorado (Colorado Division of Highways, District 1)
- Disneyworld
- Houston International Airport
- Los Angeles International Airport
- Minneapolis (Minnesota Department of Highways)
- Philadelphia (Delaware Valley Regional Planning Commission)
- Wyoming (Wyoming State Highway Department)
- Yellowstone National Park

This section of the Manual summarizes some of the systems to illustrate the practice at some sites. A list of HAR users in 1980 can be found in Reference 54.

The system at the Los Angeles International Airport is probably the most established and recognized radio system. It is owned by the Los Angeles Airport Authority, but had been operated for several years by a private organization. The system, licensed by the FCC, consists of two buried cables. Over 1 mile (1.6 km) of cable is buried on the approach road (Century Blvd.), and approximately 6,000 ft. (1.8 km) is buried along the terminal loop road. This provides capabilities for two separate radio systems that operate at the same frequency (530 kHz). A closed circuit television camera mounted on the airport tower provides visual surveillance of terminal and approach roads. In addition, parking lot attendants radio parking information to the central control room (see Figure 17-2). Prerecorded continuous loop tapes in cartridges are played on the recorder/playback unit depending on roadway and parking conditions. Approximately 100 prerecorded cartridge tapes are available.

Another functional system is employed at the Houston Intercontinental Airport to provide information concerning parking conditions. The system output is low-power and uses tape cartridge broadcasts. Depending upon various parking conditions, designated tapes are initiated. Transmission is made using a single-dipole, circular radiation antenna (see Figure 17-3). Two antennas are used in the system to provide a broadcast zone of approximately 6.0 miles (9.6 km) with the present configuration. The transmitter and antennas are connected in circuit using existing phone line. With the low-power output, broadcasts may be conducted on any frequency between 535-1600 kHz.

