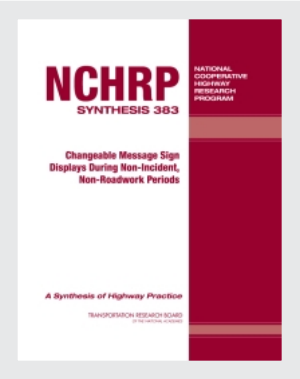


Changeable Message Sign Displays During Non-Incident, Non-Roadwork Periods

DETAILS

68 pages | | PAPERBACK
ISBN 978-0-309-42955-9 | DOI 10.17226/23070

AUTHORS

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 383

Changeable Message Sign Displays During Non-Incident, Non-Roadwork Periods

A Synthesis of Highway Practice

CONSULTANT
CONRAD L. DUDEK
Dudek & Associates
Bryan, Texas

SUBJECT AREAS
Highway Operations, Capacity, and Traffic Control

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2008
www.TRB.org

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

NCHRP SYNTHESIS 383

Project 20-5 (Topic 38-11)
ISSN 0547-5570
ISBN 0-309-09813-7
Library of Congress Control No. 2008907264

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at:
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academys p urposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Donna Vlasak
Senior Program Officer
Transportation
Research Board

This synthesis was prepared about using Changeable Message Signs (CMSs) to display types of messages other than real-time messages for non-recurrent, environmental, special event traffic, and other special problems, as well as AMBER alerts, during non-incident/non-roadwork periods as an alternative to leaving the CMS blank. Guidelines for design and display of CMS messages for incidents and roadwork are available; however, guidelines are not available for non-incidents/non-roadwork periods. This synthesis provides that state of the practice as a first step toward developing guidelines. This report is about the state of the practice as it involves state departments of transportation (DOTs) and toll road, turnpike, and parkway transportation agencies. The primary intent was to identify practices that have proven effective, as well as those that have not. It intends to offer guidance in making more effective uses of CMSs for non-incident/non-roadwork periods. It appears that a division of opinion may still exist among traffic management centers (TMCs) that do not have the capability or need to display travel time information about whether or not it is best to leave the CMS blank during non-roadwork/non-incident periods or to display messages. TMCs reported that some motorists prefer messages, some do not. Objective data are needed to assist TMCs in their decisions.

The information presented here is based on an extensive literature review and a nationwide survey of state DOT TMCs and of agencies that operate toll roads.

Conrad L. Dudek, Dudek & Associates, Bryan, Texas, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

CHANGEABLE MESSAGE SIGN DISPLAYS DURING NON-INCIDENT, NON-ROADWORK PERIODS

SUMMARY

Permanently mounted changeable message signs (CMSs), sometimes referred to as variable message signs or dynamic message signs, are used primarily to display real-time messages for non-recurrent, environmental, special event traffic, and other special operational problems. CMSs are also used for AMBER (America's Missing: Broadcast Emergency Response) alerts. (*Permanently mounted CMSs* are referred to as *CMSs* in this synthesis). When the CMSs are not used for the aforementioned problems, the traditional wisdom has been to leave the CMSs blank; however, some state departments of transportation (DOTs) and agencies that operate toll roads are using their CMSs to display other types of messages during non-incident/non-roadwork periods as an alternative to leaving the signs blank. Guidelines for the design and display of CMS messages for incidents and roadwork are available. However, guidelines do not exist for messages displayed during non-incident/non-roadwork periods. This synthesis was prepared to provide the state of the practice concerning the display of messages during non-incident/non-roadwork periods as a first step toward developing guidelines. Additionally, the state of the practice concerning AMBER alert messages also was examined.

The content of this synthesis is based on information from an extensive literature review and a survey of state DOT traffic management centers (TMCs) and in agencies that operate toll roads. Responses to the survey were received from 100 TMCs in urban and rural areas. Responses were received from 40 state DOTs and 6 toll road agencies with a total of 100 TMCs. The TMCs operated 3,023 CMSs in urban areas and 821 CMSs in rural areas. Forty-two TMCs operated CMSs only in urban areas, 8 only in rural areas, and 50 in both urban and rural areas.

During the past 10 years, there has been an increase in the number of transportation agencies that display messages on CMSs during non-incident/non-roadwork periods instead of leaving the signs blank. Part of this increase is the result of the greater use of travel-time information on CMSs. Travel-time messages are recommended by FHWA and in current CMS message design and display guidelines. However, congestion, speed, safety campaign, public service announcements (PSAs), and/or traffic law or ordinance messages are also displayed by some TMCs. A division in opinion still exists among TMCs that do not have the capability, or need to display travel time as to whether it is best to leave the CMS blank during non-incident/non-roadwork periods or to display messages.

The results of the survey indicated that the decisions by TMCs to display congestion, speed, safety campaign, PSA, and/or traffic law or ordinance messages in lieu of leaving the CMSs blank are based primarily on administrative and upper management preference, TMC manager and supervisor preference—or both—rather than on objective research data.

As in the past, the rationale of some TMCs that leave CMSs blank is that drivers will notice the essential messages when they are displayed and the messages will be more effective. The rationale expressed by some TMCs that display messages is that the public appreciates that the CMSs are being used, thus justifying the expensive investment in the signs. In addition, requests from administrators or management to display messages strongly influences the decision.

One of the concerns and challenges of TMCs that leave the CMSs blank is uncertainty as to the best way to convince motorists that the signs are functional. For the TMCs that display

messages other than travel time, there is uncertainty as to the best type of messages that should be displayed during non-incident/non-roadwork periods.

There is a trend in urban areas toward increased use of travel-time messages as an alternative to leaving CMSs blank during non-incident/non-roadwork periods. A majority of the TMCs that display travel-time messages reported very favorable or favorable public response. Travel time is generally not displayed on all of the system CMSs, just on selected CMSs. Some CMS locations in a system are not conducive for displaying travel time.

A review of the travel-time messages currently displayed by TMCs indicated that there is little uniformity with respect to message format. Also, many of the travel-time messages exceed the recommended maximum of four units of information per message. Thus, it is expected that unfamiliar drivers will not be able to read and recall the messages while traveling at typical freeway speeds. Some of the TMCs reported that drivers reduced speed to read the travel-time messages.

TMCs are experiencing difficulty in accurately measuring and displaying travel times during rapidly deteriorating freeway operating conditions such as during the transition from off-peak to peak periods or when incidents occur. During these times, the calculated travel time that is displayed is significantly lower than the actual time it takes to traverse the section of freeway. Therefore, credibility of the CMSs is adversely affected. Current travel-time messages are based (at best) on recent data. Predictive models and algorithms are needed to enhance credibility.

There is inconsistency among TMCs regarding the frequency at which travel times are updated on the CMSs, and guidance is needed by TMCs regarding the frequency at which travel times should be updated. Other conclusions drawn from the survey of TMCs are as follows:

- When used, travel times should be displayed and updated automatically.
- Several TMCs in urban areas do not currently display travel time because of inadequate infrastructure or software to accurately compute travel time.
- The cost of added infrastructure and/or software to implement the capability to display travel-time messages varies widely among TMCs.

Although several TMCs surveyed display messages during non-incident/non-roadwork periods, the percentage of TMCs that *regularly* display messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank is: congestion (12%), safety campaign (8%), PSA (3%), speed (2%), and traffic law or ordinance (2%) messages. Higher percentages of TMCs display these messages often, sometimes, or rarely.

The basis for displaying congestion, speed, PSA, safety campaign, and traffic law or ordinance messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank was found to be primarily (and, in some cases, solely) administrative/upper-management preference, TMC manager/supervisor preference, or both. Very little, if any, objective data from focus groups or other research studies were used in the decision-making process for displaying the messages. A significant percentage of TMCs that display these types of messages did not know the public's attitude about the messages; therefore, there is uncertainty among TMCs as to the effectiveness of these messages and whether they are beneficial.

CMS messages that indicate the levels of traffic congestion are discouraged by the authors of CMS message design and display guidelines because of the difficulty in finding adequate words to describe the large continuum of congested traffic conditions during the peak period. The problem with finding adequate descriptors during the peak period is compounded when incidents occur. The survey results, however, indicated that some TMCs display congestion messages. Some TMCs expressed concern that the differences between the various levels of congestion (e.g., heavy, moderate, or light) are not clear to drivers.

Messages that provide the beginning and end of traffic congestion are helpful to the motorists. Because the locations and limits of congestion change very quickly, several TMCs experience difficulty in displaying accurate messages.

Results of research reported in the literature revealed that speed messages are not ranked high among the information needs of motorists when incidents occur on the freeway or when roadwork is affecting traffic flow and may be easily misinterpreted. Therefore, the display of speed information on CMSs during incidents or roadwork is not recommended. The major concern and challenge expressed by the TMCs when displaying speed messages during non-incident/non-roadwork periods was to display accurate speed information and to change the speed message when traffic flow and weather conditions change. Credibility can be an issue.

The display of PSAs is discouraged by FHWA. There are strong arguments against displaying PSAs, including adverse public response, credibility, and the possibility of change blindness—the failure to see the CMS message change—when important messages are displayed. One consequence of displaying PSAs is that this leads to requests from other agencies to display non-traffic-related messages.

The display of safety messages associated with a safety campaign is allowable under provisions of the *Manual on Uniform Traffic Control Devices* (MUTCD). Safety campaign messages should be current and displayed for a limited time. The results of the survey revealed that safety campaign messages are currently displayed by a large majority of TMCs. Comparable to PSAs, display of safety campaign messages often leads to requests from other agencies to display non-traffic-related messages.

Few TMCs reported on their experiences, lessons learned, concerns, and challenges with displaying traffic law or ordinance messages. There is some indication that law enforcement agencies favor the display of these types of messages.

AMBER alert messages are displayed by 100% of the TMCs that responded to the survey. The majority of the TMCs reported very favorable or favorable public response to such messages, although 16% of the TMCs did not have sufficient information to comment on the public's response.

Many of the TMCs reported that they are not certain as to the most effective message content for AMBER alert messages. Some TMCs recognized that the messages they posted were too long for drivers to read and recall; drivers tended to slow down to read the messages. Research results reported in the literature indicated that there is a hierarchy of CMS message elements and specific terms for each message element preferred by motorists.

Most of the TMCs display AMBER alert messages that exceed current effective message design guidelines concerning the maximum number of units of information in a message. Therefore, it is expected that drivers will not be able to read and recall the messages, particularly license plate numbers and 10-digit telephone numbers.

Many TMCs encounter problems with getting complete and timely information from law enforcement agencies. Therefore, they are concerned about not being able to display accurate and timely information.

CHAPTER ONE

INTRODUCTION

GENERAL PURPOSE OF CHANGEABLE MESSAGE SIGNS

Road signs exist to communicate information to motorists. Static guide signs are permanent and are limited to presenting information that is largely "geographically linked." Changeable message signs (CMSs) can present up-to-the-moment traffic and roadway information.

CMSs are programmable traffic control devices that can usually display any combination of characters to present messages to motorists. These signs are either permanently installed above or on the side of the roadway or portable devices attached to a trailer or mounted directly on a truck and driven to a desired location. Portable CMSs are much smaller than permanent CMSs and are oftentimes used in highway work zones, when major crashes or natural disasters occur, or for special events (e.g., sporting events). This synthesis addresses only permanent CMSs.

When installed, CMSs become a part of the total motorist information system. Thus, the information presented on CMSs and the placement of the signs must be consistent and compatible with static signs used on the freeway.

CMSs perform a critical role on freeways. Such signs can furnish motorists with real-time traveler information that can advise them of a problem and, in some cases, a suggested course of action. CMSs also are used to improve motorist safety and reduce traffic congestion and delay. Additionally, CMSs can be used to manage traffic by displaying early warning, advisory, and alternative route messages.

BACKGROUND

It has been estimated that more than $300 million has been spent in the deployment of CMSs in the United States. CMSs as defined in the *Manual on Uniform Traffic Control Devices* (MUTCD) are sometimes referred to as dynamic message signs (DMSs) or variable message signs (VMSs) (*1*). Permanently mounted CMSs are used primarily for the following applications:

- Non-recurrent problems—caused by random, unpredictable incidents such as crashes; stalled vehicles spilled loads; or caused by temporary, preplanned activities such as construction, maintenance, or utility operations.
- Environmental problems—caused by acts of nature such as fog, floods, ice, snow, etc.
- Special event traffic problems—problems associated with special events (e.g., ball games and parades).
- Special operational problems—operational features such as high occupancy, reversible, exclusive, or contraflow lanes; and certain design features such as drawbridges, tunnels, and ferry services.
- AMBER (America's Missing: Broadcast Emergency Response) alerts—notification program to help locate missing children believed to have been abducted.

When the CMSs are not used for the aforementioned applications, the traditional wisdom has been to leave permanent CMSs blank. However, some state departments of transportation (DOTs) are using their CMSs to display other types of messages during non-incident/non-roadwork periods. Provisions in the MUTCD allow agencies to display safety-campaign messages and non-incident, transportation-related messages (*1,* §2A.07). Certain types of messages, such as travel-time information and AMBER alerts, are gaining popularity among state DOTs. These practices may lead to more frequent use of CMSs. However, there is concern that more frequent use of these non-incident/non-roadwork transportation-related messages can compromise the credibility of the CMSs. If CMSs distract drivers from more critical tasks while traveling at prevailing speeds, or if the messages are erroneous or outdated, then driver acceptance can be compromised. In addition, if the messages are too long, complex, and/or confusing to read and comprehend, drivers may reduce speed to read the messages and this could result in a potential safety problem.

Guidelines for the design and display of CMS messages for incidents and roadwork are available. However, guidelines are not available for messages displayed during non-incident/non-roadwork periods, and information is not available concerning state practice regarding messages displayed during non-incident/non-roadwork periods.

SYNTHESIS OBJECTIVES

The objective of this synthesis was to provide current information concerning the display of messages during non-incident/non-roadwork periods gathered from the literature and state, toll road, turnpike, and parkway transportation agencies that operate permanent CMSs. (In subsequent sections of this

synthesis, *permanent CMSs* are referred to as *CMSs*.) Information gathered for this synthesis included the following:

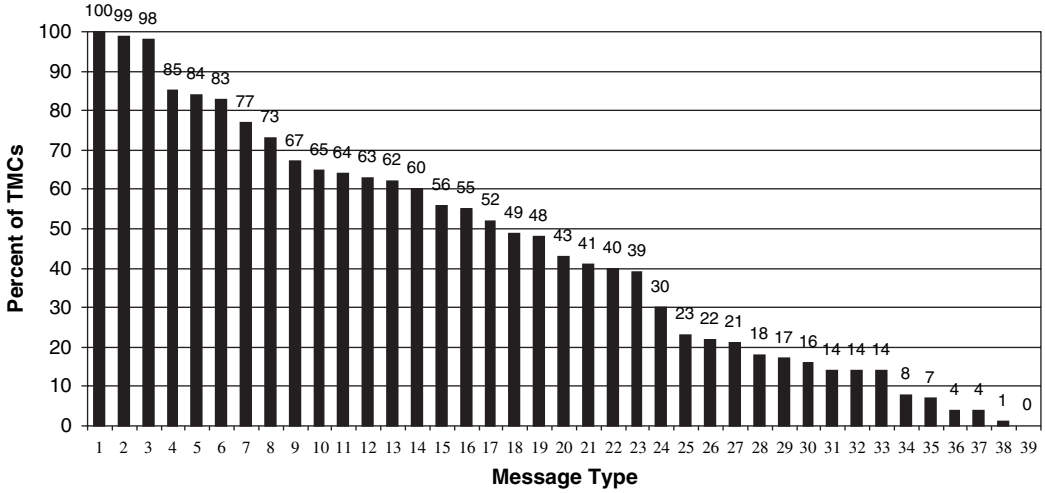
- Agency policies, guidelines, practices, and procedures for displaying or prohibiting messages during non-incident/non-roadwork periods in both urban and rural areas;
- Categories of messages displayed;
- Prioritization of messages displayed and rank order, if applicable;
- Message content;
- Experiences and lessons learned by agencies about displaying messages [e.g., travel time, AMBER alert, public service announcements (PSAs), and other non-incident, non-roadwork messages] or leaving CMSs blank, including information gained from public reaction or feedback, surveys, and focus groups; and
- Results from completed and on-going research concerning the design, display, and operation of CMSs, especially as related to human factors issues.

The primary intent of this synthesis was to identify practices that have proven effective, as well as those that have not. It serves as a guide to states and other transportation agencies in making more effective use of CMSs for non-incident/non-roadwork messages.

STUDY APPROACH

A review of the literature was conducted to evaluate relevant results from completed and on-going research concerning the design, display, and operation of CMSs related to human factors issues. In addition, an online survey was conducted to obtain current practice from state DOTs and toll road agencies that operate CMSs. The questionnaire developed for the survey was sent to 50 state DOTs and 10 toll road agencies that operate CMSs.

An e-mail with the online questionnaire was sent in mid-February 2007 to members of the AASHTO Subcommittee on Operations and Management and to the 10 toll road agencies. Because it was likely that the practice of displaying CMS messages during non-incident/non-roadwork periods varied among the traffic management centers (TMCs), instructions



1 AMBER alert
2 Roadwork
3 Incidents
4 Flood
5 Advance notice of upcoming roadwork
6 Ice on road
7 Snow on road
8 Planned special events
9 Special high-volume traffic (e.g., holiday weekend)
10 Evacuation during chemical spills
11 Fog
12 Snow
13 High water but passable
14 Evacuation during terrorist attack
15 Evacuation during wildfire
16 Wind
17 Support of highway advisory radio
18 Advance notice of special event
19 Evacuation during hurricane
20 Smog/ozone
21 Rain
22 Homeland security
23 Truck restrictions
24 Sand/dust
25 Advance notice of holiday/recreation traffic
26 HOV lanes
27 Hazardous cargo
28 Mountain pass control
29 Bridge control
30 Tunnel control
31 Contra-flow lanes
32 Reversible lanes
33 Inter-modal (e.g., ferry schedule, Amtrak)
34 Mixed-flow managed lanes
35 Advanced parking system
36 International border crossing
37 Exclusive lanes
38 Highway/railway grade-crossing
39 Highway/light rail transit crossing

FIGURE 1 Current applications of CMSs.

in the e-mail requested that the questionnaire be forwarded to the manager/supervisor of all TMCs within the agency.

The questionnaire, as shown in Appendix A, contained several decision logic branches so that certain questions were automatically skipped based on responses to other questions. Therefore, a respondent completing the questionnaire online may not have seen all of the questions that are shown in the version in Appendix A. In addition, some of the questions in the online version were shown in a slightly different format.

The questionnaire was structured to highlight the following types of non-incident/non-roadwork messages, which, based on the experience of the author and a review of the literature, would most likely be the types of messages that may be regularly or periodically displayed by the transportation agencies as an alternative to leaving CMSs blank:

- Travel time,
- Congestion,
- Speed,
- Safety campaigns,
- PSAs, and
- Traffic law or ordinances.

Although AMBER alert messages are displayed for child abductions and not as a substitute for leaving the CMSs blank, the survey provided an opportunity to obtain more information on issues relative to displaying AMBER alert messages.

The survey was also used to determine the other types of messages that the transportation agencies currently display. Therefore, after self-identification questions, the respondents were presented with a list of 39 message applications related to traffic operations and were asked to identify the types of messages that they currently display on CMSs. The list of message applications included incidents, roadwork, and other types of messages that would be used for specific applications (e.g., non-recurrent, environmental, special event traffic, and special operations problems). The list did not include travel time, congestion, speed, PSAs, safety campaign, or traffic law and ordinance messages because they were addressed separately in the questionnaire. However, AMBER alert was one of the message types included in the list.

AGENCY RESPONSE TO SURVEY

Responses were received from 40 state DOTs and 6 toll road agencies with a total of 100 TMCs. The TMCs operated 3,023 CMSs in urban areas and 821 CMSs in rural areas. Forty-two TMCs operated CMSs only in urban areas, 8 only in rural areas, and 50 in both urban and rural areas. A list of the agencies and the TMCs within each agency that completed the questionnaire and the number of CMSs operated by each is shown in Appendix B.

CURRENT APPLICATIONS OF CHANGEABLE MESSAGE SIGNS

As a starting point to the objectives of the survey conducted as part of the study, the TMCs were asked to identify current applications of CMSs. The results are shown in Figure 1. Of particular interest is that all of the TMCs that responded to the questionnaire display AMBER alert messages. In addition, 99% display roadwork messages and 98% display incident information. The lone exception to roadwork messages was one toll road agency. The exception to incident information was one state DOT that has two TMCs that operate a small number of CMSs only in rural areas.

CHAPTER TWO

CHANGEABLE MESSAGE SIGN MESSAGE DESIGN AND DISPLAY GUIDELINES AND POLICIES

PUBLISHED CHANGEABLE MESSAGE SIGN MESSAGE DESIGN AND DISPLAY GUIDELINES FOR INCIDENTS AND ROADWORK

The first comprehensive set of guidelines for designing and displaying CMS messages for incidents and roadwork was documented in the *Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 1—Design Guide* (*2*) in 1978. The design guide was written following extensive human factors laboratory, controlled field, and operational studies. The emphasis in the report was on (1) the recommended content of CMS messages for various traffic situations; (2) the manner in which messages should be displayed (format, coding, style, length, load, redundancy, and the number of repetitions); and (3) where messages should be displayed with respect to the situations they explain.

Following additional human factors laboratory, controlled field, and operational studies, the 1978 *Design Guide* was updated in a 1986 report, *Manual on Real-Time Motorist Information Displays* (*3*).

A 1991 report, *Guidelines on the Use of Changeable Message Signs* (*4*), provided guidance on (1) selection of the appropriate type of CMS display, (2) the design and maintenance of CMSs to improve conspicuity (target value) and motorist reception of messages, and (3) pitfalls to be avoided. CMS technology developments after 1986 were emphasized.

In 1997, the New Jersey DOT funded a multiyear research study that included human factors laboratory and controlled field studies dealing with CMS message design and operations. The research led to the development of the 2001 *Variable Message Sign Operations Manual* (*5*). The report includes detailed step-by-step processes for designing messages for incident and roadwork situations and includes CMS operational policies. It provides very specific information for CMS operators and entry-level personnel, reminders for experienced personnel, and high-level information for managers.

The 2004 FHWA *Changeable Message Sign Operation and Messaging Handbook* (*6*), an updated and expanded version of the New Jersey study (*5*), was written for national use with added emphasis on CMS policy and operational procedures. The design and display of messages on CMSs introduce many challenges to transportation agencies. Recommendations to meet these challenges were presented in this handbook. In addition, a few operational practices were discussed with respect to conformance and nonconformance to recommended message design and display options that are based on human factors studies.

Texas DOT's (TxDOT's) 2006 *Dynamic Message Sign Message Design and Display Manual* (*7*) is patterned after the New Jersey DOT's *Variable Message Sign Operations Manual* and FHWA'S *Changeable Message Sign Operation and Messaging Handbook*. To date, TxDOT's manual includes the latest objective data and information that meets the specific needs of TxDOT.