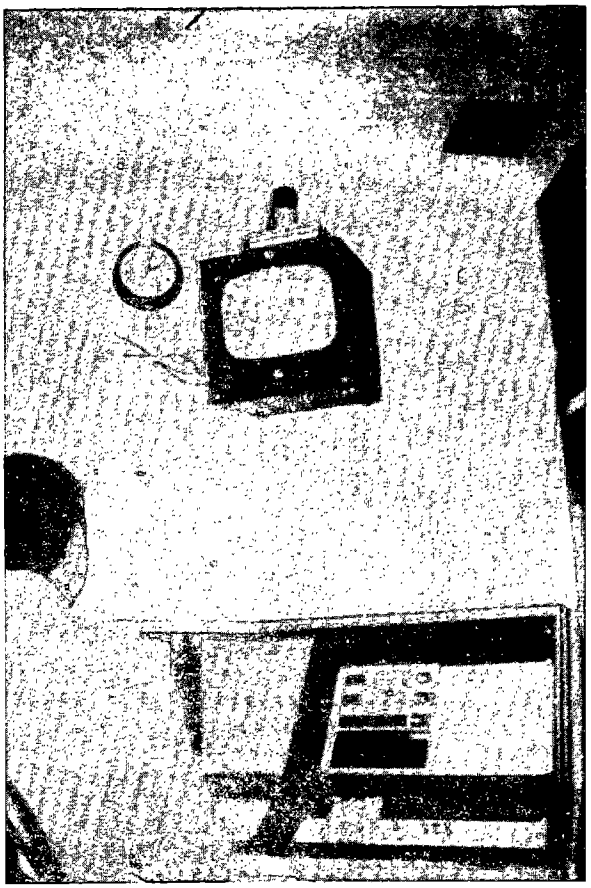
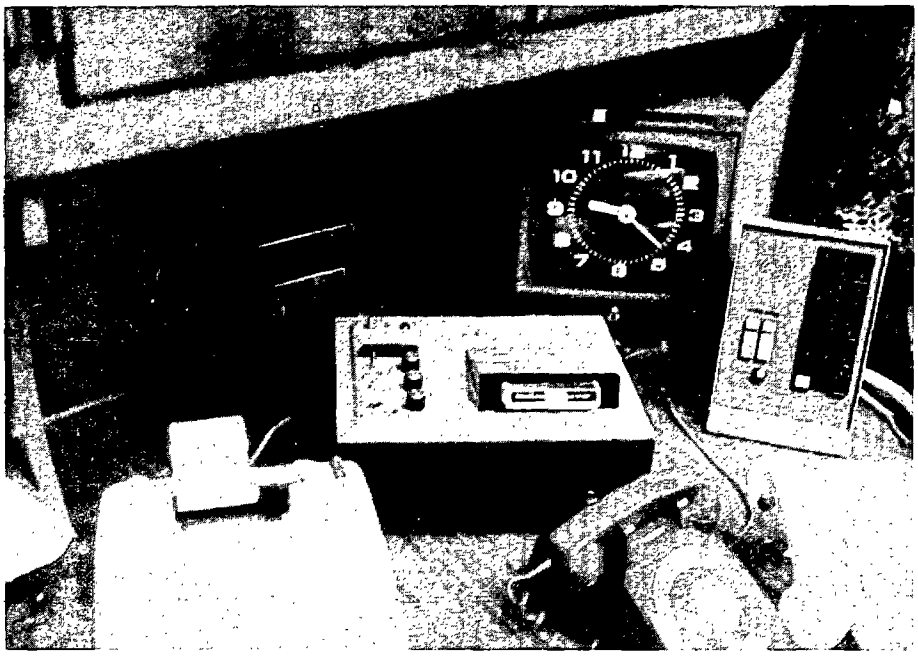
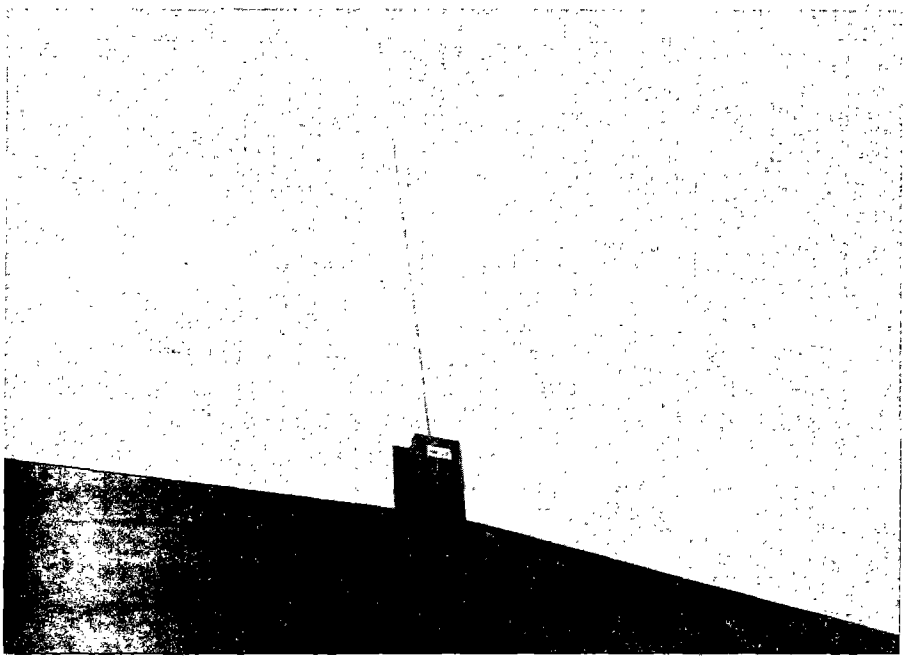


Figure 17-2. Los Angeles International Airport
Radio System Control Room



Radio Broadcast Equipment



Single Dipole Antenna Mounted on Terminal

**Figure 17-3.** Houston International Airport System

However, broadcasts are made on 1100 kHz without interference from local commercial broadcasts.

In Colorado, motorists approaching the Eisenhower Tunnel on I-70 may tune their radios to 1610 kHz and receive advisory information concerning tunnel conditions, road surface conditions (approaching the tunnel and at Loveland and Berthoud pass), traffic conditions and alternate routing if necessary. The information is gathered at the tunnel control center and appropriate messages are taped and played back over telephone lines to transmitters located at Dumont on the east and Dillon on the west side. These HAR systems operate with an FCC experimental radio license. Both transmitters broadcast on 1610 kHz with up to 10 watts of RF power into above ground monopole antennas.

In 1975, the Delaware Valley Regional Planning Commission (DVRPC) operated a HAR system on the Walt Whitman Bridge in Philadelphia. The system informed inbound motorists from 6:30 a.m. to 9:00 a.m. of free parking to encourage the use of mass transit, reduced toll rates for carpools, and traffic conditions on the Schuykill Expressway (I-676), the main arterial to the CBD. This HAR system contained 6,000 feet (1,820 m) of cable antenna that was suspended on the bridge, a 10-watt AM transmitter, and a telephone line interconnected tape deck. It operated on 530 kHz with an FCC experimental radio station license. Five additional HAR systems were installed in July 1976. Each operated at 530 kHz within FCC Rules and Regulations Part 15. Each system contained a low powered AM Transmitter and 9,000 feet (2,750 m) of buried cable antenna.

The Minnesota Department of Highways installed a HAR system on I-35W in Minneapolis as part of an extensive surveillance and control system. The system contains 1 mile (1.6 km) of cable antenna, a 10W AM transmitter, and a tape deck with a telephone interconnect. The transmitter operates at 530 kHz with an FCC experimental radio station license.

# 18. MESSAGE TRANSMISSION CONSIDERATIONS

This Chapter provides guidelines on techniques for improving the intelligibility of audio messages and preparing drivers to listen to the messages. Specifically, the following are discussed:

- Vocal characteristics (voice quality, voice pitch, and message delivery and style)
- Techniques for improving radio speech transmission in extreme noise
- Alerting techniques (audio tones, verbal, advance signs)

Gordon, et al. (55) provide a more complete review of the literature. You are advised to read their summary for additional understanding of the recommendations presented herein.

## A. Vocal Characteristics

### A.1 Voice Quality

The voice that presents an audio message to drivers over any kind of transmission medium is nearly as important as the message itself. The audio message should be understood by drivers to be:

- Official (i.e., this is a responsible traffic authority talking),
- Applicable to them at the time it is received, and
- Important in terms of highway safety, time saved, or other significant considerations.

Selection and/or training the announcer who will present messages for the audio traffic control system is very important. Good speaking characteristics can be identified as (56, 57):

- Clear enunciation without obvious dialect,
- Devoting more time to syllables and less to pauses,
- Greater speech intensity, and
- Greater pitch variability.

**GOOD TALKERS TEND TO ENUNCIATE CLEARLY, SPEAK LOUDLY AND AT A MODERATELY FAST RATE, AND AVOID A DRONING MONOTONE.**

Several facilities such as the Los Angeles International Airport, Houston Intercontinental Airport, and Disney World use taped announcements prerecorded by professionally trained speakers (58). It is recommended that the same approach be used for HAR systems.

Local and state agencies often use supervisory or law enforcement personnel to give messages over the radio about traffic conditions. Many of these people are not trained speakers and will not be as effective in communicating the message. When prerecorded professionally produced messages will not fit the needs of a particular system, it is suggested that operational personnel responsible for presenting messages be selected on the basis of voice quality and delivery, and then be carefully trained.

### A.2 Voice Pitch

There are no differences in intelligibility between high and low pitched voices, provided that the transmission system can handle the range of frequencies (59). For both males and females, the critical range of reproduction is between 200-3000 Hertz (Hz). Many automatic warning systems with verbal messages use low-pitched female voices with good results (60).

### A.3 Delivery Style and Speed

This consideration is related to voice quality, as already discussed, but is also related to the rate of word presentation and the way in which a given message is expressed. In order to convey the sense of importance and relevance to the driver, the style of delivery should appear serious and authoritative. The speaker should emphasize the more important information such as names of streets on a diversion route.

**THE MESSAGE SHOULD BE READ IN A CALM, MATTER OF FACT, AND DIGNIFIED MANNER.**

The type of narration heard in documentaries on television could serve as a model for style.

An appropriate speed of delivery of radio messages is about 175 words per minute (61, 62). At this rate, a 29-word message could be read in about 10 seconds and a 44-word message in about 15 seconds. Any delivery speed below

110 words per minute tends to sound "dragged out" and may give the impression of a less significant and important message.

## B. Techniques for Improving Radio Speech Transmission in Noise

This Section discusses several methods which have been employed to increase the likelihood of a driver hearing and understanding a radio message when there are extreme traffic noises. One method under the control of the traffic engineer is using a standardized language so that, even if the words are partly masked by noise, the driver may correctly interpret the message. Other methods involve modifying the transmission itself by limiting the dynamic range and by peak clipping.