DEFINITIONS AND CHANGEABLE MESSAGE SIGN MESSAGE DESIGN CONSIDERATIONS

Developing Effective Changeable Message Sign Messages

To be effective, a CMS must communicate a meaningful message that can be read and understood by motorists within a very short time period (constrained by the sight distance characteristics of the location and design features of the CMS). Effective message design involves recognition of the basic principles for the following (*2–7*):

- Message content,
- Message length,
- Message load and units of information (informational unit),
- Message format, and
- Message splitting.

Message Content

Message content refers to specific information displayed on a CMS. Essentially, the key elements are: what is wrong ahead and what the motorist should do about it. If CMSs are to be read and believed by motorists, the content of the message must provide information relative to their needs. Above all, motorists want to know if something "ahead" has occurred on the roadway that would change their plans. A CMS message should also present "advice." This appears at the end of the brief message. It may be *REDUCE SPEED*, *EXIT AND TAKE OTHER ROUTES,* or some other advice.

Many motorists will ignore advice unless a reason is offered for taking it. The "reason" in most cases is the problem (e.g., *MAJOR ACCIDENT*, *LEFT 2 LANES CLOSED*). Motorists expect this information to appear first in a CMS message. They also would like to know where the problem has occurred. This is given on the second line. If the incident occurs far away, it may not affect them if they planned to exit long before then.

Message Length

Message length refers to either the number of words or the number of characters and spaces in a CMS message. With CMS line capacity less than optimal, it becomes necessary to count the characters in a message to determine if the message will fit. If the message does not fit, acceptable abbreviations can be used and/or redundant words can be eliminated. It may, at times, be necessary to split the message and display the parts in two phases.

The maximum length of a CMS message is controlled in part by *reading time*—the time the motorist has available to read the message. Reading time is affected by (1) the time that the motorist is within the legibility zone of the CMS message, and (2) by the amount of activity in the traffic stream to which the motorist must attend (e.g., reading signs, adjusting vehicle speed, and lane positioning). The entire message must be short enough to allow motorists to glance at the sign and read and comprehend the message while attending to the complex driving situation.

Message familiarity enhances motorist reading time. When information displayed on a CMS applies to unfamiliar drivers, or when the information being presented to commuters is unusual, longer reading times will be required than for information posted frequently and seen repeatedly by commuting traffic. Site-specific characteristics and normal CMS operating procedures dictate what information is usual and what is not, and therefore this factor varies from location to location.

Another important consideration in designing CMS messages is the need for motorists to time-share their attention to the roadway, to traffic, and to reading signs. Adults can read quite fast while sitting at home reading a newspaper or a novel or while in stopped traffic reading a sign or billboard. However, drivers cannot always devote full attention to sign reading; they must share their attention between information necessary for the task of driving and the information on signs. Because of this time-sharing situation, it will take longer to read a sign than if the driver could devote all of their attention to the sign.

It is important to note that unfamiliar drivers must typically read the entire message on a CMS to properly comprehend the information being presented. In contrast, they do not have to read the entire guide sign to obtain relevant information about guidance. Therefore, it takes a driver longer to read a CMS message than to read the message on a guide sign. In a driving situation, the driver has a limited amount of time to read a message on a sign. He or she can start reading a sign when the words become legible at the legibility distance of the sign. Guidelines recommend that the character height on CMSs on freeways should be at least 450 mm (18 in.) so that drivers can read and comprehend typical CMS messages while traveling at typical freeway speeds. The legibility distances that should be used when designing and displaying messages on CMSs with characters that are 450 mm (18 in.) high are shown in Table 1 (*5–7*).

About 85% of drivers can begin reading a message on the newer light-emitting diode (LED) CMSs with 450 mm (18-in.) characters—desirable on freeways—about 245 m (800 ft) in front of the sign (*8*). Research strongly suggests that motorists can read an 8-word message (excluding prepositions such as *TO* and *AT*) in 8 s, or one word per second (*2–10*). Based on the known legibility distance of CMSs, this translates to the following maximum message lengths (*11–13*):

- Eight words while the motorist is traveling at 90 km/h (55 mph),
- Seven words at 105 km/h (65 mph), and
- Six words at 115 km/h (70 mph).

Longer messages than these should be avoided because motorists will often reduce their speeds in order to read the message or will simply not read the entire message.

When the complexity of the driving situation increases owing to extremes in geometrics, heavier traffic volumes,

TABLE 1
LEGIBILITY DISTANCES FOR USE IN MESSAGE DESIGN AND DISPLAY ON CHANGEABLE MESSAGE SIGNS WITH 450-mm (18-in.) HIGH CHARACTERS (*5–7*)

	Light-Emitting Diode*		Fiber Optic		Flip Disk	
Condition	Meters	Feet	Meters	Feet	Meters	Feet
Sun: Mid-Day	244	800	244	800	183	600
Sun: Washout	244	800	244	800	122	400
Sun: Backlight	183	600	152	500	76	250
Nighttime	183	600	183	600	76	250

*Valid only for the newer aluminum indium gallium phosphide (or equivalent) LEDs.

Exhibit 1

UNIT OF INFORMATION

Question	Answer	Unit of Information
1. What happened?	ACCIDENT	1 unit
2. Where?	PAST ROWLAND	1 unit
3. Who is advisory for?	FAIR PARK	1 unit
4. What is advised?	USE FITZHUGH	1 unit

increased traffic conflicts (e.g., merging and lane changing), or climatological conditions, motorists will attend to those information needs they believe are most important to them and to their safety. These demands on the motorist will result in less time available to read the CMS message.

In addition, lighting and environmental conditions affect CMS legibility. For example, during part of the day, the sun may not affect the legibility of the CMS. However, if the sun shines directly in the eyes of the motorist, then the legibility distance for the motorist can be greatly reduced. It may be necessary to reduce the length of the message to account for the reduced visibility.

The CMS message designer should always look for ways to reduce the message length without losing the intent of the message. Reducing message length can sometimes be accomplished by using alternative phrases that are understandable by motorists and have the same meaning as the original phrase. Also, there may be redundant or unimportant information in the message, which can be omitted.

Message Load and Units of Information

The term load refers to the units of information in the total message. A unit of information (or informational unit) refers to the answer to a question a motorist might ask. Stated another way, a unit of information is each data item in a message that a motorist could use to make a decision. Each answer is one unit of information. The incident message in Exhibit 1 has four units of information and serves to illustrate the concept of units of information.

A typical unit of information is one to three words, but can be up to four words. Because motorists can process a limited amount of information, the amount of information that should be displayed on a CMS is also limited. Too much information, particularly when the driving situation is complex, can result in driver information overload. Driver information overload results from providing too much information through devices or conditions for a driver to respond properly (*14*). When drivers are confronted with more information than they can process, they may decelerate severely or drive unduly slowly, make late or erratic maneuvers, take an improper route alternative, ignore critical information, fail to monitor other traffic, or have excessive eyes-off-the-road episodes. Research results indicate that drivers need 2 s per unit of information to be able to read, comprehend, and react to CMSs messages. The maximum number of units in a message is influenced by the legibility distance of the CMS and the operating speed on the freeway. Tables 2 and 3 contain information on the maximum number of units of information that should be displayed on LED, fiber optic, and flip disk CMSs (the most common types of CMSs) with characters that are 450 mm (18 in.) high (*5–7*). The recommendations shown in Tables 2 and 3 are based on research and operational experience (*8–13*). In addition, the following principles apply (*5–7*):

- No more than four units of information should be in a message when the traffic operating speeds are 56 km/h (35 mph) or more.

TABLE 2
MAXIMUM NUMBER OF UNITS OF INFORMATION FOR USE IN MESSAGE DESIGN AND DISPLAY ON LIGHT EMITTING DIODE* AND FIBER OPTIC PORTABLE CHANGEABLE MESSAGE SIGNS WITH 450-mm (18-in.) HIGH CHARACTERS (*5–7*)

	70–80 km/h (45–50 mph)	90–105 km/h (55–65 mph)	115–120 km/h (70–75 mph)	130 km/h (80 mph)
Daytime	4 units	4 units	4 units	3 units
Daytime with Sun Behind Sign	4 units	3 units	3 units	2 units
Nighttime	4 units	3 units	3 units	2 units

*Valid only for the newer aluminum indium gallium phosphide (or equivalent) LEDs.

TABLE 3
MAXIMUM NUMBER OF UNITS OF INFORMATION FOR USE IN MESSAGE DESIGN AND DISPLAY ON FLIP DISK PORTABLE CHANGEABLE MESSAGE SIGNS WITH 450-mm (18-in.) HIGH CHARACTERS (*5–7*)

	70–80 km/h (45–50 mph)	90–105 km/h (55–65 mph)	115–120 km/h (70–75 mph)	130 km/h (80 mph)
Daytime	4 units	3 units	3 units	2 units
Daytime with Sun on Sign Face	3 units	2 units	2 units	2 units
Daytime with Sun Behind Sign	2 units	1 unit	1 unit	1 unit
Nighttime	2 units	1 unit	1 unit	1 unit

- No more than five units of information should be displayed when the operating speeds are less than 56 km/h (35 mph).
- No more than three units of information should be displayed in a one message phase.
- No more than two units of information should be displayed on a message line.

Message Format

Message format refers to the order and arrangement of the units of information on a CMS. The CMS message must contain the proper information in the expected order to allow motorists to easily read and interpret the information and make rational decisions based on that information.

Message Splitting

Occasionally, the required message may be too long to display on three CMS lines. Under this circumstance, a long message may be broken (chunked) into phases with compatible informational units. The MUTCD specifies that for freeway and expressway applications, no more than two phases should be used to display a CMS message (*1*, §2E21). To ensure that drivers are not overwhelmed with long messages, some state DOTs and TMCs have found it more effective to restrict CMS messages to three lines, and they do not use two-phase messages.

Dynamic Features on Changeable Message Signs

Experience has shown that some state DOTs use dynamic features on CMSs (i.e., flashing the message, flashing one of the lines in a message, or alternating one of the lines of a two-phase message) with the belief that the dynamic feature will attract the attention of drivers. Research reported by Dudek et al. (*15, 16*) indicated that these dynamic features should not be used. Using a driving simulator, Dudek et al. conducted studies to determine the effects of (1) flashing a one-phase, three-line message; (2) flashing one line of a one-phase, three-line message; and (3) alternating one line of a two-phase, three-line sign while keeping the other two lines constant between the phases (redundancy). In the first dynamic feature, all three lines were flashed. Only the top line was flashed for the second dynamic feature. Messages with these three dynamic features were compared with comparable static messages. The measures of effectiveness were reading times, comprehension, and preference. In addition, driver performance measures of effectiveness were acceleration noise (an indication of the number and degree of speed changes), average lane position, standard deviation of lane position, average distance headway, maximum distance headway, minimum distance headway, and standard deviation of distance headway.

No differences in average reading time were found between the messages in which all three lines flashed and static messages. However, the results suggested that flashing an entire one-phase message may have adverse effects on message understanding for drivers who are unfamiliar with this dynamic mode of display. A significant percentage of the subjects preferred the static display.

The average reading time for the flashing line (top line) messages was significantly longer than the static messages. The results also suggested that unfamiliar drivers will be adversely affected by this particular display feature, relative to comprehension of the entire message. The subjects liked the flashing line and static messages equally as well.

The average reading time for the alternating line messages (with redundancy) was significantly longer than that for the messages that did not alternate (no redundancy). There was no significant difference in comprehension of each message line or for the number of message lines recalled. However, slightly less than 70% of subjects understood all four message lines for both message modes.

CHANGEABLE MESSAGE SIGN OPERATIONS POLICIES

A distinction is made between CMS operations policies and guidelines. CMS operations policies contain the guiding principles that are considered to be prudent and that influence the actions taken by the managers of TMCs in the operation of CMSs (e.g., the determination that CMSs should or should

not be blank when there are no incidents or roadwork on the freeway). CMS guidelines outline and describe the day-to-day operation of the CMSs (e.g., the content and format of CMS messages).

Available information on guidelines was presented at the beginning of this chapter. Suggested polices that can be adopted by state DOTs for CMS operations are presented in previous research (*5–7*). There are no written CMS operations policies at the national level. However, policies, standards, and guidance are embodied in the MUTCD (*1*) and in four FHWA policy memoranda (*17–20*). In addition, another memorandum (*21*) describes FHWA's recommendation for displaying travel time on CMSs. These FHWA memoranda are briefly described in the section that follows.

FHWA Policies and Guidelines

Use of CMSs

Use of Changeable Message Signs (CMSs) (*17*), an FHWA policy memorandum dated January 19, 2001, supports use of CMSs as a traffic control device to safely and efficiently manage traffic by informing motorists of roadway conditions and the required actions to perform. The primary sections addressing CMSs in the MUTCD are *Section 2A.07 Changeable Message Signs*; *Section 2E.21, Changeable Message Signs*; and *Section 6F.55, Portable Changeable Message Signs*. Excerpts of the January 19, 2001, memorandum that relate to policies and guidelines follow:

> . . . Section 2A.07 of the *Manual on Uniform Traffic Control Devices* (MUTCD) requires that a CMS shall conform to the principles established in the MUTCD related to the use of signs within the right-of-way of all classes of public highways, and to the extent practical, the design and applications prescribed in Sections 6F.02 and 6F.52 (now Section 6F.55). Section 2E.21 of the MUTCD specifies that "Changeable message signs shall display pertinent traffic operational and guidance information only, not advertising."
>
> The FHWA supports the use of a CMS as a traffic control device to safely and efficiently manage traffic by informing motorists of roadway conditions and required actions to perform. The appropriate use of a CMS and other types of real-time displays should be limited to managing travel, controlling and diverting traffic, identifying current and anticipated roadway conditions, or regulating access to specific lanes or the entire roadway.
>
> . . . The use of a CMS for the display of general public information or other nonessential messages is discouraged. Only essential messages should be displayed on a CMS.
>
> The content of a CMS message should be based on requiring the motorist to take an action. However, operational, road condition, and driver safety focused messages are acceptable to be displayed on a CMS. If driver safety focused messages are to be displayed on a CMS, they should be kept current and relate to a safety campaign. The period of time that a specific message is displayed for a safety campaign should be limited to a few weeks . . .

Safety Campaign Messages

"Click It or Ticket" Signs, (*18*), an FHWA policy memorandum dated March 6, 2002, addresses whether the safety campaign message *CLICK IT OR TICKET* is in conformance with the MUTCD. Although the memorandum primarily addresses static signs, it implies that a *CLICK IT OR TICKET* message is appropriate for display on CMSs. The following statements are contained in this memorandum:

> The display of safety messages associated with a safety campaign is allowable under the current MUTCD, as long as it conforms to sign design, location, and spacing requirements and does not block other regulatory, guide, and/or warning signs. We have determined that the "Click It or Ticket" signs meet the design requirements and are in conformance with the Manual based on the following analysis.
>
> The Millennium Edition of the MUTCD does not specifically address safety message signs; however, there are provisions in Section 1A.03 and Section 2B.51 (now Section 2B.54) that allow an agency to develop its own regulatory and warning message signs, as long as they follow the basic guidelines on color, appearance, etc. Section 2B.51 (now Section 2B.54) of the Manual also includes the seat belt symbol.
>
> The Federal Highway Administration (FHWA) supports the use of a Changeable Message Sign (CMS) as a traffic control device to safely and efficiently inform motorists of roadway conditions and required actions to perform. The FHWA issued a policy memorandum on CMS January 19, 2001. That policy gives general guidance and allows driver safety messages to be displayed on a CMS including those associated with a safety campaign. The "Click It or Ticket" sign design for a safety campaign conforms to the information in this memorandum.

AMBER Alert Messages

AMBER Alert—Use of Changeable Message Sign (CMS) (*19*), a policy memorandum dated August 16, 2002, clarifies FHWA policy on the use of CMSs to display child abduction messages as part of an AMBER Plan Program. Parts of the memorandum that relate to policies and guidelines follow:

> If public agencies decide to display AMBER alert or child abduction messages on a CMS, FHWA has determined that this application is acceptable only if (A) it is part of a well-established local AMBER Plan Program, and (B) public agencies have developed a formal policy that governs the operation and messages that are displayed on CMS.
>
> (A) A local AMBER Plan Program would include written criteria for issuing and calling off an AMBER alert, procedures on issues to coordinate with local agencies and other interests, and conforms to the recommendations of the national program. Specific criteria for issuing an alert and the associated procedures may include:
>
> 1. Confirmation that a child has been abducted;
> 2. Belief that the circumstances surrounding the abduction indicate that the child is in danger of serious bodily harm or death; and
> 3. Enough descriptive information about the child, abductor, and/or suspect's vehicle to believe an immediate broadcast alert will help.

(B) The formal public agency policy and procedures relating to displaying AMBER alert or child abduction messages on CMS must address the following issues:
   1. The criteria under which CMS will be used for AMBER alerts.
   2. Clear identification of the law enforcement agency responsible for issuing the alert (e.g., state police, local police department, etc.).
   3. Agencies, interests, and persons to be contacted and information to be disseminated to initiate or call off an AMBER alert.
   4. Specific recognition that traffic messages, such as lane closures, fog alerts, detours, etc., are the highest priority, and circumstances under which the AMBER alert message could or could not be displayed.
   5. Length of time to display the message (should be of short duration, typically a few hours). (Note: 4 and 5 should be defined in cooperation with the responsible law enforcement agency based on the specific circumstances of the abduction.)
   6. Geographic area over which the information is to be displayed (should be limited to a reasonable search distance that is reachable within a few hours).
   7. Circumstances that would cause the discontinuation of use of the CMS if the AMBER alert message creates an adverse traffic impact such as queues, markedly slowing of traffic, etc.
   8. Format and content of the messages to be displayed. Agencies should follow the recommended national CMS practices related to the development, use of text, manner in which messages should be displayed, and how CMS are operated.

Emergency Security Messages

Use of Changeable Message Sign (CMS) for Emergency Security Messages, (*20*) an FHWA memorandum dated March 21, 2003, contains documentation of FHWA policy for use of CMSs for emergency security. The part of the memorandum that addresses FHWA policy, should a public agency decide to display emergency or security alert messages on CMSs, follows:

> If public agencies decide to display emergency or security alert messages on a CMS, FHWA has determined that this application is acceptable if public agencies have developed policies and procedures that govern the messages that are displayed on CMS and their operation. The public agency policy and procedures relating to displaying emergency or security alert messages on CMS must address the following issues:
>
> 1. The criteria under which CMS will be used for emergency or security alert messages, including the necessary coordination with public safety or security agencies. Formal policies among critical stakeholders (such as law enforcement, security, transportation, and public safety) can be used to establish these agreed upon criteria.
> 2. Protocols or hierarchy for prioritizing messages and determining which messages are to be displayed.
> 3. Geographic area over which the information is to be displayed, to be determined in cooperation with public safety and security agencies.
> 4. Identification of the circumstances under which transportation-related messages, such as lane closures, fog alerts, detours, or other messages that may be needed because of dangerous travel conditions in the immediate vicinity, would preempt emergency or security alert messages.
> 5. The criteria that would cause the discontinuation of use of the CMS if the emergency or security alert message creates an adverse traffic impact such as queues, markedly slowing traffic, etc.
> 6. Methodology for developing and displaying messages that are appropriate for CMS display including but not limited to standard message sets. Agencies should follow the recommended national CMS practices related to the development, use of text, manner in which messages should be displayed, human factors related to understandability of the messages, and how CMSs are operated.

Travel-Time Messages

Information and Action: Dynamic Message Sign (DMS) Recommended Practice and Guidance, (*21*) an FHWA policy memorandum dated July 16, 2004, notes that FHWA strongly recommends the display of travel-time information on CMSs whenever possible. A relevant part of the memorandum follows:

> . . . Our goal should be to have travel-time information as the default information available to motorists throughout the day. A "dark" or blank CMS is a transportation investment that is not being fully utilized. We should be asking why is it dark and what will it take to get travel time posted on an ongoing basis. Furthermore, no new CMS should be installed in a major metropolitan area or along a heavily traveled route unless the operating agency and the jurisdiction have the capability to display travel-time messages.

State Department of Transportation Policies and Guidelines

The TMCs were asked in the survey whether they have a written policy or guidelines regarding the design and/or display of CMS messages. Seventy-five percent of the TMCs that responded have a written policy or guidelines. The specific agencies that reported having a written policy or guidelines are listed here:

- Alabama DOT
- Arizona DOT
- California DOT (Caltrans)
- Colorado DOT
- Connecticut DOT
- Delaware DOT
- Georgia DOT
- Florida DOT
- Iowa DOT
- Kansas DOT
- Kentucky Transportation Cabinet
- Louisiana DOTD
- Maine DOT
- Maryland SHA
- Minnesota DOT
- Missouri DOT
- Nevada DOT
- New York State DOT
- North Carolina DOT

- Oklahoma DOT
- Oregon DOT
- Pennsylvania DOT
- Rhode Island DOT
- South Dakota DOT
- Tennessee DOT
- Texas DOT
- Utah DOT
- Virginia DOT
- Wisconsin DOT
- Harris County Toll Road Authority
- Illinois Tollway
- New Jersey Turnpike Authority, Turnpike Division
- Pennsylvania Turnpike Commission.

CHAPTER THREE

NON-INCIDENT/NON-ROADWORK MESSAGES

STATUS OF CHANGEABLE MESSAGE SIGNS

Background

Once a CMS system is installed, a question always arises concerning when messages should be displayed during non-incident/non-roadwork periods. There are the following two schools of thought on this topic:

1. Display messages only when unusual conditions exist on the freeway.
2. Always display messages regardless of whether or not unusual conditions exist on the freeway; or, at a minimum, always display a message during the peak periods and only when unusual conditions exist during the off-peak periods.

The authors of early CMS message guidelines recommended the first of the two approaches (display messages only when unusual conditions exist) unless travel-time messages could be displayed (*2–4*). The recommendations were based on human factors principles and came about because of difficulties in designing and displaying other types of messages when incidents or roadwork were present, particularly during peak periods. The second approach (always display a message) leads to violation of the following two important human factors principles for a CMS:

- Don't tell drivers something they already know; and
- For more effective systems, use the CMSs only when some response by drivers is required (i.e., change in speed, path, or route).

In the absence of incidents during the peak periods, more often than not, bottleneck locations and the subsequent locations and durations of congestion can be predicted by motorists. Consequently, the same congestion information will most likely be displayed almost daily. There is concern by some that display of repetitive information will result in many drivers failing to read the CMS, even when important information is given, owing to the psychological visual change detection phenomenon referred to as change blindness (*22*). Change blindness is the phenomenon in which a person viewing a visual scene apparently fails to detect large changes in the scene. With respect to the issues discussed herein, a driver may fail to recognize that the current message is different than the message the driver previously saw on the CMS; thus, the driver fails to read the message. Associated with the change blindness phenomenon is a potential credibility problem. The issue of change blindness has caused some agencies to consider the use of flashing beacons on CMSs to attract the attention of motorists when incident, roadwork, or similar messages are displayed, even though CMSs, particularly light-emitting signs, are designed to attract the attention of motorists. At this time, it is not known if the practice of using flashing beacons improves motorist attention to the CMS message. To date, no research has been conducted to evaluate the effects of change blindness with respect to CMS messages.

Another consideration, with respect to displaying messages for recurring congestion, is that one simply runs out of descriptors for the various possible levels of congestion. For example, if descriptors such as *HEAVY CONGESTION* or *MAJOR DELAY* are used to describe recurrent congestion during the peak period, then descriptors are not available for the more severe congestion when incidents occur.

An example of negative public reaction to displaying messages during non-incident/non-roadwork periods was the experience of the TMC in Los Angeles. Initially, Caltrans personnel in the Los Angeles TMC displayed public service messages on freeway CMSs to avoid having blank signs. Although these messages were transportation-oriented in nature (e.g., *NEXT TIME TRY AMTRAK TO LAS VEGAS*, *RELIEVE CONGESTION–RIDESHARE*, etc.) they did not relate to the operation of the freeway system. Public reaction to the use of the CMSs in this manner was quite negative. There was a belief among traffic operations professionals that such use led to a public disregard of messages on the CMSs, thus making the signs less effective when traffic operational messages were displayed. The practice was discontinued, and the CMSs were then only used for messages pertaining to unusual real-time traffic flow conditions (D. Roper, former Deputy District Director, Operations, Caltrans, personal communication, Mar. 21, 2002). As will be discussed later, the TMCs in Los Angeles and other locations in California now display travel time.

In contrast, in 1992, Smith reported that CMSs were installed for the INFORM (INformation FOR Motorists) Project on Long Island more than 18 months before the system became operational because of delayed construction schedules (*23*). Adverse public reaction to having expensive

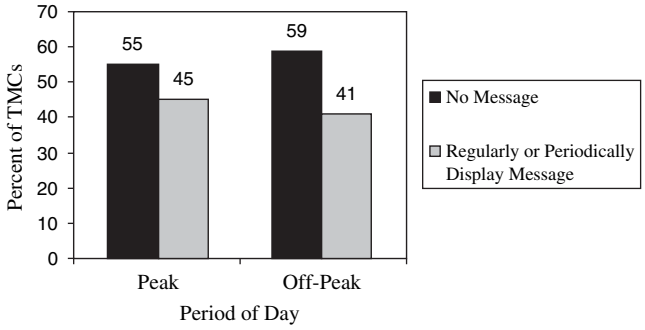


FIGURE 2 Status of CMSs during non-incident/non roadwork periods.

CMSs sitting idle for several months prompted New York DOT to adopt a policy of displaying some type of message on the freeway CMSs at all times.

Survey Results

General

A summary of the status of the CMSs during non-incident/non-roadwork periods reported by the agencies that responded to the questionnaire is shown in Figure 2. The results indicated that during the peak period, 55% of the TMCs do not display messages, whereas 45% regularly or periodically display a message. During the off-peak period, 59% do not display messages, whereas 41% regularly or periodically display a message.

Over the years, a decreasing number and percentage of transportation agencies have left CMSs blank during non-incident/non-roadwork periods. Conversely, the number that regularly or periodically displays messages has increased. In 1997, 77% of the state DOTs that responded to a survey had a policy of displaying messages only when unusual conditions were present on the facility and left the CMSs blank during other times (*24*).

Basis for Decision to Leave the CMS Blank or to Display a Message

The TMCs were asked for the basis for the decision to leave the CMSs blank or to regularly or periodically display messages during non-incident/non-roadwork periods. The results are summarized in Table 4.

Interestingly, the decision by 78% of the TMCs as to whether to leave the CMS blank or to display a message during non-incident/non-roadwork periods was based solely on agency administrative/upper-management preference and/or TMC manager/supervisor preference. An additional 7% included feedback from telephone calls, newspapers, radio, and/or television. Only 15% of the TMCs based their decision partly on information from focus groups or research.

Blank CMSs (No Message)

Status of CMSs When No Message Is Displayed Not all of the 59 TMCs that do not display messages during non-incident/non-roadwork periods leave the CMSs totally blank. Nine percent display a single pixel, and 5% display a set of pixels. A summary of the status of the CMSs for those TMCs that do not display messages during non-incident/non-roadwork periods is shown in Figure 3.

Public Response to Blank CMSs A summary of the responses to the question, "What has been the public reaction to leaving the CMSs blank?" is shown in Figure 4. Twenty-six percent of the 59 TMCs that do not display messages indicated that they have received very favorable (13%) or favorable (13%) responses. Thirty-seven percent indicated a somewhat favorable (13%) or neutral (24%) response. Thirty-seven percent indicated that they did not have sufficient information to comment on the public's response.

Experiences and Lessons Learned about Blank CMSs The experiences of the TMCs that do not display messages

TABLE 4
BASIS FOR DECISION TO DISPLAY OR NOT DISPLAY MESSAGES DURING NON-INCIDENT, NON-ROADWORK PERIODS

Basis		Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	27	78
	TMC manager/supervisor preference only	17	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	34	
Preference and Feedback	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	7	7
Preference and/or Research or Focus Group	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	3	15
	Research conducted by agency only	2	
	Research conducted by others only	7	
	Focus group studies only	3	
		100	100

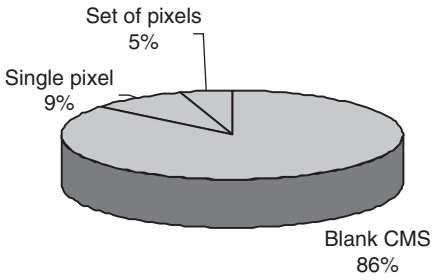


FIGURE 3 Status of CMSs for TMCs that do not display messages during non-incident, non-roadwork periods ($n = 59$).

appeared to be good, and several advantages were noted. Some of the experiences and lessons learned reported by the TMCs regarding CMSs left blank are as follows:

- No adverse comments from the public (18 TMCs).
- Driver acceptance/satisfactory experience (13 TMCs).
- Drivers pay more attention to the message when one is displayed. Messages are more effective when they are displayed. Frequent display of non-essential messages will result in drivers ignoring more important messages (15 TMCs).
- The CMSs are seen by some as underutilized (2 TMCs).
- CMS conspicuity and message urgency is preserved (1 TMC).
- Relevant, timely information enhances driver respect for the CMSs (1 TMC).
- Credibility is the key to success (1 TMC).
- Reduces the potential for displaying erroneous information (1 TMC).
- A lot of questions and confusion are eliminated by leaving the CMSs blank unless posting travel times or other advisory or incident messages (1 TMC).
- Time and temperature displayed is not the same as the time and temperature displayed in everyone's vehicles and a lot of people call to let you know "your time is off" or "your temp is wrong" (1 TMC).

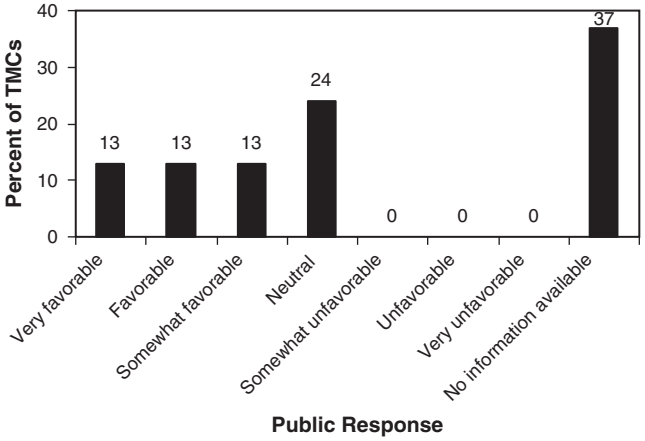


FIGURE 4 Reported public response to blank CMSs during non-incident/non-roadwork periods ($n = 59$).

- Test the CMSs, so the public knows they are working. Do not test the signs with a time and temperature display feature (1 TMC).
- CMSs should be reserved for traffic impacting incidents unless used for a safety campaign during off-peak hours (1 TMC).
- Drivers do not appreciate being "lectured to" with safety-oriented messages, even when there is not anything else important to say (1 TMC).
- Less maintenance is required on CMSs (1 TMC).
- We get complaints if we over-use taxpayer money being spent for signs that are not needed (1 TMC).
- We get complaints if we overuse them for construction lane closures off the system (adjacent freeway) (1 TMC).
- Displaying messages that may be unrelated to the motorist's travel could actually increase motorist disregard for the CMS when there are relevant messages displayed (1 TMC).
- A lot of questions and confusion are eliminated by leaving the CMSs blank unless posting travel times or other advisory or incident messages improves the focus of the project and does not create questions for the public. Back and forth flashing symbols to indicate the sign is working result in confusion and questions (1 TMC).
- We should develop procedures to better utilize the CMS (1 TMC).

Experiences and Lessons Learned about Displaying One or More Pixels As noted earlier, some of the TMCs display one or more pixels on the CMSs rather than leaving the signs totally blank. Some experiences and lessons learned by TMCs are as follows:

- Some drivers believe that a single pixel displayed on a CMS is a malfunctioning sign (1 TMC).
- We do get some negative feedback when a flashing dot is used. We still think leaving them blank is better (1 TMC).
- At one point, we tried displaying safety-related messages, and the feedback was very negative, so we went back to just a flashing pixel in the off-peak hours (1 TMC).

Concerns and Challenges The primary concerns and challenges regarding leaving the CMSs blank centered on (1) ways to convince motorists that the signs are functional and (2) pressures from administrators/upper-level management and others to display messages.

Plans for Changing Policy for Blank CMSs The agencies that currently leave the CMSs blank during peak, off-peak, or both, were asked whether they plan to change their policies. As shown in Figure 5, 90% of the 59 TMCs that leave their CMSs blank did not intend to change, whereas 10% planned to change their policy. About one-half of the TMCs that indicated that they intend to change their policy would like to display travel-time information whenever resources become available. The results indicate that the vast majority of the TMCs that leave the CMSs blank are satisfied with their current policy.

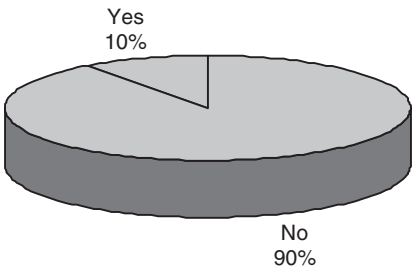


FIGURE 5 Percent of TMCs that plan to change policy regarding blank CMSs ($n = 59$).

Messages Displayed

Public Response to Messages Displayed during Non-Incident/Non-Roadwork Periods Twenty-three of the 45 TMCs (51%) that regularly or periodically display messages during non-incident/non-roadwork periods as an alternative to leaving the signs blank reported a very favorable (22%) or favorable (29%) public response. Several of these TMCs currently display travel-time information. Twenty percent reported a somewhat favorable (7%) or neutral (13%) response. Comparable to TMCs with blank CMSs, 27% reported that they had insufficient information to comment on the public's reaction. The public response is summarized in Figure 6.

Experiences and Lessons Learned about Displaying Messages Some of the experiences and lessons learned reported by the TMCs regarding messages displayed on CMSs are as follows:

- Positive feedback from motorists about travel time (10 TMCs).
- If the messages are unfamiliar or too long, motorists sometimes slow down to read messages (3 TMCs).
- Public likes that the CMSs are being used and not blank (3 TMCs).
- Some motorists like messages; some do not (2 TMCs).
- Keep messages simple (2 TMCs).

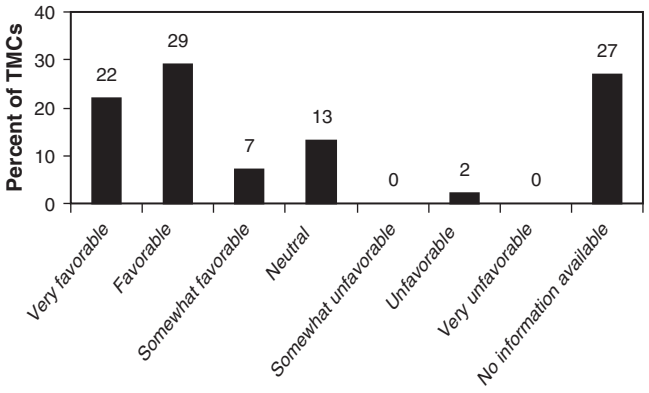


FIGURE 6 Public response to displaying messages during non-incident/non-roadwork periods ($n = 45$).

- Display messages that only are related to a motorist's commute (1 TMC).
- We get complaints if we override the trip times with other information, such as "big event this weekend" (1 TMC).
- Being able to display travel times has helped us to stay away from safety messages since we do not leave the CMSs blank (1 TMC).
- In addition to travel times, we have also displayed public service campaign messages (*MOVE OVER FOR STOPPED EMERGENCY VEHICLES*, *BOOZE AND LOSE IT*, *CLICK IT OR TICKET*) on a very limited basis. These have only been over weekends and only in conjunction with statewide media blitz campaigns. These types of media campaigns are limited to roughly one weekend once a quarter (1 TMC).
- We prefer to post positive messages such as *TRAFFIC MOVING WELL TO EXIT X* to reassure drivers that the system is working. If a sign is blank it could mean that nothing is going on or the sign is broken (1 TMC).
- Well received by other agencies (1 TMC).
- Leaving the CMSs blank is more effective since it removes the tendency for motorists to become complacent. More use is leading to less attentiveness (1 TMC).
- Motorists appreciate information disseminated for congestion and other motor-related laws (1 TMC).
- We have received numerous calls from the public in support of our traffic safety messages (1 TMC).
- We get to "exercise" the CMSs and make sure that we keep good preventive maintenance on them (1 TMC).

As noted, many TMCs display travel time during non-incident/non-roadwork periods. Several positive comments reported by the TMCs will be discussed further in the upcoming section on Travel-Time Messages.

Concerns and Challenges The primary concerns expressed and challenges noted by TMCs that display messages other than travel time were (1) uncertainty as to the best types of messages that should be displayed and (2) that when displayed, the messages are not changed often enough.

Plans for Changing Policy of Displaying Messages Plans for the 45 TMCs that regularly or periodically display

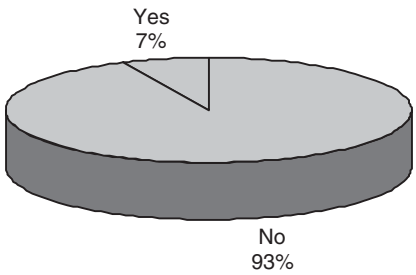


FIGURE 7 Percent of TMCs that plan to change policy regarding displaying messages during non-incident/non roadwork periods ($n = 45$).

messages during the peak, off-peak, or both, when incidents or roadwork are not present are summarized in Figure 7. Ninety-three percent stated that they do not have plans to change their policy, whereas 7% plan to change.

TRAVEL-TIME MESSAGES

Background

Types of Time-Related Information

As a prelude to discussion of the survey results dealing with travel-time messages, it is important to review the different types of time-related information that could be displayed on CMSs. There are five ways in which time-related information may be displayed on CMSs when a freeway is the driver's primary facility. They are as follows:

1. *Travel time* on the freeway,
2. *Comparative travel times* on the freeway and alternate route,
3. *Time saved* by taking an alternate route,
4. *Delay* on the freeway, and
5. *Delay avoided* by taking the alternate route.

Travel time is simply the time in minutes required to traverse from one specified location to another. It does not necessarily imply that a problem of some sort exists on the freeway. The other four types of time-related information are classified as "effects" of some specific problem occurring on the freeway. Travel time and delay refer to the freeway only. Conversely, comparative travel times, time saved, delay, and delay avoided, presume that an alternative route exists and refer to a difference in travel times between the freeway and the alternative route. Travel time and comparable travel-time messages are briefly discussed in the paragraphs that follow.

Travel time displayed on a CMS (e.g., 20 MIN TO [*destination*]) may be easily checked by the driver who scans a watch or dashboard clock. If the actual driving time differs significantly from the promised 20 min, there is concern that credibility of the CMS may be weakened. Some TMCs display a travel time range (e.g., 20–25 MIN TO [*destination*]) to reduce the possibility of error.

It should be understood that many factors could affect the actual travel time of a given vehicle after the driver reads the message on the CMS. For example, it has been observed that travel time between two points on a freeway can significantly change during the transitional period between the off-peak to peak periods or when a crash occurs on the freeway. Thus, there is the concern that the travel time displayed could be significantly incorrect (underestimated). Another consideration of displaying travel-time information is that drivers are left to their own resources to decide whether to use the freeway or to divert to an alternative route. There is no hint of whether the alternative route being considered is actually "faster" than the freeway.

Travel times can also change significantly between two points on a freeway during the transition between peak and off-peak periods. In these cases, the calculated and posted travel time may be significantly higher than that experienced by drivers. Although erring on the high side (overestimating) is not as critical as erring on the low side for the driver's trip, the erroneous messages compromise credibility.

Messages with comparative travel-time information display the travel times along both the primary and alternative routes to a specific destination point. In contrast to time saved, delay, or delay avoided, comparative travel times would normally be displayed on a separate CMS and not in a message in combination with other freeway-related information (e.g., *ACCIDENT*, *2 LANES CLOSED*, etc.).

Note that comparable travel-time information leaves the driver the task of subtracting one value from the other to determine time savings. It takes longer to read than simply giving the time saved. It requires mental arithmetic and checking which route has which time. The driver must also be careful not to accidentally invert the two routes in performing the arithmetic operation. Furthermore, some analysts believe that most drivers expect CMS messages to advise them as to which route to take. Comparative travel-time information does not do this.

Displaying Travel Times

In 1991, Dudek and Hutchingson (*25*) recommended that transportation agencies display travel time on CMSs as an alternative to leaving them blank as soon as the necessary hardware, software, and funding became available. Travel time is very useful to motorists because it gives them some indication of the potential arrival time at their destination. Also, travel times can be displayed during the peak and off-peak periods and provides the added advantage that a message will be displayed on the CMS more frequently rather than having the sign blank in the absence of an incident or roadwork. Because of rapidly changing traffic conditions, it is difficult to post travel time information manually. It is more efficient to display travel times automatically using system software.

Travel time is generally calculated from speed measurements taken at loop detector stations or measured directly with automated vehicle identification or toll tag sensors. A computer algorithm calculates the estimated travel time between two points on the highway. It is important to recognize that the data available from these sources are estimated travel times of current conditions (loop detectors) or the travel times of the vehicles that recently traveled between two automated vehicle identification sensor stations. In essence, it is *historical* travel time. The process of, and algorithms for, accurately *predicting* the travel times of drivers are not currently available.

Although display of travel times is advantageous, the following possible credibility issues have created concerns for some CMS operators:

- Display of historic travel times; and
- Daily repetition of the same travel times displayed to commuters.

First, as previously noted, current technology does not allow TMCs to accurately predict travel times; therefore, recent historical travel times are displayed. Motorists can easily measure their own travel times and dispute incorrectly posted travel times. If the posted travel times are not accurate, credibility may be weakened. To circumvent this concern, Houston's TransStar displays the time of day of the most recent calculation of travel times. Another approach used by TransGuide in San Antonio is to display a range of the estimated travel time.

In 2000, Dudek et al. (*26*) evaluated two alternative travel-time message formats (shown in Exhibit 2) that were similar to those displayed by TransStar and TransGuide. The results indicated that displaying recent historical travel times may not pose a credibility issue provided that the differences in expected and actual travel times are not significantly different.

The second concern with displaying travel time on a regular basis is the possibility that commuter drivers may see the same travel times posted daily if traffic conditions do not change from day to day and may begin to ignore the CMS at later dates and not read the sign when important incident information is presented—the so-called change blindness effect described previously. To date, no research has been conducted to validate or disprove this concern.

In 2004, PBS&J (*27*) conducted a scan of practice by means of interviews with representatives from 12 state DOTs and 2 FHWA division offices and made the following observations:

- In new deployments, seek feedback from, and educate, the public before travel-time messages are instituted;
- Travel times must be dynamic;
- Travel-time messages can be structured to benefit more than the local traveler;
- Messages for travel time should be considered differently from emergency messages; and
- Travel times should not be simultaneously provided for both high-occupancy vehicle and general-purpose lanes on the same sign because it is too much information for drivers to absorb.

Exhibit 2

TRAVEL TIME **TO I-610** **20 MIN AT 8:20**	**TRAVEL TIME** **TO US-281** **8-12 MINUTES**
Alternative 1 *TranStar* (*Houston*)	*Alternative 2* *TransGuide* (*San Antonio*)

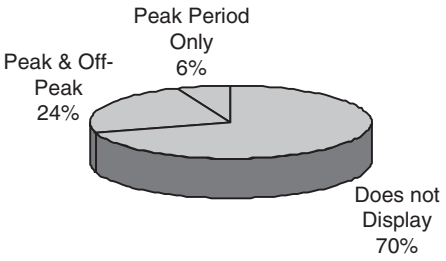


FIGURE 8 Percent of TMCs that display travel time.

Survey Results

Display of Travel Time by TMCs

The percentage of TMCs that display travel-time messages during the peak and off-peak periods is shown in Figure 8. Thirty percent of the TMCs that responded to the survey display travel-time messages. Twenty-four percent display travel time during both the peak and off-peak periods and 6% display travel time only during the peak period. During the off-peak period, 21% display other types of messages in addition to travel time, and 2% only display travel time. The percentage of TMCs that only display travel time and those that display other messages in addition to travel time are shown in Figure 9. The specific TMCs that display travel time are given in Table 5.

The frequency of display of travel-time messages during the peak and off-peak periods is shown in Figure 10. The results show that 26% of the TMCs regularly display travel time during the peak periods and 18% regularly display travel time during the off-peak period.

A summary of the relative number of CMSs on which TMCs display travel-time information during the peak and off-peak periods is shown in Figure 11. The results show that, as a rule, most TMCs that display travel time do not display these messages on all of their CMSs. During the peak period, only 3% of the TMCs display travel time on all CMSs and only 5% display travel time on most CMSs. Likewise, only 3% display travel time on all the CMSs during the off-peak period, whereas 4% display travel time on most CMSs.

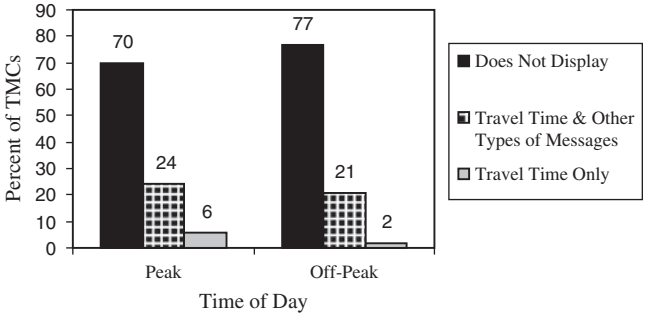


FIGURE 9 Percent of TMCs that display travel time and other messages during non-incident/non-roadwork periods.