Noise levels inside motor vehicles vary from 70 db(A) for a large air-conditioned luxury car to over 80 db(A) for an economy import (59). Cabs of diesel trucks tend to have noise levels somewhat higher than 85 db(A). Ambient traffic noise can be as high as 85-90 db(A). These noise levels cannot be considered white noise (i.e., comprised of across-the-sound-frequency spectrum); much of traffic noise is tire noise and exhaust noise which are predominantly low frequency sounds. The lower the masking noise in frequency (below 500 Hz), the more effective the masking. Hence, traffic noise and vehicle noise can and do disrupt intelligibility over a car radio. The driver who is enveloped in a noisy freeway corridor with his windows down must turn his radio up to the point that serious distortion does not occur, since he must obtain a signal-to-noise ratio of a least 12, and preferably 20 db(A), to receive a broadcast at a reasonable level of intelligibility. The signal-to-noise ratio (S/N) is the difference in decibels between the intensity of the sound that is to be heard and the intensity of the sound that interferes (noise). In the above example, a level of 97 db(A) (85 + 12) would be required for adequate communication in an 85 db(A) traffic environment. Many inexpensive car radios are incapable of such performance without producing rattling low frequency sounds, and ear-shattering shrieks for high frequencies. One cure for this situation can be peak clipping which permits even inexpensive radio receivers to be turned to near maximum gain.

### B.1 Limit Vocabulary

One strategy for improving performance under less-than-optimum band width and power conditions of speech transmission, especially in noise, is to limit the vocabulary used in messages. This is one of the reasons for the 10-code and the specialized jargon of CB radio (63). This predictable and limited vocabulary enhances understanding under CB radio conditions of multiple talkers on the same channel, atmospherics, cheap equipment, power compression, limited response, and detuning.

This strategy in setting up a real-time traffic information system will be aided by a public education campaign, and will be applicable to the fullest only for the familiar (i.e., commuter) driver. Any communication system will

benefit if the jurisdiction adopts a consistent and small vocabulary similar to or the same as that used in visual signing, and sticks with it.

### B.2 Dynamic Range

Fundamental speech sounds require at least 28.2 db(A) dynamic range in the transmission system (64). Typically, commercial broadcasting facilities provide for 40 to 45 db(A) (64, 65). This range is for the frequency band of 250 to 4000 Hz. Human speech is intelligible from a whisper level (30-40 db re 0.0002 microbar) to the loudest shout (110 to 120 db(A) re 0.0002 microbar). It should be noted that a speech signal at the ear to achieve acceptable intelligibility will require a signal-to-noise ratio of 12 db(A).

Communications engineers deal in concepts such as the Articulation Index to judge or predict the performance of a speech transmission and reproduction system. Any evaluation of a speech information delivery system must assess in some manner the fraction of total speech bandwidth which is delivered to the listener, as well as the signal-to-noise ratio at his ear (64). A popular method for deriving the Articulation Index consists of measuring or estimating the levels of speech and noise present in each of 20 contiguous frequency bands. Step-by-step methods are available from several sources, but the traffic engineer is well advised to seek professional aid in the field of communication engineering in determining the transmission system characteristics that will best get the message broadcast over the radios in the vehicles.

The mode of transmission virtually dictates what the dynamic range and the signal-to-noise ratio will be under optimal conditions. The engineer in traffic operations is faced with the problem that the receiving end of the communication system is under the driver's control. The system's success is dependent upon:

- The gain (volume level) selected by the driver (including "OFF")
- The response characteristics of the receiver apparatus
- The noise environment around the driver
- The inclination of the driver to also be a listener

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**THE TRAFFIC ENGINEER'S PRIMARY RESPONSIBILITY IN THE AREA OF SPEECH TRANSMISSION IS TO PROVIDE AS HIGH-QUALITY AND NOISE-FREE SPEECH SIGNAL AS POSSIBLE WITHIN THE LIMITATIONS OF THE EQUIPMENT AND THE FREQUENCIES ASSIGNED.**

---

Table 18-1 places in perspective various compromises that different systems may demand with respect to what is generally considered acceptable speech transmission--standard broadcast (amplitude modulation).