TABLE 5
TMCs THAT DISPLAY TRAVEL TIME*

Agency/Traffic Management Center Location	Peak	Off-Peak
California Department of Transportation		
• Irvine	X	X
• Los Angeles	X	X
• Oakland	X	X
• Sacramento	X	X
• San Bernardino	X	X
• San Diego	X	X
Colorado DOT		
• Golden (statewide)	X	X
Delaware Department of Transportation (statewide)	X	
Florida DOT		
• Orlando	X	X
Georgia DOT		
• Atlanta	X	
Harris County Toll Road Authority	X	X
Illinois DOT		
• Chicago	X	X
Illinois Tollway	X	X
Kansas DOT		
• Lees S ummit (bi-state)	X	
Kentucky Transportation Cabinet		
• Louisville	X	X
Louisiana DOTD		
• Baton Rouge	X	X
• Shreveport	X	X
Minnesota DOT		
• Minneapolis–St. Paul	X	
North Carolina DOT		
• Raleigh	X	
Oklahoma		
• Oklahoma City	X	
Oregon DOT		
• Portland	X	X
Tennessee DOT		
• Knoxville	X	X
• Nashville	X	X
Texas DOT		
• Fort Worth	X	X
• Houston	X	X
• San Antonio	X	X
Utah DOT		
• Salt Lake City	X	
WSDOT–NW Region		
• Bellingham	X	X
• Seattle	X	X
Wisconsin (statewide)	X	X

*The TMC in Kansas City, Missouri, began displaying travel time after the survey was completed and is not shown in the table.

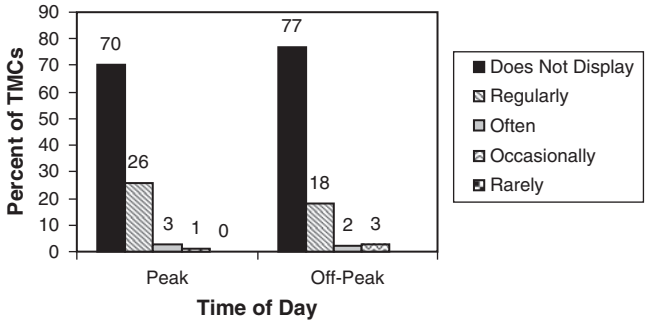


FIGURE 10 Travel time display frequency.

Reasons for Not Displaying Travel Time

The primary reasons cited as to why travel-time information was not displayed were that (1) infrastructure and/or software was not available and (2) congestion was not a problem. A summary of the specific reasons given follows:

- Lack of funding, lack of adequate infrastructure and/or software to support display of travel times (18 TMCs).
- Congestion is not a problem where CMSs are located (11 TMCs).
- Detectors lose their accuracy too quickly and need to be recalibrated. This is a time-consuming process (1 TMC).
- Currently displaying messages manually; travel time needs to be displayed automatically (1 TMC).
- Problems with confidence in data from detectors (1 TMC).
- Freeway system is too small to display travel times (1 TMC).
- CMSs are not in appropriate locations where travel-time messages would be useful (1 TMC).

Public Response

Sixty percent of the TMCs reported that they received a very favorable response (43%) or favorable response (17%) to travel-time messages. Thirty-seven percent reported that public responses have been somewhat favorable (27%) or neutral (10%). Only 3% reported that they had insufficient information to judge the reaction from the public. A summary of the reported responses from the public about travel-time messages is shown in Figure 12.

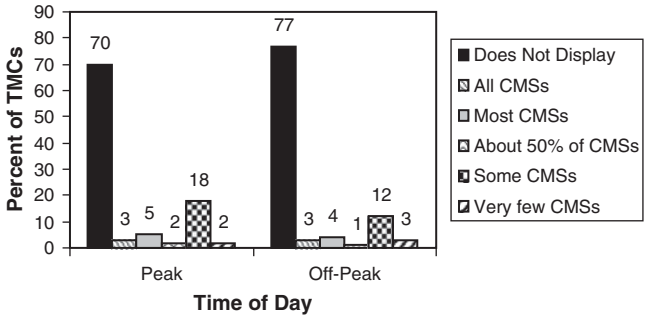


FIGURE 11 Relative number of CMSs on which travel-time messages are displayed.

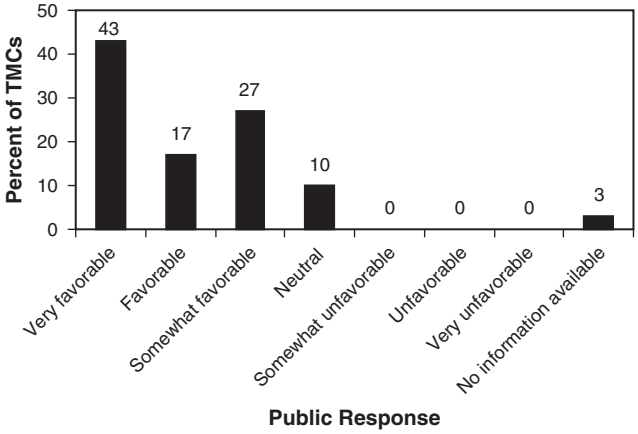


FIGURE 12 Public responses to travel-time messages ($n = 30$).

Examples of Typical Travel-Time Messages

Exhibit 3 provides examples of typical messages that were reported by the 30 of 100 TMCs that display travel times.

The examples in Exhibit 3 indicate that there is little uniformity with respect to message format among the TMCs. In addition, many of the messages far exceed the maximum number of units of information that should be displayed to allow unfamiliar drivers to read and comprehend the messages while traveling at typical freeway speeds, and will result in information overload. However, if the same travel-time messages were displayed every day on a given CMS, familiar drivers would quickly learn that the only information that changes is the actual time to the destinations, and they would learn to ignore the other elements in the message.

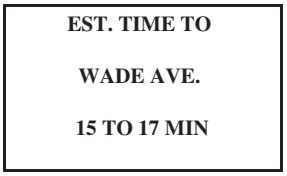
Experiences and Lessons Learned

Some of the TMCs that display travel-time information commented on the need to make sure that the travel times are accurate. Also, experiences indicated that it is difficult to display accurate travel times during rapidly deteriorating traffic operating conditions (e.g., transition between off-peak and peak periods and occurrence of incidents). A summary of the experiences and lessons learned with displaying travel time follows:

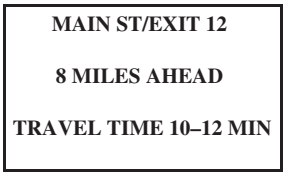
- When displayed, travel times need to be accurate; CMS system credibility is at risk and drivers may not react positively to other travel-time messages (6 TMCs).
- It is very difficult to accurately calculate travel times during rapidly deteriorating conditions. To address this problem, travel-time messages should be immediately deleted during situations that will likely result in rapidly deteriorating conditions (4 TMCs).
- Messages must be short (2 TMCs).
- Some drivers are requesting that travel-time messages be displayed during construction (2 TMCs).

Exhibit 3

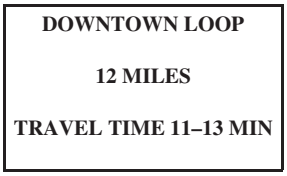
For Single Destination



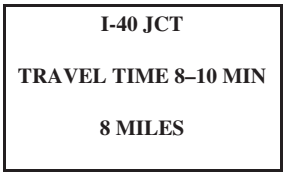
Example 1



Example 2



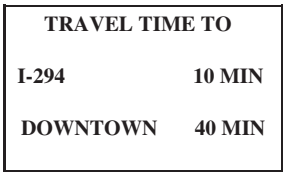
Example 3



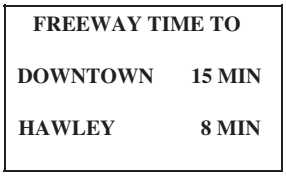
Example 4

Example 5

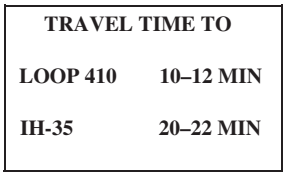
For Two Destinations



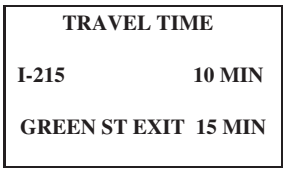
Example 1



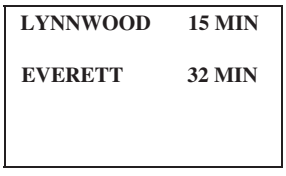
Example 2



Example 3

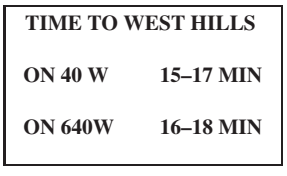


Example 4

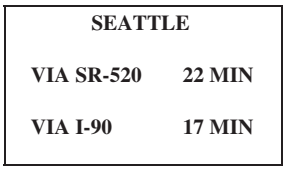


Example 5

For Single Destination with Two Alternative Routes



Example 1



Example 2

- Drivers were slowing down to read the signs (2 TMCs).
- Initial deployment of travel-time messages caused additional congestion (1 TMC).
- Check the times regularly to make sure they are accurate (1 TMC).
- If the travel times are thought to be inaccurate by the TMC staff, the messages should be deleted while investigating the inaccuracy (1 TMC).
- We hear complaints when times are not being displayed as a result of special events or ozone alerts. We no longer post ozone alerts (1 TMC).

- It is not necessary to display travel times on all CMSs. Some CMS locations do not lend themselves to travel-time messages (1 TMC).
- Traffic- and incident-related messages take priority over travel-time messages (1 TMC).
- For some locations, we installed additional detection equipment to enhance the accuracy of the travel-time calculations (1 TMC).
- Any time we employ a new CMS for travel times, a few motorists complain that it's slowing traffic down. The complaining lasts only a day or two (1 TMC).
- Displaying travel times on CMSs manually is very difficult and can cause considerable delay in posting. It is best to have an automated system to display travel time (1 TMC).
- About 20% of comments from the public were asking for travel times on alternate routes so they can make route choices (1 TMC).

Concerns and Challenges

The primary concerns and challenges dealt with ensuring that the travel times displayed are accurate because of loss of infrastructure and problems with rapidly deteriorating traffic conditions during certain times of the day and when incidents occur. A list of the comments received follows:

- Accuracy is a concern owing to poor reliability of detectors, loss of communications, or inadequate spacing of detectors. Ensuring that detectors are calibrated regularly and maintained is a major concern (8 TMCs).
- Travel-time information is not very accurate during rapidly deteriorating traffic conditions such as transition from off-peak to peak traffic flows or when incidents occur. The lag in recognition time during these conditions causes the displayed times to be too short during the window of time characterized by rapid deterioration (3 TMCs).
- Guidance is needed on the best message content and format (1 TMC).
- The travel time experienced by drivers can be longer than that shown on the CMS. Need information on the best ways to educate the public that the travel times displayed are not yet predictive. Also, how will we ever get the public to understand that if an incident happens after they pass under the sign that the information was correct at the time they saw the message (1 TMC)?
- Current system does not allow us to automatically update travel times. Displaying travel times manually is very difficult and often results in inaccurate travel times displayed on CMSs (1 TMC).
- Guidance is needed on the frequency that travel times should be updated during congested periods (1 TMC).
- There are concerns about driver complacency after seeing the same travel time information every day because traffic conditions are the same each day (1 TMC).
- We have an internal struggle over the format for travel-time messages and whether the travel-time values should be rounded to the nearest 5-min interval (1 TMC).
- It is not clear whether a two-phase message should be used when travel times are displayed (1 TMC).

Update Frequency of Travel Times

The agencies and TMCs were asked to comment on the frequency with which they update the travel-time messages displayed on CMSs. The results of the 30 TMCs that responded are shown in Figure 13.

A total of 77% of the TMCs update the travel time displayed on CMSs within 5 min. Seventeen percent update every minute, 20% every 2 min, 27% every 3 min, and 13% every 5 min. Thirteen percent of the TMCs change the travel times when traffic conditions change. Interestingly, 3% update every 10 min, 3% every 15 min, and 3% update every 30 min.

Cost to Implement Travel-Time Messages

The cost to develop and add software to existing systems to display travel time messages varied widely and ranged between $30,000 and $250,000. The difference in cost was due primarily to each TMC's current infrastructure and software capabilities.

Reasons for Not Displaying Travel Time

The agencies and TMCs that do not currently display travel-time messages were asked to cite the reasons for their decisions. The results are shown in Figure 14.

Forty-four percent of the 70 respondents reported that they did not have the infrastructure to accurately calculate travel times, 29% stated that they did not have the necessary software, 16% were systems in rural areas and did not have the need and facilities to display travel time, and 10% reported that they did not have sufficient recurrent congestion to justify displaying travel time. One TMC (1%) reported

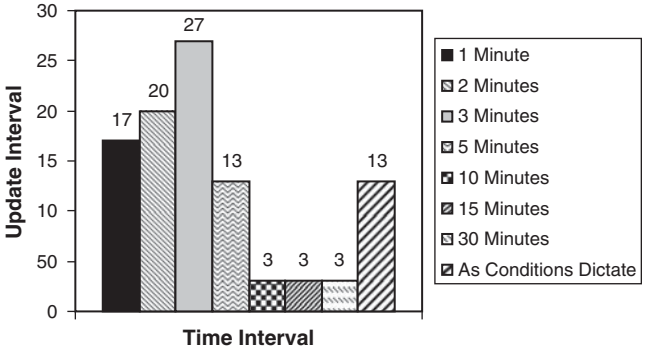


FIGURE 13 Update frequency of travel-time information displayed on CMSs ($n = 30$).

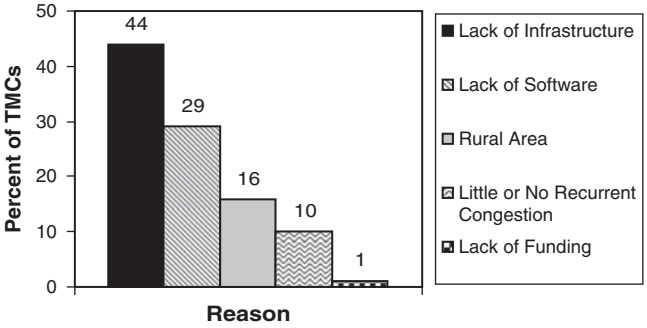


FIGURE 14 Reasons for not displaying travel time ($n = 70$).

that travel time was not displayed owing to the lack of funding to implement the necessary hardware and software.

CONGESTION MESSAGES

Background

Sometimes CMSs are used to present information about traffic conditions when the freeway becomes congested. The difficulty in doing so involves the large continuum of possible traffic operational conditions that are very difficult to describe on CMSs. Additionally, if a multitude of descriptors are used during the peak period in attempts to describe congested traffic conditions, then it becomes very difficult for the CMS message designer and CMS operator to think of words to describe congested conditions when incidents occur. For example, if the term *HEAVY CONGESTION* is displayed during the peak period, then what descriptor should be used to describe an even more congested state when an incident occurs?

Human factors laboratory studies were conducted as early as the mid-1970s to evaluate descriptors for levels of congestion. Letter grades (A, B, C, D, and F), number coding (1 to 10), and word descriptors (e.g., *CONGESTED, MODERATE CONGESTION, HEAVY CONGESTION, and JAMMED TRAFFIC*) were studied in laboratory studies conducted at different locations in the United States (*2*). The studies revealed that the subjects could not associate letter grades or number codes with the degree of congestion. In addition, there were inconsistencies between small and large city motorists as to the relative level of congestion associated with the word descriptors. Interpretation problems with the letter grades were also found in actual field studies conducted in Houston and reported by Stockton et al. (*28*).

In 2001, FHWA's Johnson (*29*) noted that care must be exercised in displaying messages that provide motorists with information about the state of traffic. Messages such as *CONGESTION AHEAD*, *NORMAL TRAFFIC*, or *EXPECT DELAYS* do not offer meaningful or useful information to travelers and contribute to the erosion of the public's trust in these systems and of the information they provide. Inaccurate, incomprehensible, or inappropriate information displayed on a

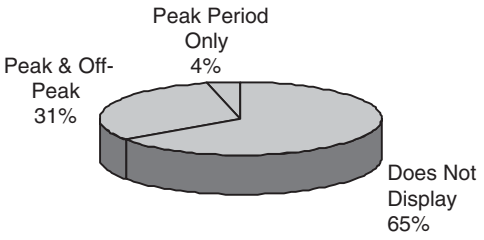


FIGURE 15 Display of congestion messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

CMS can cause motorists to question the credibility and ignore all CMS messages.

CMSs are also used to display the limits of congestion—the locations of the beginning and end of congestion. Displaying the limits of congestion is useful because it helps the familiar motorist understand the extent of the problem and assess where to return to the freeway if the motorist decides to avoid the congestion by routing around the problem (*7*).

Survey Results

Display of Congestion Messages

The percentage of TMCs that regularly or periodically display congestion messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank is shown in Figures 15 through 17. Figure 15 shows that 65% of the TMCs do not display congestion messages, 31% display congestion messages during both peak and off-peak periods, and 4% display congestion messages only during the peak period.

As shown in Figure 16, 65% of the 100 TMCs reported that they do not regularly or periodically display congestion messages in peak periods during non-incident/non-roadwork periods, whereas 35% of the TMCs regularly or periodically display congestion messages. Only 12% of the TMCs indicated that they regularly display congestion messages and only 8% often display congestion messages as an alternative to leaving the CMSs blank during non-incident/non-roadwork periods.

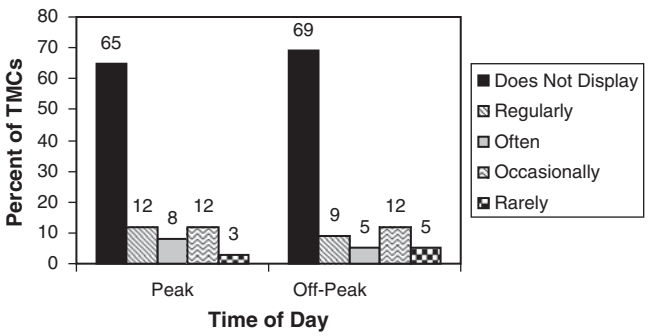


FIGURE 16 Display frequency of congestion messages during non-incident, non-roadwork periods as an alternative to leaving the CMSs blank.

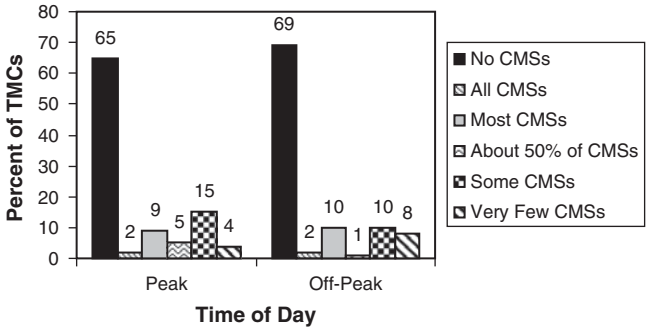


FIGURE 17 Number of CMSs on which congestion messages are displayed as an alternative to leaving the CMSs blank.

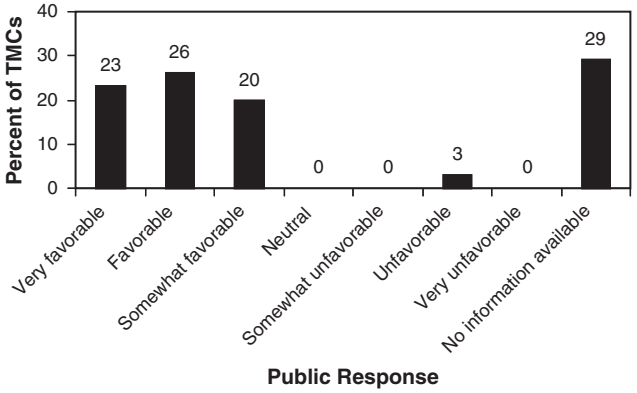


FIGURE 18 Public response to congestion messages during non-incident, non-roadwork periods ($n = 35$).

During the off-peak, 69% of the TMCs reported that congestion messages are not displayed during non-incident/non-roadwork periods. Thirty-one percent stated that congestion messages are regularly or periodically displayed. Of these, 14% display congestion messages regularly (9%) or often (5%), and 17% display congestion messages occasionally (12%) or rarely (5%).

The results in Figure 17 show that during peak period congestion messages are displayed on all of the CMSs by only 2% of the TMCs. Nine percent of the TMCs display congestion messages on most CMSs and 5% on about 50% of CMSs. Similarly, during off-peak periods only 2% of the TMCs display congestion messages on all of CMSs, 10% on most of CMSs, and 1% on about 50% of CMSs.

Basis for Decision to Display Congestion Messages

The basis for the decision of the 35 TMCs to display congestion messages during non-incident/non-roadwork periods is summarized in Table 6. As the results show, the decision of 63% of the 35 TMCs was based only on agency administrative/upper-management preference, TMC manager/supervisor preference, or both. An additional 25% was influenced by feedback from telephone calls, newspapers, radio, and/or television. Therefore, a total of 88% of the 35 TMCs did not base this decision on objective results from focus group or other research studies. As shown in Table 6, only 12% made decisions based on information from focus group or other research results.

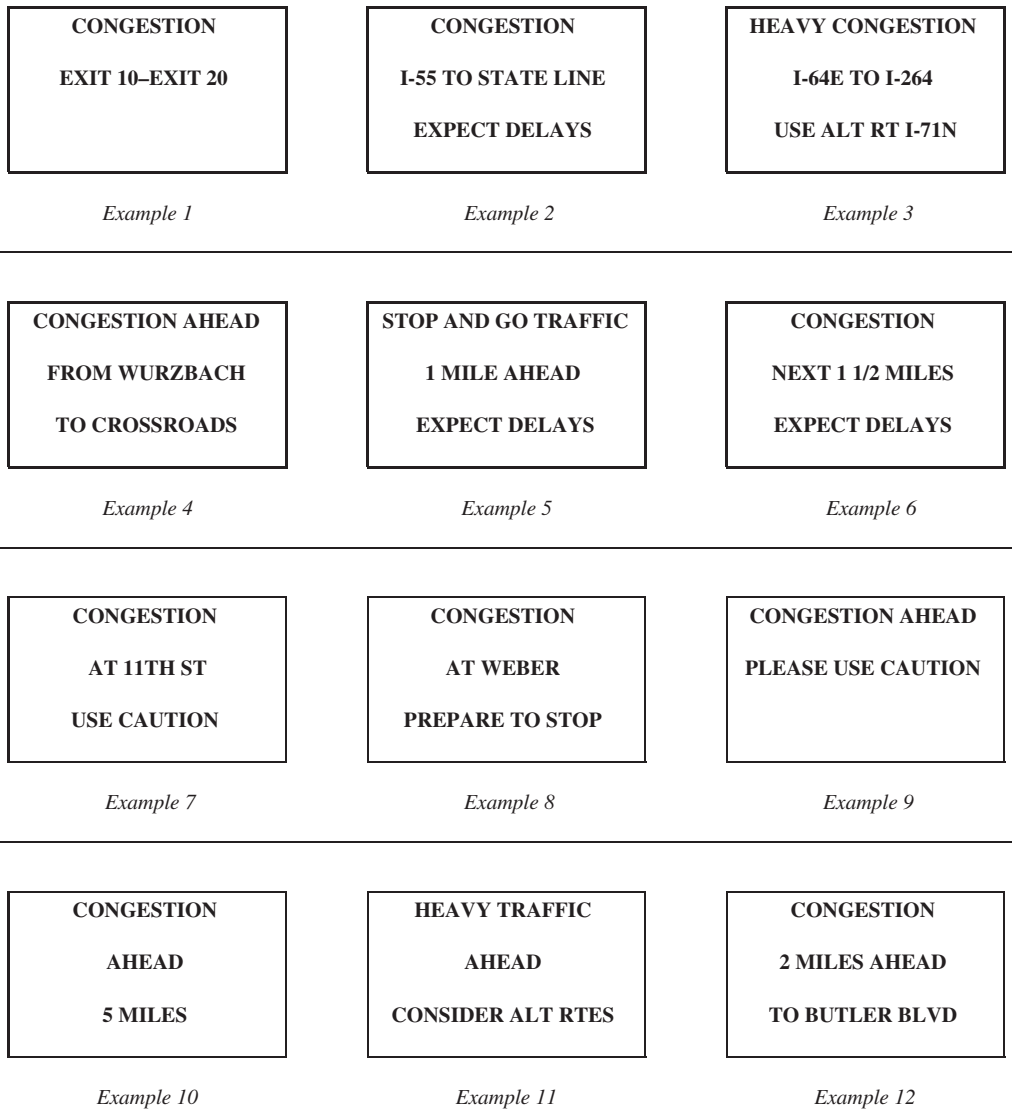
Public Response

A summary of the reported public response to congestion messages during non-incident/non-roadwork periods is shown in Figure 18. Forty-nine percent of the 35 TMCs indicated that they received very favorable (23%) or favorable (26%) comments from the public. Somewhat favorable responses were reported by 20% of the TMCs. Twenty-nine percent of the TMCs had no information regarding public response to congestion messages.

TABLE 6
BASIS FOR DECISION TO DISPLAY CONGESTION MESSAGES DURING NON-INCIDENT, NON-ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE CMSs BLANK ($n = 35$)

	Basis	Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	14	63
	TMC manager/supervisor preference only	20	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	29	
Preference and Feedback	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	25	25
Preference and/or Research or Focus Group	TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	9	12
	Research conducted by agency only	0	
	Research conducted by others only	0	
	Focus group studies only	3	
		100	100

Exhibit 4



Examples of Typical Congestion Messages

Exhibit 4 shows examples of typical messages that were reported by the 35 of 100 TMCs that regularly or periodically display congestion messages rather than leaving CMSs blank.

Experiences and Lessons Learned

The experiences and lessons learned most noted by the TMCs that display congestion messages was that the messages must be accurate and up to date. A summary of comments from TMCs regarding congestion messages follows:

- Messages must be accurate and kept up to date as the queue changes (11 TMCs).
- Display the beginning and end points of congestion to make it valuable to motorists (2 TMCs).
- Turn message off when there is not a need for a congestion message (2 TMCs).
- Motorists do not like to see messages saying simply CONGESTION AHEAD (1 TMC).
- Keep the message brief (1 TMC).
- Do not display these messages during routine commute times, where congestion occurs on a regular day-to-day basis, but only when congestion occurs where it is not anticipated (1 TMC).
- If messages are displayed at locations where recurring congestion occurs on a daily basis, commuters may neglect the messages as it shows on CMS every day at same time (1 TMC).
- Although the local daily commuters understand the traffic flow scenarios associated with interstate travel in the area, through-traffic commuters do not have the same prevailing knowledge of the roadway topol-

ogy and issues created by congestion in this area. Providing congestion information to motorists allows the local commuter to consider an alternate route or arterial and provides additional information to unfamiliar motorists so that they may drive more safely on roadways with which they are not familiar (1 TMC).
- Traffic center technicians have to have regional and geographical knowledge. They must have all available geographical information (1 TMC).
- We have learned to vary congestion messages to remove motorist complacency (1 TMC).
- Motorists need to know what is ahead of them. My theory is that the signs can have a "calming effect" on the motorist. No one likes surprises (1 TMC).
- Limited number of CMS locations limits amount of information to motorists (1 TMC).
- Motorists may overlook CMSs when messages are regularly displayed (1 TMC).
- Monitor congestion even after operation hours (1 TMC).
- Any message creates somewhat of a hazard because motorists instinctively brake to read the entire message. That is why we try to stay with one-phase messages (1 TMC).
- Public feedback indicates that motorists favor queue length messages rather than delay times (1 TMC).
- Congestion messages are good for unusual circumstances when motorists would not expect heavy congestion at that time of day or place (1 TMC).
- There is perception that on certain sections of the highway, motorists tend to slow down prior to a CMS to read the message on the sign. The congestion message on the sign can thereby contribute to the existing delay (1 TMC).
- Ample distance between incident and sign is very important (1 TMC).
- Trucking firms and truckers like travel times rather than congestion messages (1 TMC).
- Congestion messages are favored by trucking, taxi services, and professional drivers (1 TMC).

Concerns and Challenges

Several concerns and challenges were noted by the TMCs. A summary of the concerns and challenges follows:

- One challenge is ensuring that accurate information is displayed at all times (4 TMCs).
- A major challenge is an understanding of the differences between the various levels of congestion (e.g., heavy, moderate, and light) (1 TMC).
- Giving drivers up-to-date location and duration/length of congestion is difficult even with cameras and sensors. Traffic conditions may change quickly while the operator is responding to a crash or other problem (1 TMC).
- Often numerous small incidents happen that will clear too quickly for specific messages but will cause residual delays; therefore, generic messages needed but still have to be different enough in hot spots to get motorists' attention from day to day (1 TMC).
- The nature of urban congestion is such that when you try to report on the location of congestion (e.g., "Delays to Exit 290") by the time you enter the message, the end of congestion has moved—like a caterpillar (1 TMC).
- In areas where there are no cameras getting updates, it is a challenge to ensure the messages are up to date (1 TMC).
- A concern and challenge is how to measure congestion to display accurate information (e.g., delay time and queue length) (1 TMC).
- Displaying congestion messages consistently during all hours (1 TMC).

SPEED MESSAGES

Background

Travel speed does not rank high on the list of information needs of motorists when incidents occur on the freeway or roadwork is affecting traffic flow. In addition, unless the speed information is displayed in a correct format, it is likely that some motorists will misinterpret the information and some may react in adverse ways. Therefore, travel speed should not be displayed as part of an incident or roadwork message.

In an early study in 1971, Dudek et al. (*30*) found that travel speed between various reference points ahead was not considered as important to motorists as the location and length of congestion, degree of congestion, and the reason for the congestion. In another study conducted in Houston and Dallas in 1978 (*31*), traffic speed was considered less important by commuters than the type of incident, lane blockage, level of congestion, amount of delay, and the location of the nearest exit.

In 1971, based on their studies in the Los Angeles area, Hulbert and Beers (*32*) concluded that referencing to specific miles per hour could elicit dangerous overreaction (deceleration) from motorists. In a 1998 study in Toronto, Smiley and Dewar (*33*) found that in response to the message phrase *SPEED 30–40 KM/H NEXT 3 KM*, only a slight majority of test subjects in Toronto thought that the speed message referred to the average speed, which is what this message was intended to convey. However, almost as many thought the message referred to a recommended speed, and almost one-fifth thought it referred to the legal speed limit. Results from a study by Vercruyssen in 1997 (*34*) in Minneapolis on CMS messages for application in highway work zones showed that the most common (67% of the subjects) interpretation of the message *CURRENT SPEED/30 MPH* was that the speed limit through the construction zone was 48 km/h (30 mph), an incorrect interpretation. Thus, if downstream travel speeds are to be displayed on CMSs to indicate the degree of congestion, it is important that the information be specific so that motorists realize that the speeds posted are not speed limits.

Another factor to consider is that speed information is not the best choice of alternative traffic descriptors to elicit diversion. In the 1998 Toronto study by Smiley and Dewar (*33*), the message *SPEED 20–40 KM/H* (*12–25 MPH*)

resulted in a lower percentage of subjects who indicated they would divert than did the message *HEAVY CONGESTION*.

Several studies have been conducted to evaluate advisory speed messages on CMSs in highway work zones. Results of controlled field studies by Richards et al. (*35*) in Texas indicated that advisory speed messages reduced average vehicle speeds by only 7% regardless of the speed posted. Based on these findings, Richards and Dudek (*36*) recommended that speed messages on CMSs in work zones should be only 8–16 km/h (5–10 mph) lower than the normal operating speed on urban freeways, and 8–24 km/h (5–15 mph) on rural freeways.

Survey Results

Display of Speed Messages

The percentage of TMCs that regularly or periodically display speed messages as an alternative to leaving the CMSs blank is shown in Figure 19. Eighty-five percent of the TMCs do not display speed messages. In contrast, 15% display speed—14% during both peak and off-peak periods and 1% only during the peak period.

As shown in Figure 20, 12% of the TMCs rarely display speed messages during both the peak and off-peak periods; whereas only 2% regularly display speed messages during the peak, and 1% during the off-peak periods. When used, speed messages are displayed on only a very few CMSs (see Figure 21).

Basis for Decision to Display Speed Messages

The basis for the decision of each of the 15% of TMCs that regularly or periodically display speed messages as an alternative to leaving the CMSs blank is summarized in Table 7. Interestingly, the decisions were based solely on administrative/upper-level management (12%) or TMC manager/supervisor preference (88%). In no case was the decision based on objective data, such as results of focus groups or other types of studies.

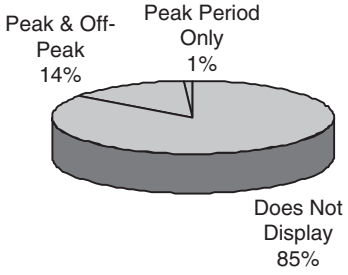


FIGURE 19 Display of speed messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

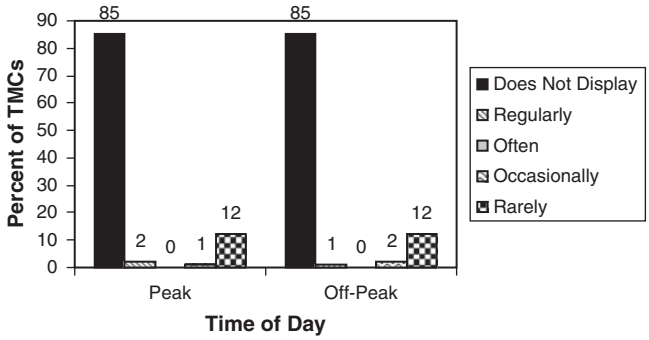


FIGURE 20 Display frequency of speed messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

Public Response

The public response reported by the TMCs that display speed messages is shown in Figure 22. Eighty percent of the TMCs had no information from the public to justify the decision to display speed messages and only 7% indicated that they received a favorable response.

Examples of Typical Speed Messages

Exhibit 5 shows examples of typical messages that were reported by the 15 of 100 TMCs that regularly or periodically display speed messages rather than leave CMSs blank.

Experiences and Lessons Learned

Very few of the TMCs that display speed provided comments regarding experiences and lessons learned. The two comments that were received follow:

- Need regular input from the maintenance crews in the field to keep the speeds appropriate for conditions in rural areas.
- It is more feasible to display speeds in 19 km/h (10 mph) increments for our situations.

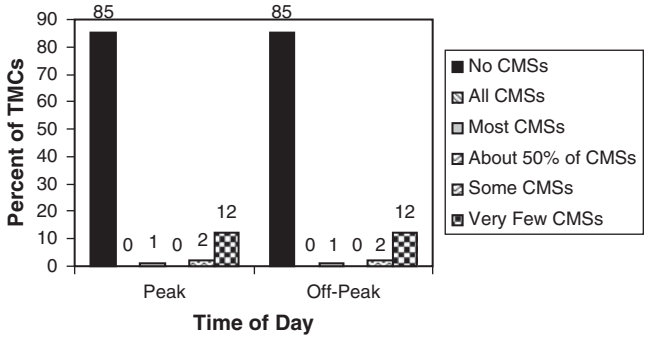


FIGURE 21 Number of CMSs on which speed messages are displayed during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

TABLE 7
BASIS FOR DECISION TO DISPLAY SPEED MESSAGES DURING NON-INCIDENT/ NON-ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE CMSs BLANK (n = 15)

	Basis	Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	12	100
	TMC manager/supervisor preference only	88	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	0	
Preference and Feedback	Agency administrative/upper management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	0	0
Preference and/or Research or Focus Group	TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	0	0
	Research conducted by agency only	0	
	Research conducted by others only	0	
	Focus group studies only	0	
		100	100

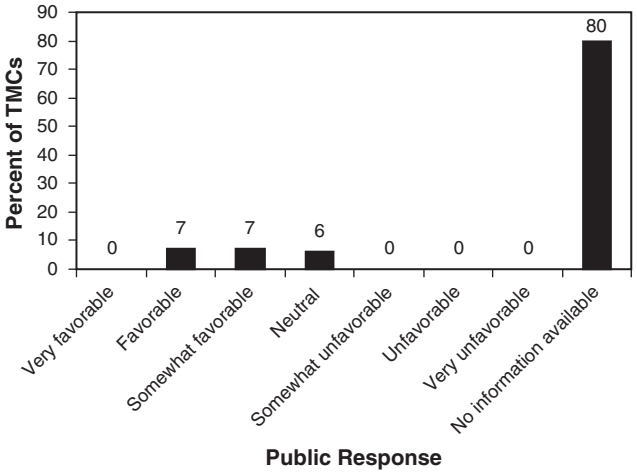


FIGURE 22 Public response to speed messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank (n = 15).

Concerns and Challenges

Only three comments were received regarding concerns and challenges. Specific comments follow:

- A concern and challenge is maintaining credibility.
- Challenge is keeping the speed limit in sync with weather conditions and traffic flow.
- It is difficult to convey that the speed is an average and the speed may differ along the freeway.

PUBLIC SERVICE ANNOUNCEMENTS

Background

PSAs do not provide drivers with real-time safety or travel efficiency information. PSAs provide motorists with information that can be given more effectively through other methods such as media campaigns or pamphlets (*5–7*). These, and other methods, would benefit a greater majority of the motoring public because they would not be limited to only those who travel on freeways with CMSs.

One argument in support of not displaying PSAs is the concern that motorists who continually travel a specific route will become accustomed to the PSA and then begin to ignore the CMSs. Subsequent messages indicating lane closures, detours, etc., that directly affect the motorists' travels may then tend to be unnoticed. This is another example of the potential for the change blindness phenomenon. If there is a concern that the CMSs are infrequently used, then it may be desirable to display other information that may affect the motorists' travel (e.g., existing or planned roadwork on the specific facility or on other intersecting freeways, expressways, or toll roads; or travel-time information) rather than PSAs.

Exhibit 5

DENSE FOG ADVISE 30 MPH	SPEED LIMIT 55 DRIVE SAFELY	I-285 CONDITIONS WEST EAST 40 MPH 50 MPH
Example 1	*Example 2*	*Example 3*

A second argument is the potential negative response by the public when PSAs are displayed because the information is nonessential. As discussed previously, Caltrans personnel in the Los Angeles TMC discontinued displaying PSAs as a result of negative feedback from the public (D. Roper, former Deputy District Director, Operations, Caltrans, personal communication, Mar. 21, 2002).

Survey Results

Display of PSAs

Seventy percent of the TMCs reported that they do not display PSAs as an alternative to leaving CMSs blank, 16% display PSAs during both peak and off-peak periods, 1% during the peak period only, and 14% only during the off-peak period. The percentage of TMCs by the time of day during which PSAs are displayed is summarized in Figure 23.

The general frequencies of PSAs displayed during the peak and off-peak period are shown in Figure 24. A higher percentage of TMCs do not display PSAs during the peak period in comparison with off-peak (83% versus 70%). Three percent reported that they regularly display PSAs during the peak and off-peak periods. The trend for the TMCs that display PSAs is to display the messages occasionally or rarely.

As shown in Figure 25, PSAs are displayed on all CMSs by 4% of the TMCs during the peak period and 8% during the off-peak period. Five percent of TMCs display PSAs on most CMSs during the peak and 8% on most CMSs during the off-peak period.

Basis for Decision to Display PSAs

The basis for each TMC's decision to display PSAs as an alternative to leaving CMSs blank is shown in Table 8. The decision by 93% of the TMCs that display PSAs was based solely on agency administrative/upper-management or TMC manager/supervisor preference, or both. Only 7% of the TMCs made their decisions based on information received from research.

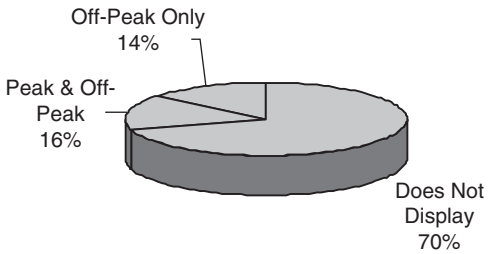


FIGURE 23 Display of PSAs during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

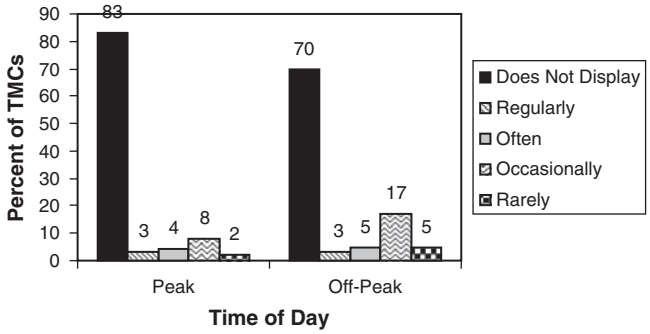


FIGURE 24 Display frequency of PSAs during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

Public Response

The reported public response is summarized in Figure 26. Only 17% of the TMCs that display PSAs as an alternative to leaving the CMSs blank reported that they received a favorable response from the public. An additional 37% reported that the response was somewhat favorable (10%) or neutral (27%). Three percent reported unfavorable response and 43% had no information available to comment on the public's reaction.

Examples of Typical PSA Messages

Exhibit 6 shows examples of typical messages that were reported by the 30 of 100 TMCs that regularly or periodically display PSAs rather than leaving CMSs blank.

Experiences and Lessons Learned

The experiences and lessons learned reported by the TMCs that display PSAs centered around (1) the importance of wording, (2) not displaying during the peak traffic flow, (3) limiting the duration of message display, (4) displaying relevant PSAs, and (5) coordination with other agencies. Specific reported experiences and lessons learned are as follows:

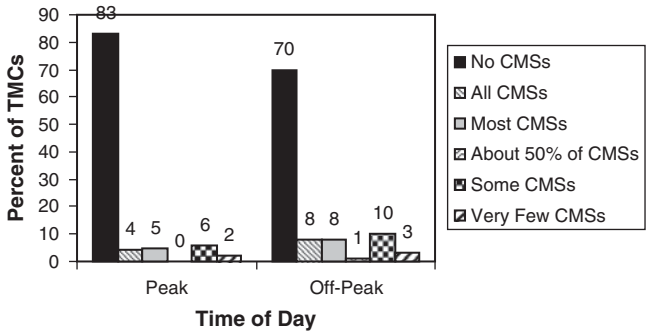


FIGURE 25 Number of CMSs on which PSAs are displayed during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

TABLE 8
BASIS FOR DECISION TO DISPLAY PSAs DURING NON-INCIDENT/NON-ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE CMSs BLANK ($n = 30$)

	Basis	Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	57	93
	TMC manager/supervisor preference only	13	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	23	
Preference and Feedback	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	0	0
Preference and/or Research or Focus Group	TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	7	7
	Focus group studies only	0	
	Research conducted by agency only	0	
	Research conducted by others only	0	
		100	100

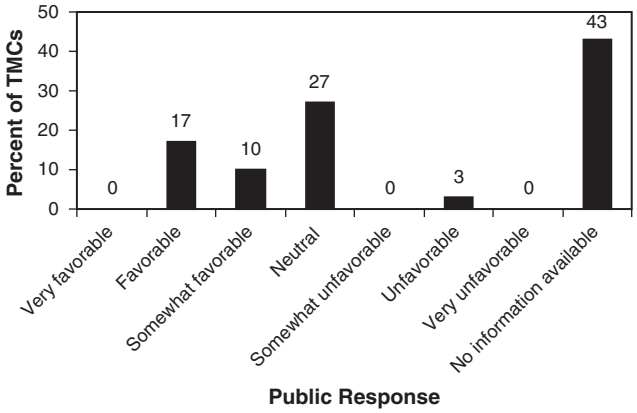


FIGURE 26 Public response to PSAs during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank ($n = 30$).

- A message should be run for a short period of time and/or should not be displayed too often (8 TMCs).
- Only display for selected, well-organized and advertised statewide campaigns (3 TMCs).
- Messages must provide value to motorists (2 TMCs).
- We display the PSAs typically on one CMS per corridor, with travel times being displayed on all others available (1 TMC).
- Coordinate any PSA with local government (1 TMC).

Concerns and Challenges

Concerns and challenges expressed by the TMCs included the lack of clear guidance as to what messages constitute PSAs and how to display consistent messages. In addition, concern was expressed about the requests from other agencies to display

Exhibit 6

REPORT DWI **1-877-DWI-HALT**	**BLOOD DRIVE** **HINSDALE OASIS**	**VAN AND CARPOOL** **CALL 1-800-555-5555**
Example 1	*Example 2*	*Example 3*
NEW ORLEANS **SHUTTLE INFO** **1-877- XXX- XXXX**	**AIR QUALITY ALERT** **TODAY** **TUNE TO 530 AM**	**BURN BAN** **IN EFFECT FOR** **NUECES CTY**
Example 4	*Example 5*	*Example 6*

non-traffic-related messages if PSAs are posted. Some TMCs voiced differences of opinion with agency administration/management about displaying PSAs. Specific comments received are as follows:

- They [PSAs] open the door for other requests that are not transportation related. Denying requests is a problem (2 TMCs).
- A concern and challenge is how to display consistent messages (2 TMCs).
- Requests for other types of messages often reference the PSAs as the reason (2 TMCs).
- Operations staff not wanting to use the signs for this purpose versus administrative requests (2 TMCs).
- Lack of clear, concise direction on what qualifies as a PSA (1 TMC).
- Wording is critical (1 TMC).

SAFETY CAMPAIGN MESSAGES

Background

Messages that assist the state DOT in improving highway safety are often displayed on CMSs. Normally, these messages are part of statewide safety campaigns. The display of safety messages associated with a safety campaign is allowable under the current MUTCD (*1*, §2A07). Safety-related messages should be current, displayed for a limited time, and should relate to a specific safety campaign (*17*).

No reported research studies that objectively address the effects of driver safety campaign messages on driver credibility and change blindness were found in the literature. However, in preference studies conducted by Benson (*37*) of 517 motorists in the Washington, D.C., area, 67% said that general traffic safety messages should be posted on CMSs.

Survey Results

Display of Safety Campaign Messages

Fifty percent of the TMCs reported that they display safety campaign messages during both the peak and off-peak periods and 33% display the messages only during the off-peak period. Only 17% reported that they do not display campaign messages. The distribution of the time of day during which safety campaign messages are displayed is shown in Figure 27.