TABLE 18-1

DYNAMIC RANGE AND OTHER CONSIDERATIONS IN RADIO SPEECH TRANSMISSION

| Dynamic Range | Frequency Response | Quality | System |
|---|---|---|---|
| 40-45 db | 200-5000 Hz | Acceptable | AM broadcast |
| 40 db | 300-3000 Hz | Somewhat unsatisfactory to acceptable | CB |
| 40 db | 500-5000 Hz | Lower frequency clipped, somewhat unsatisfactory | Roadside radio, lower end of dial |
| 40 db | 300-3000 Hz | Upper frequency clipped, somewhat unsatisfactory | Roadside radio, upper end of dial |

### B.3 Speech Clipping

Low frequencies contribute little to intelligibility of human speech (56). The minimum range essential for intelligibility is 200 to 3000 Hz. Thus, the bandwidth of the transmitting system can be conserved in a crowded urban broadcasting band by frequency limitations--although such economy is purchased at the price of requiring much more selective tuning on the part of the driver to receive the stations. If the system selected is roadside or area radio at the extremes of the AM dial, this approach is not recommended, since many radios will be able to tune in only a fraction of the signal.

**AMPLITUDE PEAK CLIPPING IS AN ESPECIALLY ATTRACTIVE APPROACH FOR ROADSIDE RADIO AND FOR CB APPLICATIONS.**

Clipping packs available transmitter power into the middle range of voice power input. It provides the same performance with respect to speech intelligibility as unclipped speech, with up to a 20:1 saving in transmitter power (13 db(A) saving in peak signal power) (64). This advantage is gained at the cost of loss of voice quality and musical reproduction. Peak-clipped sound reproduction resembles that achieved by pre-electronic sound recording, the "wind up Victrola" type. Such voice transmission, especially heard in noise, may be very satisfactory for real-time traffic information transmission. The amplitude distortion represented by peak clipping is minimized by masking noise, as far as listener detection is concerned.

## C. Alerting Techniques

### C.1 Alerting by Signals

An alerting sound or signal can be of material aid in insuring that even casual listeners in the traffic stream heed traffic advisory messages. Local circumstances will have to be considered in making a selection of an alerting signal. If popular broadcasting stations in your area use a distinctive tonal signal (like a cuckoo sound, warble, or other sound effect), you will have to choose one which is different from any of those signals. Several guidelines can be given, however.

The most attention-demanding signal is a modulated signal, at a frequency of modulation of 1 to 3 Hertz (61). Pitch modulation will work better than loudness changes. Pitch should vary at least 100 Hertz over the modulation cycle. The duration of the signal should be over 500 milliseconds. The mean frequency should be around 1000 Hertz.

There are many unique alerting sounds that could be used, such as those used at the beginning and end of news broadcasts (provided they are not in local usage). Avoid any sound effect which resembles an emergency equipment siren or a police whistle since presentation of these signals could distract drivers from their task.

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**THE ALERTING SIGNAL SHOULD BE NO MORE THAN FIVE SECONDS IN DURATION. IT SHOULD PRECEDE THE SPOKEN MESSAGE BY AT LEAST 0.5 SECOND AND NO MORE THAN 3 SECONDS TO CONSERVE TRANSMISSION TIME. THE SIGNAL SHOULD BE PRESENTED SUCH AS TO BE 10 DB(A) OVER THE BROADCAST LEVEL ESTABLISHED FOR THE MESSAGE TRANSMISSION (62).**

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## C.2 Alerting by Attention Statement

Adequate attention getting can be achieved for all but the very inattentive listener (or one who has his receiver turned very low in volume) by a verbal statement. The announcer should say, "Attention _____ Traffic." Recommendations for the attention message statement are provided in Chapter 15.

The organization of the message elements themselves also serve as a form of alert. The problem is explained first so the driver is prepared to listen for an advisory message (action message statement).

As indicated previously, the message should be repeated twice. If the message is too long for a complete repetition within the broadcast range constraints, then the attention message statement and the action message statement only may be repeated. The alert restatement assures drivers that the message is addressed to them, and repeating the action message statement gives them an additional opportunity to learn the street names along a diversion route. The action message statement (advisory) is the part that must be retained and acted upon and, hence, is most important.

## C.3 Alerting by Advance Signs

In-vehicular requirements for attracting a driver's attention over the radio were discussed in Sections B.1 and B.2. These methods assume that the radio is already on and tuned to the correct frequency. An advance visual sign is necessary to attract the driver's attention initially and get him to tune to the station. (See Chapter 16).

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