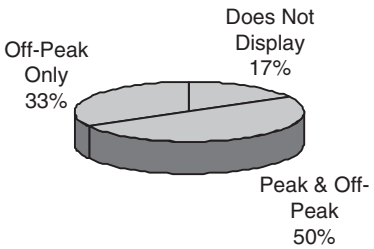


FIGURE 27 Display of safety campaign messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

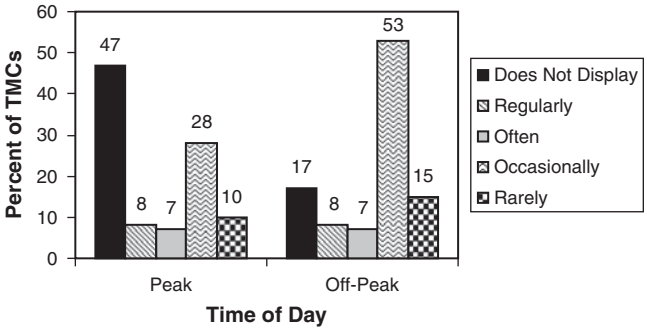


FIGURE 28 Display frequency of safety campaign messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

The display frequency of safety campaign messages is summarized in Figure 28. During the peak period, 47% of TMCs do not display safety campaign messages. The messages are displayed regularly by 8% of TMCs, displayed often by 7%, occasionally by 28%, and rarely by 10%. During the off-peak period 17% do not display safety campaign messages, 8% regularly display the messages, 7% display often, 53% occasionally, and 15% rarely.

During the peak periods, the majority of TMCs that display safety campaign messages post the messages on all CMSs and most CMSs. Similarly, the majority of TMCs display safety campaign messages on all CMSs and most CMSs during the off-peak periods, as shown in Figure 29.

Basis for Decision to Display Safety Campaign Messages

Ninety-nine percent of the TMCs reported that the decision to display safety campaign messages was based on agency

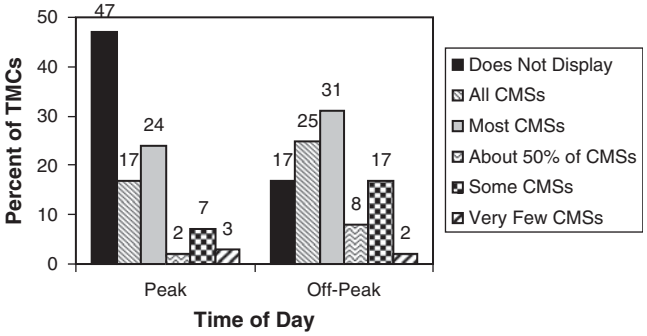


FIGURE 29 Number of CMSs on which safety campaign messages are displayed during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

administrative/upper-management preference, TMC manager/supervisor preference, both administrative and TMC preference, or as part of governor safety program, statewide safety program, or law enforcement agency request. Only 1% of the TMCs included research results in their decision. The basis for each TMC's decision to display safety campaign messages is shown in Table 9.

Public Response

The reported public response to safety campaign messages reported by the TMCs is shown in Figure 30. Only 12% of the TMCs reported that the response was either very favorable (2%) or favorable (10%). Thirty-five percent reported that the response was either somewhat favorable (17%) or neutral (18%). The majority of the TMCs (51%) had no information available to assess public opinion.

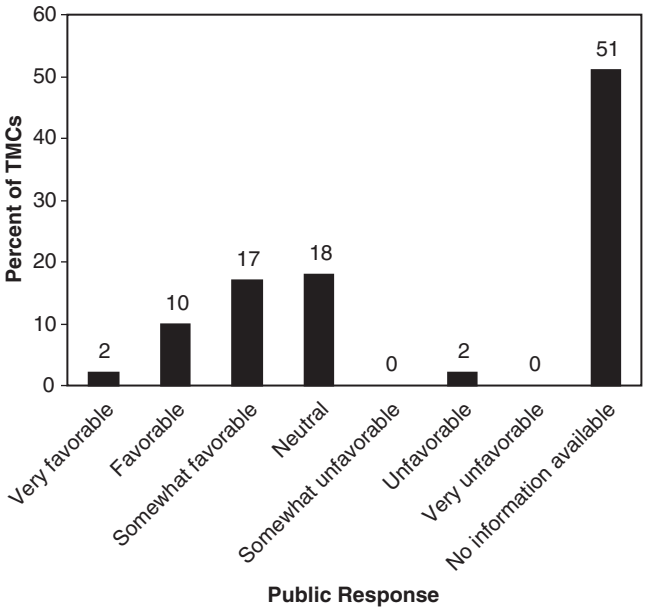


FIGURE 30 Public responses to safety campaign messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank ($n = 83$).

Examples of Typical Safety Campaign Messages

Exhibit 7 provides examples of typical messages that were reported by the 35 of 100 TMCs that regularly or periodically display safety campaign messages rather than leaving CMSs blank.

Experiences and Lessons Learned

More comments were received regarding experiences and lessons learned with displaying safety campaign messages as an alternative to leaving CMSs blank than for the other messages discussed in this report. The responses from the TMCs focused on that the safety campaign messages (1) resulted in requests from agencies that other non-traffic-related messages be displayed, (2) uncertainty about the effectiveness of the messages, (3) should be displayed for short periods of time, (4) generated negative feedback (although this was not reflected in the data shown in Figure 29), and (5) should be displayed during certain periods. Comments received from the TMCs follow:

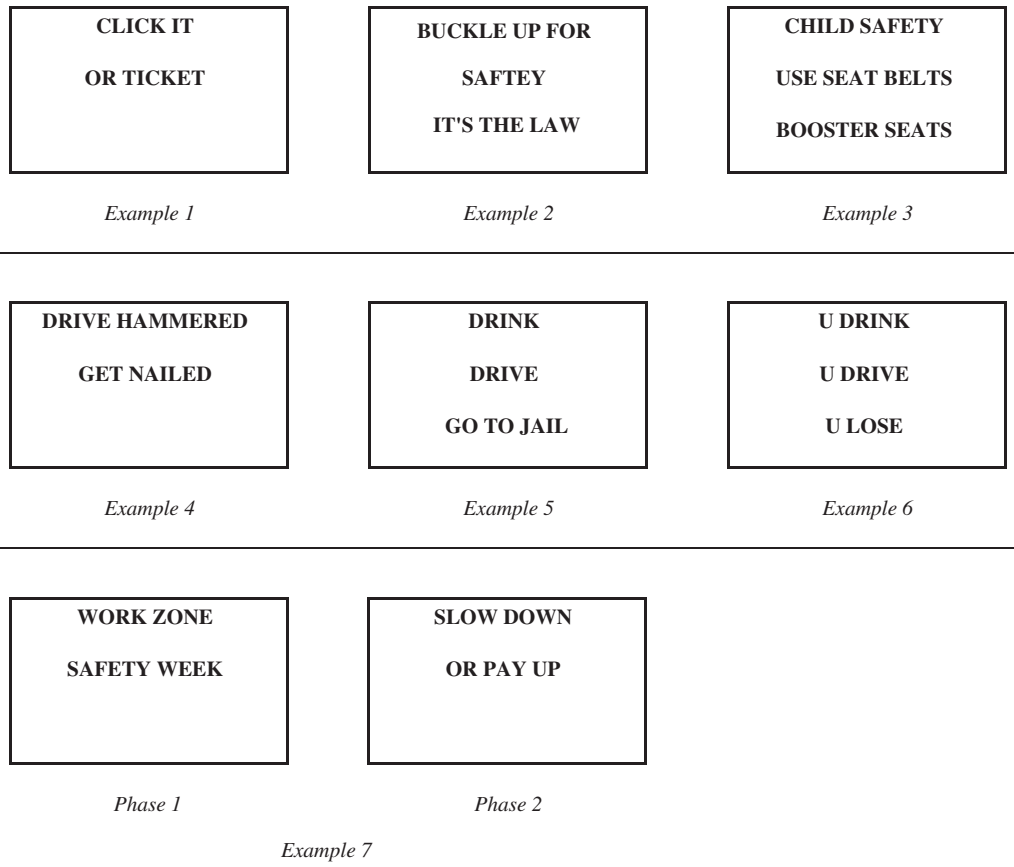
- A message should be displayed for a short period of time and/or should not be displayed too often (18 TMCs).
- We get negative feedback from the public (8 TMCs).
- Only display for selected, well–organized, and advertised statewide safety campaigns (7 TMCs).
- Public is generally receptive to the messages (6 TMCs).
- Keep messages simple and easy to understand (4 TMCs).
- They are effective (3 TMCs).

TABLE 9
BASIS FOR DECISION TO DISPLAY SAFETY CAMPAIGN MESSAGES DURING NON-INCIDENT/NON ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE CMSs BLANK ($n = 83$)

	Basis	Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	48	99
	TMC manager/supervisor preference only	5	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	29	
Other	Other*	17	
Preference and Feedback	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	0	0
Preference and/or Research or Focus Group	TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	1	1
	Research conducted by agency only	0	
	Research conducted by others only	0	
	Focus group studies only	0	
		100	100

*Governor safety program, statewide safety program, or requests from law enforcement agencies.

Exhibit 7



- Post only during off-peak or in off-peak direction to minimize unintended congestion (2 TMCs).
- Only display safety-related or agency-supported messages (2 TMCs).
- Make sure that it is not a distraction to motorists (2 TMCs).
- Message must have broad public impact (1 TMC).
- Establishing a statewide policy as to what type, and when messages should be displayed, is very important (1 TMC).
- Make sure there is value in the message to the public (1 TMC).
- Coordinate any safety campaign message with local government (1 TMC).
- We receive and deny requests for messages that are advertising (1 TMC).
- Generally, these messages do not appear to have any impact on motorists (1 TMC).
- Even the radio disc jockeys and traffic reporters make jokes about them (1 TMC).
- Public would rather see travel times (1 TMC).
- Received positive feedback from law enforcement when conducting routine traffic stops in areas where messages are displayed (1 TMC).
- Do not display messages on all CMSs (1 TMC).
- Messages that include CALL 911 can result in a lot of phone calls for 911 operators (1 TMC).

Concerns and Challenges

Concerns and challenges included (1) insufficient research to determine whether the messages are beneficial, (2) appropriate time to display the messages, (3) issues of consistency and credibility, and (4) requests for other types of non-traffic-related messages. Specific comments are as follow:

- They open the door for other requests that are not transportation related. Denying requests is a problem (6 TMCs).
- Do not know if the messages are beneficial and useful to motorists (3 TMCs).
- A concern and challenge is how to display consistent messages (2 TMCs).
- Need guidance as to when messages should be displayed and/or how to display consistent messages that provide value to the motoring public (2 TMCs).
- There is a lack of clear, concise direction on what qualifies as a safety message (1 TMC).

- Trying to avoid private-interest type requests (1 TMC).
- There are differences of opinion between operations staff not wanting to use the signs for this purpose versus administrative requests (1 TMC).
- Will support administrative concerns by displaying them (1 TMC).
- Some of the public have expressed dislike of unimportant messages being displayed while others like it. We are afraid that people will get complacent seeing these types of messages very much and not pay attention to real emergency messages (1 TMC).

TRAFFIC LAW OR ORDINANCE MESSAGES

Background

No reported research studies that objectively address the effects of traffic law or ordinance messages were found in the literature. However, observations by the author indicated that some state DOTs display traffic law or ordinance messages and, therefore, these types of messages were included in the survey.

Survey Results

Display of Traffic Law or Ordinance Messages

Seventy-four percent of the TMCs do not display traffic law or ordinance messages as an alternative to leaving CMSs blank. Nineteen percent display the messages during both the peak and off-peak periods and 7% display this type of message only during off-peak. The time of day during which traffic law or ordinance messages are displayed is shown in Figure 31.

Figure 32 contains a summary of the frequency at which traffic law or ordinance messages are displayed. Only 2% of the TMCs regularly display these types of messages either during the peak or off-peak periods. Most TMCs that display traffic law or ordinance messages display these messages only occasionally or rarely.

As shown in Figure 33, only 6% of the TMCs display traffic law or ordinance messages on all CMSs. The messages are displayed on most CMSs during the peak period by 8% of the TMCs and during the off-peak by 13% of the TMCs.

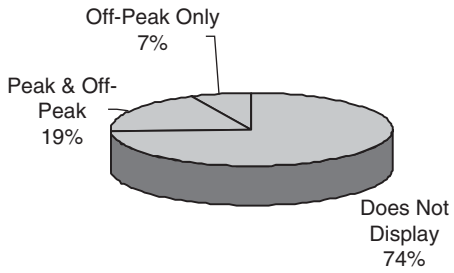


FIGURE 31 Display of traffic law or ordinance messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

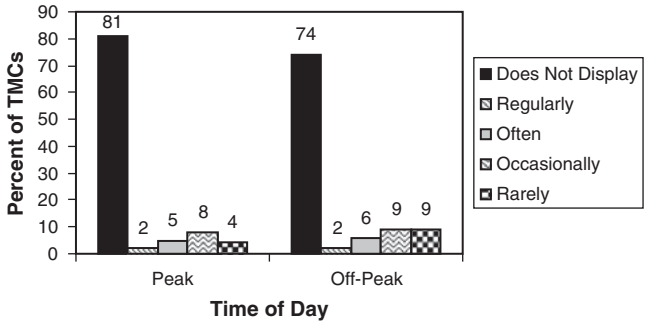


FIGURE 32 Display frequency of traffic law or ordinance messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

Basis for Decision to Display Traffic Law or Ordinance Messages

Comparable to the previously discussed messages, the primary decision to display traffic law or ordinance messages was made based on agency administrative/upper-management preference, TMC manager/supervisor preference, or both. As shown in Table 10, only 4% of the TMCs that display the messages considered feedback from telephone calls, newspapers, radio, and/or television, and only 4% used support from research results in their decision.

Public Response

Public response to traffic law or ordinance messages is shown in Figure 34. As indicated, only 12% of the 26 TMCs that display the messages reported very favorable (8%) or favorable (4%) responses. Fifty-seven percent indicated that the public was somewhat favorable (19%) or neutral (38%). Thirty-one percent of the TMCs had no information available to assess public opinion.

Examples of Typical Traffic Law or Ordinance Messages

Exhibit 8 shows examples of typical messages that were reported by the 26 of 100 TMCs that regularly or periodically

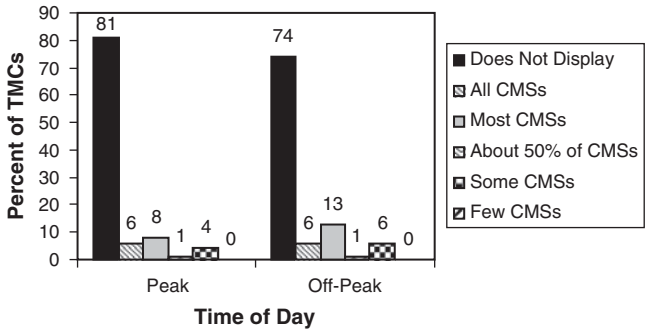


FIGURE 33 Number of CMSs on which traffic law or ordinance messages are displayed during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank.

TABLE 10
BASIS FOR DECISION TO DISPLAY TRAFFIC LAW OR ORDINANCE MESSAGES DURING NON-INCIDENT/NON-ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE CMSs BLANK ($n = 26$)

	Basis	Percent of TMCs	Percent of TMCs
Preference Only	Agency administrative/upper-management preference only	46	92
	TMC manager/supervisor preference only	11	
	Agency administrative/upper-management preference, and TMC manager/supervisor preference	35	
Preference and Feedback	Agency administrative/upper-management preference, and TMC manager/supervisor preference, and Feedback from telephone calls, newspapers, radio, and/or television	4	4
Preference and/or Research or Focus Group	TMC manager/supervisor preference, and Research conducted by agency and/or research conducted by others	4	4
	Research conducted by agency only	0	
	Research conducted by others only	0	
	Focus group studies only	0	
		100	100

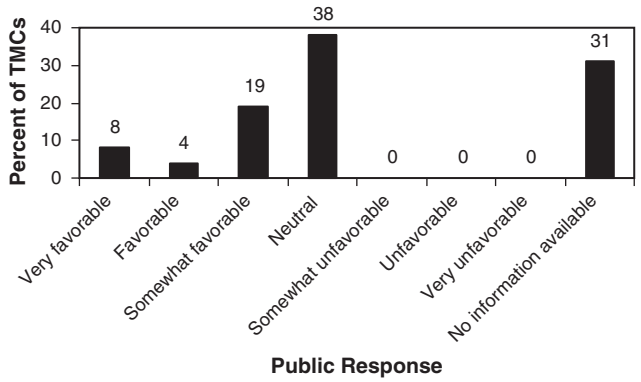


FIGURE 34 Public response to traffic law or ordinance messages during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank ($n = 26$).

display traffic law or ordinance messages rather than leaving CMSs blank.

Experiences and Lessons Learned

Only a few TMCs reported on their experiences and lessons learned with displaying traffic law or ordinance messages. Those that responded reported positive feedback from law enforcement agencies and cautioned about overuse and problems with displaying the messages at inappropriate times. A summary of the responses from the TMCs follows:

- Display of traffic law or ordinance messages MUST be part of an organized campaign, usually kicked off with a media campaign (1 TMC).

Exhibit 8

SLOW DOWN OR MOVE OVER FOR EMERGENCY VEHS	MINOR ACCIDENT MOVE IT IT IS THE LAW	GEORGIA LAW AFTER AN ACCIDENT MOVE CARS TO SHOULDER
Example 1	*Example 2*	*Example 3*
DON'T MESS WITH TEXAS	GEORGIA LAW HEADLIGHTS ON WHEN RAINING	WIPERS ON HEADLIGHTS ON IT'S OUR LAW
Example 4	*Example 5*	*Example 6*

- Received positive feedback from law enforcement when conducting routine traffic stops in areas where messages are displayed. For example, we have a message explaining the Texas law requiring traffic to move over when an emergency vehicle is stopped on the roadway. Troopers have noticed an increase in the number of vehicles observing this law than in the past (1 TMC).
- Traffic law or ordinance messages can be useful when they are used in a real-time, logical way such as displaying, *HEADLIGHTS ON WHEN RAINING* during a driving rainstorm, or *MOVE OVER 1 LANE FOR EMERGENCY VEHS ON SHOULDER* when there is an emergency vehicle on the shoulder just ahead. However, displaying traffic law messages when the scenario is not present is not good. For instance, displaying *HEADLIGHTS ON WHEN RAINING* on a sunny day looks stupid to passing motorists (1 TMC).
- Can be very effective as part of a public education campaign for new traffic laws. They broaden exposure to new laws (1 TMC).
- Positive. It should not be displayed for every traffic law. Sign only for those laws that affect freeway travel lanes (1 TMC).
- Make sure there is a law or ordinance. Have a program in place to assure the CMS is not abused (1 TMC).

Concerns and Challenges

The main concern and challenge reported dealt with making sure that the messages were consistently designed and applied.

Summary of Message Types That Are Regularly Displayed

Of particular interest are the types of messages that are regularly displayed on CMSs during non-incident/non-roadwork periods as an alternative to leaving the signs blank. As noted earlier, 43% of the TMCs responding to the survey regularly display messages during non-incident/non-roadwork periods during the peak period. Likewise, 35% regularly display messages during the off-peak period. The types of messages that are regularly displayed by the TMCs are listed in Table 11.

TABLE 11
TYPES OF MESSAGES REGULARLY DISPLAYED ON CMSs DURING NON-INCIDENT/NON-ROADWORK PERIODS AS AN ALTERNATIVE TO LEAVING THE SIGNS BLANK

Message Type	Percent Of TMCs	
	Peak	Off-Peak
Travel Time	24	15
Congestion	9	8
Safety Campaign	3	4
Travel Time Congestion	2	1
Speed	2	1
Travel Time Safety Campaign	0	1
Travel Time PSAs	0	1
Congestion PSAs Safety Campaign	0	1
PSAs Safety Campaign	1	1
Safety Campaign Traffic Law or Ordinance	1	1
PSAs Safety Campaign Traffic Law or Ordinance	1	1
	43	35

From Table 11, the predominant message that is regularly displayed rather than leaving CMSs blank is travel time. Twenty-four percent of the TMCs exclusively display travel time during the peak period, and 15% display travel time during the off-peak period. Congestion messages are exclusively displayed by 9% and 8% of the TMCs during the peak and off-peak periods, respectively. Speed, safety campaign, PSAs, and traffic law and ordinance messages are regularly displayed by very few TMCs.

CHAPTER FOUR

AMBER ALERT MESSAGES

BACKGROUND

AMBER alert is a notification program to help locate missing children believed to have been abducted. The Emergency Alert System (formerly known as the Emergency Broadcast System) is used to alert the public by means of television and radio in the event of an AMBER alert. America's AMBER Plan Program through which emergency alerts are issued to notify the public about potential abductions of children is voluntary. As previously discussed, every state DOT and agencies that operate toll roads and own and operate CMSs, display AMBER alert messages.

The AMBER Plan Program encourages the most effective methods of communicating with the public on behalf of abducted children. FHWA notes that CMSs are not always the most effective or safest method to disseminate information related to child abductions. Only a limited amount of information can be conveyed on a CMS. When there is a need to provide extensive information to motorists, FHWA states that it is critical that other types of traveler information media [e.g., 511, highway advisory radio (HAR), websites, and commercial radio] be used or that the messages on a CMS supplement these other media (*19*).

CHANGEABLE MESSAGE SIGN MESSAGE CONTENT

One of the issues of concern is the content of the CMS AMBER alert messages that will provide motorists with sufficient information for the Program to be effective. Ullman et al. (*38,39*) reported the results of laboratory studies conducted in 2004 in six cities in Texas concerning message content. The authors evaluated driver preferences and ratings for message elements that should be included in an AMBER alert CMS message. The hierarchy of message elements selected by the participants was as follows, in order of importance:

1. Situation descriptor,
2. Vehicle descriptor,
3. License plate number,
4. Telephone number, and
5. Tune to radio action descriptor (HAR or local radio station).

Ullman et al. also evaluated different terms for each of these message elements. The options that participants believed would best communicate the information are summarized in Table 12. Overall, there was no situation descriptor selected by the majority of the participants to best communicate the information that a child has been taken, although the term *AMBER ALERT* was selected most often, (32%) followed by *ABDUCTED CHILD* (22%), and *KIDNAPPED CHILD* (15%). More than one-third (35%) of the participants stated their reason for not selecting *AMBER ALERT* as either they were not familiar with the term or they believed that other people would not be familiar with the term. Meanwhile, the primary reasons stated for the low response rate for *MISSING CHILD* or *MISSING GIRL* (*BOY*) descriptors was that the word *MISSING* has the connotation that a child would not be in a dangerous situation

Out of five vehicle descriptors tested, 49% of the participants selected the descriptor with the most information about the vehicle (i.e., *BLUE MAZDA 05 PICKUP*). For those who did not select this particular descriptor, the main reasons for not doing so were that the year of the vehicle was unnecessary information or would be too hard to determine (expressed by 37% of the subjects). The next most popular descriptor chosen was the one with the second most information (*BLUE MAZDA PICKUP*), selected by 38% of the participants. Overall, a total of 87% of the participants preferred the more detailed descriptors (*BLUE MAZDA 05 PICKUP* and *BLUE MAZDA PICKUP*).

The majority of the participants (68%) selected the license number containing the "#" and "-" signs. According to the participants, this format separated the numbers and words so that the license plate number did not all run together (stated by 42% of the participants), and/or that the version without these symbols was confusing (expressed by 35% of participants). Of course, the opposite view was held by the participant minority who selected the other alternative, indicating that the "#" and "-" signs were either not needed or made the message harder to read and memorize.

Eighty-seven percent of the participants selected the shorter and easier-to-remember telephone numbers, *CALL 511* (59%) or *DIAL 511* (28%). As would be expected, the main reason for not selecting the longer telephone numbers was that more numbers were too hard to remember.

Of the three radio phrases tested, 63% of the participants selected *TUNE TO 530 AM*. The main reasons the other participants gave for not selecting this term were that the

TABLE 12
TERMS SELECTED BY LABORATORY PARTICIPANTS FOR AMBER ALERT MESSAGES IN TEXAS (n = 192) (*39,40*)

Message Element	Term	Percent of Participants
1	AMBER ALERT	32
	ABDUCTED CHILD	22
	KIDNAPPED CHILD	15
	MISSING CHILD	12
	KIDNAPPED GIRL (BOY)	10
	ABDUCTED GIRL (BOY)	6
	MISSING GIRL (BOY)	3
2	BLUE MAZDA 05 PICKUP	49
	BLUE MAZDA PICKUP	38
	BLUE PICKUP	11
	BLUE MAZDA	1
	MAZDA PICKUP	1
3	LIC # SR8-493	68
	LIC SR8 493	32
4	CALL 511	59
	DIAL 511	28
	CALL 888 769 5000	7
	DIAL 888 769 5000	6
5	TUNE TO 530 AM	63
	TUNE TO LOCAL RADIO	23
	TUNE TO RADIO	14

alert information should be available on all stations anyway, that the participant does not listen to AM radio, or that the term *local* in the message was more informative to them. For the other descriptor alternatives, *TUNE TO RADIO* and *TUNE TO LOCAL RADIO*, the main reason given for not selecting them was that there was not a specific station number provided.

MESSAGE LOAD

Early experiences with displaying AMBER alert messages indicated the need to include the vehicle license plate number if the vehicle make, model, and color were also displayed. Also, some agencies included a 10-digit telephone number that the motorist should call if the vehicle with the abducted child was seen. However, agencies that included the vehicle license plate and/or telephone numbers indicated that there was a tendency for some drivers to reduce speed in order to read the AMBER alert messages. Thus, there was evidence that the messages were too long and complex for motorists to read and comprehend.

Ullman et al. (*38*) and Dudek et al. (*40*) reported on the results of studies conducted using a driving simulator and laptop computers to determine the effects of displaying license plate and 10-digit telephone numbers in AMBER alert CMS messages. The first study was conducted using the Texas Transportation Institute Driving Environment Simulator in College Station, Texas. A laboratory study was also conducted in six cities in Texas.

It was found, as expected, that the average reading time for AMBER alert messages with a license plate number was significantly longer than the reading time for messages without a license plate number. In addition, the majority of subjects were not able to recall the entire number. Similarly, the average reading time for the messages with a 10-digit telephone number was significantly longer than the messages without a telephone number. Specifically, the following findings were noted:

- A license plate number in a message is equivalent to more than three units of information, and
- A 10-digit telephone number in a message is equivalent to more than three units of information.

Thus, a message with a license plate number will exceed current effective message design guidelines that specify a maximum of four units of information in a message. Likewise, a message with a 10-digit telephone number will exceed current effective message design guidelines.

In summary, AMBER alert CMS messages that contain a license plate number with the vehicle description (make, model, and color) can contain more than seven units of information. Messages that include the license plate number and a 10-digit telephone number contain more than 10 units of information. In both cases, the number of informational units far exceeds the maximum four units of information guidelines. Therefore, drivers will not be able to read and comprehend the messages while traveling at typical freeway speeds. Drivers who attempt to read the messages before passing the CMS may reduce speed.

STATE AMBER ALERT NETWORK AND POLICIES

TMC procedures for displaying AMBER alert messages are normally influenced by statewide policies. An example of a state policy for Texas (*41*) follows:

> The Texas Amber Alert Network was activated by Gov. Rick Perry to "ensure that every available resource is used to return abducted children safely to their loved ones." The Texas Department of Public Safety is in charge of the statewide system, but any Texas law enforcement agency has the ability to activate this network of resources when needed. When the system is activated, media outlets receive notification of an abducted child and TxDOT displays AMBER alert information on CMSs. To activate the network, the law enforcement agency with jurisdiction must determine that the case meets the following criteria:
>
> - The child is 17 years of age or younger.
> - The local law enforcement agency believes that the child has been abducted, that is, unwillingly

taken from his/her environment without permission from the child's parent or legal guardian who commits an act of murder or attempted murder during the time of the abduction
- The local law enforcement agency believes that the missing child is in immediate danger of serious bodily harm or death.
- The local law enforcement agency confirms that an investigation has taken place that verifies the abduction and has eliminated alternative explanations for the missing child.
- Sufficient information is available to disseminate to the public that could assist in locating the child, the suspect, or the vehicle used in the abduction.
- Upon verification of the activation request, the Governor's Division of Emergency Management determines the circumference of the search area and issues the alert. Alerts are distributed to:
  - TxDOT's Traffic Management Center (for messages on highway signs),
  - National Weather Service's Texas Warning System (for broadcast on radio and television stations),
  - Law enforcement agencies,
  - Texas Missing Persons Clearinghouse, and
  - Texas Office of the Governor.

It is important that AMBER alert messages are designed and displayed on CMSs uniformly across the state. In some state DOTs, there is one person who has the responsibility to coordinate the design and display of AMBER alert messages for the entire state.

As a rule, the policy of agencies that operate CMSs is to turn off an AMBER alert message whenever there is a need to display messages of traffic or roadway situations that have an impact on traffic operations or safety. Also, some agencies limit the amount of time an AMBER alert message is displayed. For example, Caltrans limits the time that AMBER alert messages can be displayed to a maximum of 4 h.

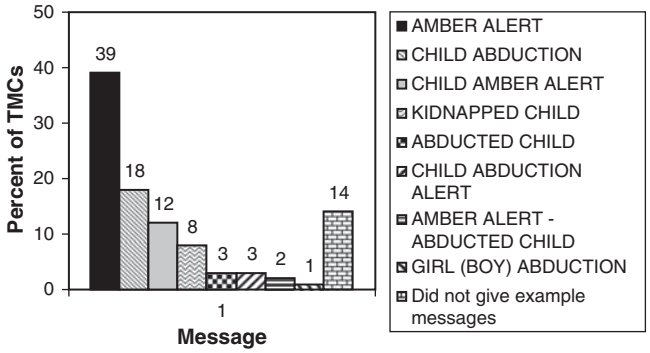


FIGURE 35 Message situation descriptor contained in AMBER alert messages.

SURVEY RESULTS

Message Content

The first line of AMBER alert messages reported by the TMCs is summarized in Figure 35. The term *AMBER ALERT* is used for the situation descriptor by 39% of the TMCs. Eighteen percent display *CHILD ABDUCTION*, 12% display *CHILD AMBER ALERT*, and 8% display *KIDNAPPED CHILD*. The terms *ABDUCTED CHILD*, *CHILD ABDUCTION ALERT*, *AMBER ALERT—CHILD ABDUCTION*, and *GIRL (BOY) ABDUCTION* are displayed by 3% or fewer of TMCs.

The other elements included in the message are shown in Table 13. The most common type of message included the vehicle make, vehicle model, vehicle color, license plate number, and telephone number (46%) in addition to the situation descriptor. The next most common type of message included the vehicle make, vehicle model, vehicle color, and license plate number (38%). Thus, 84% of the TMCs display AMBER alert messages that exceed the maximum recommended four units of information. Therefore, the majority of motorists will not be able to read and

TABLE 13
PERCENT OF TMCs DISPLAYING SPECIFIC MESSAGE ELEMENTS IN AMBER ALERT MESSAGES

Message Element Included in Message*	Message Type 1	Message Type 2	Message Type 3	Message Type 4	Message Type 5	Message Type 6	Message Type 7	Message Type 8	Message Type 9
Vehicle Make	X	X	X	X					
Vehicle Model	X	X	X		X				
Vehicle Color	X	X	X	X	X	X			
License Plate No.	X	X	X	X	X	X	X		
Telephone No.	X			X		X		X	
Radio Station			X						X
Percent of TMCs	46%	38%	1%	1%	1%	1%	4%	3%	5%

* In addition to a situation descriptor (e.g., AMBER alert).

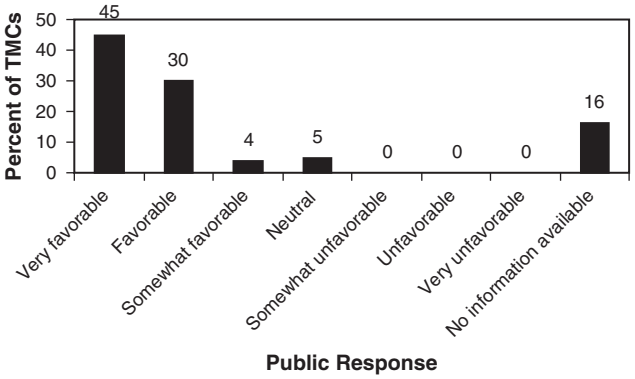


FIGURE 36 Public response to AMBER alert messages.

comprehend the messages while traveling at typical freeway speeds.

Public Response

The reported public response to AMBER alert messages is summarized in Figure 36. Overall, 75% of the TMCs stated that the response from the public has been very favorable (45%) or favorable (30%). Only 9% reported that the public response has been somewhat favorable (4%) or neutral (5%). Sixteen percent of the TMCs stated that they did not have sufficient information to judge public response to AMBER alert messages.

Examples of Typical AMBER Alert Messages

Exhibit 9 shows examples of typical AMBER alert messages.

A review of the AMBER alert messages currently being displayed by TMCs indicates a lack of uniformity of message content, particularly with the situation descriptor.

Experiences and Lessons Learned

Many of the TMCs reported positive experiences with AMBER alert messages. Some TMCs highlighted the importance of displaying information that is accurate, timely, and includes the license plate number. Others found that the messages that they posted were too long for drivers to read and recall, and drivers tended to slow to read the messages. A summary of the experiences and lessons learned from displaying AMBER alert messages follows:

- AMBER alert messages are well received by the public (20 TMCs).
- Messages should be displayed accurately and in a timely manner (4 TMCs).
- Too much information is being displayed on our message; drivers cannot read and comprehend the messages (3 TMCs).
- Drivers tend to slow down to read certain types of AMBER alert messages (3 TMCs).
- Point motorist to tune to local media for additional information (4 TMCs).
- Keep the message simple (2 TMCs).
- Message changed to *CHILD ABDUCTION* since AMBER was confused with homeland security color code several years ago (2 TMCs).
- The display of a message with a vehicle make, model, and color, but not a license plate could result in an incorrect vehicle being approached (2 TMCs).
- Make sure information displayed is clear and correct (1 TMC).
- Wait until sufficient correct information is available before activating CMSs (1 TMC).
- Only display messages when sufficient vehicle descriptive data are available (1 TMC).

Exhibit 9

One-Phase Messages

AMBER ALERT **BROWN FORD TRUCK** **TAG BHU-1234**	**ABDUCTED CHILD** **CALL 511 FOR INFO** ***HP IF SEEN**	**CHILD ABDUCTION** **BLUE FORD VAN** **CA LIC 901ABC123K**
Example 1	*Example 2*	*Example 3*
CHILD AMBER ALERT **1990 WHITE HONDA** **TN LIC 9885**	**GIRL ABDUCTED** **MO LIC# 123-ABC** **WHITE FORD PICKUP**	**CHILD ABDUCTION** **TUNE TO LOCAL** **RADIO OR 1610 AM**
Example 4	*Example 5*	*Example 6*

Two-Phase Messages

Phase 1	Phase 2
KIDNAPPED CHILD RED DODGE PU CALL POLICE	KIDNAPPED CHILD (City) (State) XX LC 123 ABC

Example 1

Phase 1	Phase 2
CHILD AMBER ALERT RED DODGE PU XX LIC 123 ABC	IF SEEN CALL 911

Example 2

Phase 1	Phase 2
CHILD ABDUCTION ALERT	BLUE CHEVY PK UP XX 1234AB CALL 911

Example 3

Phase 1	Phase 2
ABDUCTED CHILD RED CHEVY TRUCK TAG XX ABC 1234	AMBER ALERT CALL 511 INFO *HP IF SEEN

Example 4

- We provide detailed vehicle information on half of our CMS displays and direct travelers to our HAR frequency on the others where more complex information and instructions are available (1 TMC).
- Get as much information as possible from the police agency (1 TMC).
- Make sure that accurate information is provided by the law enforcement agency (1 TMC).
- We do not get the information fast enough from the police agency and have been publicly embarrassed because of untimely information (1 TMC).
- License plate number is needed otherwise messages cause large number of inquiries to local law enforcement agencies (1 TMC).
- We do not display 7–10 digit phone numbers or license plate numbers.
- AMBER alert messages on too many CMSs on the same freeway result in complaints from the public (1 TMC).
- When messages are not displayed immediately after an AMBER alert is announced, we receive inquiries from the media when we do not post CMS messages because we do not have accurate or timely information from the police agency (1 TMC).
- Law enforcement can be inundated with telephone calls (1 TMC).
- Always get a complete license plate, and include which state it was issued in (1 TMC).
- If license plate number is not known, would recommend that CMS not be used (1 TMC).
- Very effective tool. Recently, a motorist noticed the car over 200 miles away. This led to an arrest and recovery of the children (1 TMC).
- Public response to these messages is very good, based on questions generated from the public. Those questions have driven policy change to post all the information on HAR (1 TMC).
- We had to change our hardware and software to post messages statewide in a timely manner (1 TMC).
- Would be helpful to have MUTCD or FHWA suggest AMBER alert CMS message text and then do one coordinated public awareness campaign (1 TMC).
- We used to say *CALL 911* on the bottom line of AMBER alert messages, but we dropped that because we believe it is assumed that is the thing to do if you spot the vehicle in question (1 TMC).
- At the request of state police, we post AMBER messages statewide. When we don't have a vehicle license plate, we post a tune-to-local-media message. Sometimes when the AMBER alert is in one part of the state, media in other parts aren't broadcasting the message, which creates some confusion when the tune-to-local-media message is posted (1 TMC).
- If we do not have the vehicle information, we put up: *AMBER ALERT CHECK LOCAL MEDIA* (or *TUNE TO HAR*) (1 TMC).
- First time we did it, the message was to tune to local radio. They may only play the information every half-hour or hour. Received many complaints that the person tuned in and didn't hear anything. We now read entire broadcast script on the HAR (1 TMC).
- Keep deployment period on a specific CMS short, say 6 h maximum (1 TMC).
- There must be memorandum of understanding between the law enforcement agency and DOT (1 TMC).
- We must have a clear process in place to put up messages on CMSs (1 TMC).

Concerns and Challenges

The primary concerns and challenges reported by the TMCs dealt with the delays in getting accurate and timely information from law enforcement agencies and getting timely

information when the AMBER alert is no longer in effect. In addition, there were concerns about the specific message design so that the information displayed on the CMSs does not exceed the reading and understanding capabilities of drivers. A summary of the specific comments from the TMCs follows:

- We experience delays in receiving information fast enough from the police agency in order to display timely information (12 TMCs).
- We experience problems with receiving correct/complete information (including license plate number) from the police agency in order to display accurate and complete information (12 TMCs).
- We encounter delays in receiving information from the police agency when the AMBER alert is no longer in effect so that the CMS message can be deleted in a timely fashion (4 TMCs).
- Deciding what information to display because too much information can be too long for drivers to read, causing drivers to slow down to read the signs (4 TMCs).
- CMS message format is dictated by the state police (2 TMCs).
- Condensing messages into concise, actionable messages for the CMS environment is our greatest challenge (1 TMC).
- Concerned with liability of posting specific information (1 TMC).
- Being asked or directed to display an AMBER alert message with incomplete vehicle description information (1 TMC).
- Driver distractions when trying to write down information while driving (1 TMC).
- How long to display messages (1 TMC).
- Coordinating our software with the law enforcement agency software. They have other systems that need inputting first, and ours is last. Need to tie these systems together (1 TMC).
- Concerned about implications of posting vehicle information (1 TMC).
- Difficulty in getting uniformity of messages among different CMS sizes (e.g., permanent and portable CMSs) (1 TMC).
- Improving communications between TMCs (1 TMC).
- We need software that can display the same message simultaneously on all signs in the system (as you would like during an AMBER event) (1 TMC).
- Sometimes the CMS is outside a 250-mile range of occurrence (1 TMC).
- Sometimes they prematurely call statewide alerts when they are too far from our area (1 TMC).
- Bi-state rules and policies. Regional or not? Coordination with media (1 TMC).
- Driver emotions and reaction to information or identifying suspect in traffic. Motorists who take the law into their own hands (1 TMC).

CHAPTER FIVE

CONCLUSIONS

The primary purpose of this synthesis was to present the state of the practice of state departments of transportation (DOTs) and agencies operating toll roads that display messages on changeable message signs (CMSs) during non-incident/non-roadwork periods as an alternative to leaving the signs blank. A secondary objective was to present the state of the practice of displaying AMBER alert messages. Information for this synthesis was obtained from an extensive literature review and a survey of transportation agencies that operate CMSs. Responses were received from 40 state DOTs and 6 toll road agencies with a total of 100 traffic management centers (TMCs). The TMCs operated 3,023 CMSs in urban areas and 821 CMSs in rural areas. Forty-two TMCs operated CMSs only in urban areas, 8 in rural areas, and 50 in both urban and rural areas.

The intent of the literature review was to provide a brief summary of basic principles for effective CMS message design and display. The results of the survey were compiled and presented to establish the types and extent of CMS messages displayed during non-incident/non-roadwork periods. In addition, experiences, lessons learned, concerns, and challenges for displaying CMS messages during non-incident/non-roadwork periods were summarized.

CURRENT APPLICATIONS OF CHANGEABLE MESSAGE SIGNS

The eight most common applications of CMSs based on the percentage of the TMCs are as follows: AMBER alert (100%), incidents (99%), roadwork (98%), floods (85%), advance notice of upcoming roadwork (84%), ice on road (83%), snow on road (77%), and planned special events (73%).

MESSAGES DURING NON-INCIDENT/ NON-ROADWORK PERIODS

Blank Changeable Message Signs versus Display of Messages

Since 1997, there has been an increase in the number of agencies that display messages on CMSs rather than leave the signs blank during non-incident/non-roadwork periods. Of the 100 TMCs that responded to the survey, 55% leave the CMSs blank, whereas 45% display messages. There is a division among the TMCs over whether it is best to leave the CMS blank during non-incident/non-roadwork periods or to regularly display messages. The vast majority (more than 90%) in each group do not intend to change their current policy.

The issue as to whether CMSs should be blank or contain a message during non-incident/non-roadwork periods is complicated by reported contrasting public reaction. The California DOT (Caltrans) in Los Angeles received adverse public reaction to public service messages. There was a belief among the traffic operations professionals that such use led to a public disregard of CMS messages, thus making the signs less effective when traffic operational messages were displayed. The practice was discontinued, and the CMSs are now used only for travel time and for messages pertaining to unusual real-time traffic flow conditions.

In contrast, the New York DOT received adverse public reaction because of delay in posting messages after the CMSs were installed during the construction of the INFORM Project on Long Island. This prompted the agency to adopt a policy of displaying some type of message on the freeway CMSs at all times.

Blank Changeable Message Signs

Several of the 55 TMCs that leave the CMSs blank reported that they did not receive any adverse comments from the public and believed the process to be satisfactory. Several TMCs believed that by leaving the CMSs blank, drivers pay more attention to the message when one is displayed and so the CMSs are thus more effective. There was some fear that frequent display of non-essential messages will result in drivers ignoring important messages.

The reported public response to blank CMSs among the TMCs ranged between very favorable to neutral, although a high percentage of the TMCs (37%) did not have sufficient information to comment on the public's response. The primary concerns and challenges to leaving the CMSs blank centered on (1) ways to convince motorists that the signs are functional, and (2) pressures from administrators/upper-level management and others to display messages rather than leaving the CMSs blank.

Some TMCs illuminate one or more pixels as a means of informing drivers that the CMSs are operable. However, the effectiveness of this process of informing drivers is not known.

The types of messages that are displayed during non-incident/non-roadwork periods as an alternative to leaving the CMSs blank are travel time, congestion, speed, safety campaign, PSAs, and/or traffic law or ordinance messages. Fifty-one percent of the 45 TMCs that regularly or periodically display messages during non-incident/non-roadwork periods reported a very favorable (22%) or favorable (29%) public response. Several of these TMCs currently display travel-time information. Comparable to TMCs with blank CMSs, 27% reported that they had insufficient information to comment on the public's response. The primary concerns expressed and challenges noted with displaying the aforementioned types of messages (excluding travel time) were (1) uncertainty as to the best type of messages that should be displayed, and (2) when displayed, the messages are not usually changed often enough. The experiences and lessons learned by the TMCs displaying messages other than travel time were mixed. TMCs reported that some motorists prefer messages, some do not.

There is concern by some that display of repetitive information during non-incident/non-roadwork periods will result in many drivers failing to read the CMS when important information is given owing to the psychological visual change detection phenomenon referred to as *change blindness*, in which a person viewing a visual scene apparently fails to detect large changes in the scene. Change blindness can result in a credibility problem. The issue of change blindness has caused some agencies to use or consider using flashing beacons on CMSs to attract the attention of motorists when incident, roadwork, or other important messages are displayed, even though CMSs, particularly light-emitting signs, are designed to attract the attention of motorists. Whether the practice of using flashing beacons does improve motorist attention to the CMS message is not known at this time. To date, no research has been conducted to evaluate the effects of change blindness with respect to CMS messages.

Travel Time

There is a trend toward increased use of travel-time messages as an alternative to leaving CMSs blank during non-incident/non-roadwork periods. Travel time is currently displayed by 30% of the TMCs (representing 20 different agencies). A few other TMCs reported that they would display travel time in lieu of blank CMSs if they had the necessary infrastructure and/or software. A majority (60%) of the reported public response to travel-time messages was very favorable or favorable.

Thirty percent of the TMCs display travel time during the peak period and 23% display travel time during the off-peak period. All of the TMCs are in urban areas. Travel time is generally not displayed on all of the system CMSs; some CMS locations are not conducive to displaying travel time.

Three travel-time message formats are currently being used by TMCs nationally. These are travel time to

1. A single destination,
2. Two destinations, and
3. A single destination by means of two alternative routes.

A review of the travel-time messages displayed indicated that there is little uniformity with respect to message format among the TMCs. Also, many of the travel-time messages currently being displayed exceed the recommended maximum of four units of information per message. Thus, it is expected that unfamiliar drivers will not be able to read and recall the messages while traveling at typical freeway speeds. Some of the TMCs reported that drivers reduced speed to read the messages, verifying concerns regarding information overload with these types of messages.

TMCs are experiencing difficulty in accurately measuring and displaying travel times during rapidly deteriorating freeway operating conditions, during the transition from off-peak to peak periods, or when incidents occur. The travel time experienced by drivers can be longer than that shown on the CMS. The problem occurs because travel time is based (at best) on recent data; predictive models do not currently exist. Accuracy is also adversely affected because of poor reliability of detectors, loss of communications, or inadequate spacing of detectors. Thus, credibility can be adversely affected.

There is inconsistency among the TMCs regarding the frequency at which travel times are updated on the CMSs, although the update interval for 77% of the TMCs is within 5 min. Seventeen percent update every minute, 20% every 2 min, 27% every 3 min, and 13% every 5 min. Meanwhile, 13% of the TMCs reported changing the travel times when traffic conditions change. Interestingly, 3% of the TMCs update every 10 min, 3% every 15 min, and 3% update every 30 min.

TMCs that display travel times manually (i.e., an operator physically calculates the travel times on the routes and/or posts the message on the CMS) encounter difficulty in changing the messages when traffic conditions change. Displaying travel time manually is difficult and often results in inaccurate information being displayed on the CMSs.

Several TMCs in urban areas do not currently display travel time because of inadequate infrastructure or software to accurately compute travel time. TMCs in rural areas generally do not have the infrastructure or the need (i.e., no congestion) to display travel time.

The cost to implement the capability (i.e., additional infrastructure and/or software) to display travel-time messages varied widely among TMCs, and was reported to be between $30,000 and $250,000. The differences were primarily the result of the amount of new infrastructure and/or software needed to implement travel-time messages.

Congestion, Speed, Public Service Announcement, Safety Campaign, and Traffic Law or Ordinance Messages

General

The types of messages other than travel time that the TMCs displayed during non-incident/non-roadwork periods rather than leaving the CMSs blank are congestion (35%), speed (15%), public service announcement (PSA) (30%), safety campaign (83%), and traffic law or ordinance (36%). However, only a small percentage of TMCs *regularly* display one or more of these non-incident/non-roadwork messages. The percentage of TMCs that regularly display messages is as follows: congestion (12%), speed (2%), PSA (3%), safety campaign (8%), and traffic law or ordinance (2%) messages. The other TMCs display the messages often, occasionally, or rarely.

Administrative/upper-management preference, TMC manager/supervisor preference, or both, was cited as the basis for making the decision to display specific types of messages for the following percentages of TMCs: congestion (62%), speed (100%), PSAs (93%), safety campaign (99%), and traffic law or ordinance (92%). Very little, if any, objective data from focus group or other research studies were used in the decision-making process.

A significant percentage of the TMCs did not know the public's attitude about the messages that are displayed during non-incident/non-roadwork periods. About one-half of the TMCs that display congestion messages reported very favorable or favorable public response, 7% that display speed reported favorable public response, 17% reported favorable response to PSAs, 12% reported favorable response to safety campaign messages, and 12% reported very favorable/favorable response to traffic law or ordinance messages.

Congestion Messages

Research results reported in the literature point to the difficulty in designing congestion messages that motorists will be able to understand. The major problem is because it is difficult to find adequate words for CMS messages because of the large continuum of congested traffic states during the peak period. The problem is compounded during the peak period when incidents occur. Some of the potential traffic state messages such as *CONGESTION AHEAD*, *NORMAL TRAFFIC*, or *EXPECT DELAY* do not offer meaningful or useful information to travelers. Thus, these messages can adversely affect credibility. However, messages that provide the beginning and end of traffic congestion are helpful to the motorist in assessing the degree of congestion and the location where the motorist can reenter the freeway should he/she decide to leave the freeway and detour around the congestion.

Some of the TMCs surveyed also expressed difficulty in understanding the differences between the various levels of congestion (e.g., heavy, moderate, and light). Several TMCs emphasized the importance of accurate congestion messages. Experiences and lessons learned with displaying congestion messages, however, indicated that it is difficult to post accurate messages because traffic conditions change rapidly. That is, the locations and limits of congestion change too quickly to keep the information current. Therefore, one challenge of TMCs that display congestion messages is ensuring that accurate information is displayed at all times.

Speed Messages

Research results reported in the literature indicated that speed messages on CMSs are not ranked high among the information needs of motorists during incidents or roadwork. Also, some motorists may misinterpret speed messages and some may react in adverse ways. The results in the literature indicate that travel speed should not be used as part of an incident or roadwork CMS message.

The major concern and challenge expressed by TMCs with displaying speed during non-incident/non-roadwork periods was maintaining credibility. It is difficult to keep the speed message synchronized with traffic flow and weather conditions. Also, it is difficult to convey that the speed displayed is an average, and that the speed may differ along the freeway.

PSAs

The display of general public information or other non-essential information is discouraged by FHWA. There are strong arguments against displaying PSAs on CMSs, including adverse public response, credibility, and the possibility of change blindness—the failure to see the CMS message change—when important messages are displayed.

TMCs that display PSAs (1) emphasized that the PSAs must be relevant and must convey a clear message, (2) recommended that PSAs should not be displayed during the peak direction of traffic flow and that the duration of display should be short, and (3) emphasized that the TMC should coordinate posting PSAs with other agencies. Concerns and challenges expressed by the TMCs included the lack of clear guidance as to what messages constitute PSAs and how to display consistent messages. In addition, concern was expressed about requests to display non-traffic-related messages from agencies not related to transportation once PSAs are posted.

Safety Campaign Messages

The display of safety messages associated with a safety campaign is allowable under MUTCD provisions. Safety campaign messages should be current and displayed for a limited time.

Of all the non-incident/non-roadwork messages included in the survey, the most comments regarding experiences and

lessons learned were with displaying safety campaign messages. The responses from the TMCs focused on the concept that the safety campaign messages (1) resulted in requests from agencies to display other non-traffic-related messages, (2) created uncertainty about the effectiveness of the messages, (3) should be displayed for short periods of time, and (4) generated negative feedback. Concerns and challenges noted by TMC personnel about these messages were as follows:

- Insufficient research is available to determine whether the messages are beneficial,
- Guidance is needed on the appropriate time to display the messages,
- Guidance is needed to establish consistency and credibility for these types of messages when used, and
- Policies and procedures on how to handle requests for other types of non-traffic-related messages are needed, given that safety campaign messages are displayed.

Traffic Law or Ordinance Messages

Only a few TMCs reported on their experiences and lessons learned with displaying traffic law or ordinance messages (e.g., *SLOW DOWN OR MOVE OVER FOR EMERGENCY VEHICLES*). The TMCs that responded reported positive feedback from law enforcement agencies and cautioned about overuse and problems with displaying these messages at inappropriate times. The main concern and challenge reported dealt with making sure that the messages were consistently designed and applied.

AMBER ALERT MESSAGES

Research results reported in the literature indicated that there is a hierarchy of CMS message elements and specific terms for each message element preferred by motorists. The message elements and terms from one scenario follow in order of importance:

1. Situation descriptor: *AMBER ALERT*,
2. Vehicle descriptor: *BLUE MAZDA 05 PICKUP*,
3. License plate number: *LIC # SR8-493*,
4. Telephone number: *CALL 511*, and
5. Tune to radio action descriptor (highway advisory radio or local radio station): *TUNE TO 530 AM*.

The results of the survey revealed that all of the 100 TMCs that responded to the questionnaire display AMBER alert messages. The most frequently displayed situation descriptors were *AMBER ALERT* (39%), *CHILD ABDUCTION* (18%), and *CHILD AMBER ALERT* (12%).

Research results from the literature review indicated the following: (1) a license plate number is equivalent to more than three units of information, and (2) a 10-digit telephone number is equivalent to more than three units of information. Thus, a message with a license plate number will exceed current effective message design guidelines that specify a maximum of four units of information in a message. Likewise, a message with a 10-digit telephone number will exceed current effective message design guidelines. Therefore, drivers will not be able to read and recall AMBER alert messages that contain a license plate number, 10-digit telephone number, or both.

A review of message content revealed that 88% of the TMCs include a license plate number, 10-digit telephone number, or both and, therefore, exceed the recommended maximum of four units of information. It is expected that most drivers will not be able to read and recall the information contained in these AMBER alert messages.

Seventy-five percent of the TMCs stated that they received very favorable or favorable responses from the public for the messages, whereas 16% indicated that they did not have sufficient information to comment on the public's response.

Many of the TMCs reported positive experiences with AMBER alert messages. Some TMCs highlighted the importance of obtaining complete information from the law enforcement agencies as quickly as possible to ensure that accurate information is displayed in a timely manner. However, many TMCs encounter problems with getting complete and timely information from the law enforcement agencies.

Many TMCs expressed uncertainty as to the correct message content and format for AMBER alert messages. Some TMCs recognized that the messages that they posted were too long for drivers to read and recall. Some drivers tended to slow to read the messages. Some TMCs emphasized the importance of including the vehicle license plate number in the CMS message (unless it is reported by means of radio or from a telephone contact).

CHANGEABLE MESSAGE SIGN MESSAGE DESIGN AND DISPLAY POLICIES AND GUIDELINES

Seventy-five percent of the TMCs reported that they have a written policy or guidelines regarding the design and display of CMS messages. Sixty-four percent have a written policy or guidelines to assist CMS operators in making decisions as to the priority of messages when two or more events occur on the freeway (e.g., incident and planned special event).

SUGGESTIONS AND FURTHER RESEARCH NEEDED TO ADVANCE THE STATE OF THE PRACTICE

Based on the results of the literature review and information gathered from the survey, it is suggested that the following actions be taken or research conducted relative to CMS messages during non-incident/non-roadwork periods to assist TMCs in more effective operation of CMSs.

General

Procedures should be developed to ensure that existing CMS message design and display manuals are available to TMCs.

Blank Changeable Message Signs versus Display of Messages

Objective data are needed to assist TMCs in their decision to either leave the CMSs blank or to display messages.

Blank Changeable Message Signs

Research is needed to determine the most effective ways to inform drivers that the CMSs are functional when no message is displayed. Public information campaigns and driver understanding of illuminating one or more pixels should be considered in the evaluations.

Display of Messages

Research should be conducted to evaluate the effects of change blindness when messages are regularly or periodically displayed and the need and effectiveness of flashing beacons mounted on CMSs should be evaluated.

Travel Time

Predictive computer algorithms are needed to accurately display travel times, particularly during rapidly deteriorating traffic conditions such as the transition from off-peak to peak traffic flows and during the occurrence of incidents.

Studies should be conducted to provide guidance to TMCs regarding the (1) best content and format for travel-time messages to enhance uniformity among TMCs; (2) frequency that travel times should be updated during congested periods; and (3) the most effective detector spacing for various levels of traffic operations.

Congestion, Speed, Public Safety Announcements, Safety Campaign, and Traffic Law or Ordinance Messages

General

The need, benefit, driver understanding, and effectiveness of various congestion, speed, PSA, safety campaign, and traffic law or ordinance messages should be evaluated.

Guidance is needed to establish message consistency, uniformity, and credibility when these types of messages are used.

Guidelines are needed to assist TMCs in distinguishing the difference between PSAs and safety campaign messages.

Computer algorithms and guidelines for detector spacing are needed to ensure that the limit of congestion is accurately displayed at all times. If effective computer algorithms exist, efforts should be taken to share the technology with other TMCs.

PSA Messages

Guidance is needed regarding the specific message content that constitute PSAs, and procedures for displaying consistent messages.

Policies and procedures are needed to assist TMCs in responding to requests for other types of non-traffic-related messages once PSAs are displayed.

Safety Campaign Messages

Guidance is needed on the appropriate times to display safety campaign messages.

Policies and procedures are needed to assist TMCs in responding to requests for other types of non-traffic-related messages once safety campaign messages are displayed.

AMBER Alert Messages

Guidance is needed on the most effective message content and format for AMBER alert messages, and display duration for AMBER alert messages.

Guidance is needed regarding the display of license plate and telephone numbers given that their use results in a message exceeding the recommended maximum number of units of information.

Procedures should be recommended to TMCs to assist them in improving the accuracy and timeliness of information from law enforcement agencies.

Procedures should be recommended to TMCs to assist them in improving notification from law enforcement agencies when AMBER alert is no longer necessary.

REFERENCES

1. *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, Washington, D.C., 2003 [Online]. Available: http://mutcd.fhwa.dot.gov/.
2. Dudek, C.L., R.D. Huchingson, W.R. Stockton, R.J. Koppa, S.H. Richards, and T.M. Mast, *Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 1—Design Guide*, Report FHWA-RD-78-5, Federal Highway Administration, Washington, D.C., Sep. 1978.
3. Dudek, C.L. and R.D. Huchingson, *Manual on Real-Time Motorist Information Displays*, Report FHWA-IP-86-16, Federal Highway Administration, Washington, D.C., Aug. 1986.
4. Dudek, C.L., *Guidelines on the Use of Changeable Message Signs*, Report FHWA-TS-90-043, Federal Highway Administration, Washington, D.C., July 1991.
5. Dudek, C.L., *Variable Message Sign Operations Manual*, Report FHWA-NJ-2001-10, New Jersey Department of Transportation, Trenton, Dec. 2001.
6. Dudek, C.L., *Changeable Message Sign Operation and Messaging Handbook*, Report FHWA-OP-03-070, Federal Highway Administration, Washington, D.C., Aug. 2004 [Online]. Available: http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=25&new=2.
7. Dudek, C.L., *Dynamic Message Sign Message Design and Display Manual*, Report FHWA/TX-04/0-4023-P3, Texas Transportation Institute, College Station, Apr. 2006 [Online]. Available: http://tti.tamu.edu/documents/0-4023-P3.pdf.
8. Dudek, C.L., R.D. Huchingson, R.D. Williams, and R.J. Koppa, *Human Factors Design of Dynamic Visual and Auditory Displays for Metropolitan Traffic Management*, *Vol. 2—Dynamic Visual Displays*, Report FHWA/RD-81/040, Federal Highway Administration, Washington, D.C., Jan. 1981.
9. Weaver, G.D., C.L. Dudek, D.R. Hatcher, and W.R. Stockton, "Approach to Real-Time Diversion of Freeway Traffic for Special Events," *Transportation Research Record 644*, Transportation Research Board, National Research Council, Washington, D.C., 1977, pp. 57–61.
10. Dudek, C.L., G.D. Weaver, D.R. Hatcher, and S.H. Richards, "Field Evaluation of Messages for Real-Time Diversion of Freeway Traffic for Special Events," *Transportation Research Record 682*, Transportation Research Board, National Research Council, Washington, D.C., 1978, pp. 37–45.
11. Upchurch, J., J.D. Armstrong, M.H. Baaj, and G.B. Thomas, "Evaluation of Variable Message Signs: Target Value, Legibility, and Viewing Comfort," *Transportation Research Record 1376*, Transportation Research Board, National Research Council, Washington, D.C., 1992, pp. 35–44.
12. Staplin, L., K. Locco, S. Byington, and D. Harkey, *Highway Design Handbook for Older Drivers and Pedestrians*, Report FHWA-RD-01-103, Federal Highway Administration, Washington, D.C., Feb. 2001 [Online]. Available: http://www.tfhrc.gov/humanfac/01103/coverfront.htm.
13. Ullman, G.L. and C.L. Dudek, "Legibility Distance of Light-Emitting Diode (LED) Variable Message Signs," *CD-ROM Compendium*, 6th World Congress on Intelligent Transport Systems, Toronto, ON, Canada, Nov. 1999.
14. Lerner, N.D., R.E. Llaneras, H.W. McGee, S. Taori, and G. Alexander, *NCHRP Report 488: Additional Investigations on Driver Information Overload*, Transportation Research Board, National Research Council, Washington, D.C., 2003, 117 pp. [Online]. Available: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_488a.pdf.
15. Dudek, C.L., S.D. Schrock, G.L. Ullman, and S.T. Chrysler, "Flashing Message Features on Changeable Message Signs," *Transportation Research Record: Journal of the Transportation Research Board, No. 1959*, Transportation Research Board of the National Academies, Washington, D.C., 2006, pp. 122–129 [Online]. Available: http://trb.metapress.com/content/v3368577l76w5527/fulltext.pdf.
16. Dudek, C.L., S.D. Schrock, and G.L. Ullman, *Impacts of Using Dynamic Features on Changeable Message Signs*, Report FHWA-HOP-05-069, Federal Highway Administration, Washington, D.C., Aug. 2005 [Online]. Available: http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=31&new=2.
17. Johnson, C.M., policy memorandum, Use of Changeable Message Signs (CMS), Jan. 19, 2001 [Online]. Available: http://www.fhwa.dot.gov/legsregs/directives/policy/pame.htm.
18. Peters, M.E., policy memorandum, "Click It or Ticket" Signs, Mar. 6, 2002. [Online]. Available: http://mutcd.fhwa.dot.gov/res-memorandum_clickit.htm.
19. Paniati, J.F., FHWA policy memorandum, AMBER Alert—Use of Changeable Message Sign (CMS), Aug. 16, 2002 [Online]. Available: http://www.fhwa.dot.gov/legsregs/directives/policy/ambermemo.htm.
20. Paniati, J.F., FHWA policy memorandum, Use of Changeable Message Sign (CMS) for Emergency Security Messages, Mar. 21, 2003 [Online]. Available: http://www.fhwa.dot.gov/legsregs/directives/policy/securmemo.htm.
21. Paniati, J.F., FHWA policy memorandum, Information and Action: Dynamic Message Sign (DMS) Recommended Practice and Guidance, July 16, 2004. [Online]. Available: http://mutcd.fhwa.dot.gov/res-memorandum_dms.htm.
22. Rensink, R.A., "Change Detection," *Journal of Annual Review Psychology*, 2002.

23. Smith, S.A., *INFORM Evaluation, Vol. I: Technical Report*, Report FHWA-RD-91-075, Federal Highway Administration, Washington, D.C., Jan. 1992.
24. Dudek, C.L., *NCHRP Synthesis of Highway Practice 237: Changeable Message Signs*, Transportation Research Board, National Research Council, Washington, D.C., 1997, 237 pp.
25. Dudek, C.L. and R.D. Hutchingson, *Use of Changeable Message Signs for Displaying Travel Times and Other Time-Related Messages*, Dudek & Associates, Bryan, Tex., Jan. 1991.
26. Dudek, C.L., N. Trout, S. Booth, and G.L. Ullman, *Improved Dynamic Message Sign Messages and Operations*, Report FHWA/TX/-01/1882-2, Texas Transportation Institute, College Station, Oct. 2000 [Online]. Available: http://tti.tamu.edu/documents/1882-2.pdf.
27. PBS&J, *AMBER, Emergency, and Travel Time Messaging Guidance for Transportation Agencies*, prepared for the Federal Highway Administration, Washington, D.C., May 2004 [Online]. Available: http://www.ops.fhwa.dot.gov/TravelInfo/resources/cms_rept/cmspractices.htm.
28. Stockton, W.R., C.L. Dudek, D.B. Fambro, and C.J. Messer, "Evaluation of Selected Messages and Codes for Real-Time Motorist Information Displays," *Transportation Research Record 600,* Transportation Research Board, National Research Council, Washington, D.C., 1976, pp. 40–41.
29. Johnson, C.M., memorandum, "Congestion Ahead" Messages, Dec. 21, 2001 [Online]. Available: http://mutcd.fhwa.dot.gov/res-memorandum_congestion.htm.
30. Dudek, C.L., C.J. Messer, and H.B. Jones, "A Study of Design Considerations for Real-Time Freeway Information Systems," *Highway Research Record 363*, Transportation Research Board, National Research Council, Washington, D.C., 1971, pp. 1–17.
31. Dudek, C.L., R.D. Huchingson, R.J. Koppa, and M.L. Edwards, *Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 10—Evaluation of Traffic State Descriptor Variables*, Report FHWA-RD-78-14, Federal Highway Administration, Washington, D.C., Feb. 1978.
32. Hulbert, S. and J. Beers, *Research Development of Changeable Messages for Freeway Traffic Control*, Institute of Transportation and Traffic Engineering, School of Engineering and Applied Sciences, University of California, Los Angeles, Aug. 1971.
33. Smiley, A. and R. Dewar, *Changeable Message Signs—A Driver Preference Survey*, Report HSF-88-03, Research and Development Branch, Ontario Ministry of Transportation, Downsview, ON, Canada, Dec. 1988.
34. Vercruyssen, M., *Variable Message Signage Content: Survey Test of Meaning and Simulation Test of Usability*, Report CTS 97-03, Center for Transportation Studies, University of Minnesota, Minneapolis, Sep. 1997 [Online]. Available: http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1234.
35. Richards, S.H., R.C. Wuhderlich, and C.L. Dudek, "Field Evaluation of Work Zone Speed Control Techniques," *Transportation Research Record 1035*, Transportation Research Board, National Research Council, Washington, D.C., 1985, pp. 66–77.
36. Richards, S.H. and C.L. Dudek, "Implementation of Work Zone Speed Control Measures," *Transportation Research Record 1086*, Transportation Research Board, National Research Council, Washington, D.C., 1986, pp. 36–42.
37. Benson, B.G., "Motorist Attitudes about Content of Variable-Message Signs," *Transportation Research Record 1550*, Transportation Research Board, National Research Council, Washington, D.C., 1996, pp. 48–57 [Online]. Available: http://trb.metapress.com/content/f140x332683454q4/fulltext.pdf.
38. Ullman, B.R., C.L. Dudek, N.D. Trout, and S.K. Schoeneman, *AMBER Alert, Disaster Response and Evacuation, Planned Special Events, Adverse Weather and Environmental Conditions, and Other Messages for Display on Dynamic Message Signs*, Report FHWA/TX/-06/0-4023-4, Texas Transportation Institute, College Station, Oct. 2005 [Online]. Available: http://tti.tamu.edu/documents/0-4023-4.pdf.
39. Ullman, B.R., C.L. Dudek, and N.D. Trout, "AMBER Alert and Major Catastrophe Messages on Dynamic Message Signs: Focus Group Studies in Texas," *Transportation Research Record 1959*, Transportation Research Board, National Research Council, Washington, D.C., 2006, pp. 114–121 [Online]. Available: http://trb.cmetapress.com/content/l7182271709717w7/fulltext.pdf.
40. Dudek, C.L., S.D. Schrock, and B.R. Ullman, "License Plate and Telephone Numbers in Changeable Message Sign AMBER Alert Messages," *Transportation Research Record 1959*, Transportation Research Board, National Research Council, Washington, D.C., 2007, pp. 64–71 [Online]. Available: http://trb.metapress.com/content/16vkv54401179h03/fulltext.pdf.
41. Texas AMBER Alert Network, Office of the Governor, Rick Perry, State of Texas [Online]. Available: http://www.governor.state.tx.us/divisions/press/initiatives/amber.

APPENDIX A

Questionnaire: Changeable Message Sign Messages During Non-Incident/Non-Roadwork Periods

TRANSPORTATION RESEARCH BOARD
NCHRP PROJECT 20-05, SYNTHESIS TOPIC 38-11

Note: This survey addresses messages displayed on large permanent changeable message signs (CMSs). These signs are defined in the MUTCD as changeable message signs; some agencies refer to the signs as dynamic message signs or variable message signs. Portable changeable message signs (PCMSs) ARE NOT included in the survey.

Off-peak periods in this survey refer to hours other than the peak traffic periods on Monday through Friday. Off-peak periods also include both day and night periods on Saturday and Sunday.

A1. Agency: _____

A2. Name, title, telephone number, and e-mail address of person(s) completing survey:

A3. Does your agency operate permanent changeable message signs (CMSs)?
____Yes *Go directly to question A4.*
____ No *Thank you for responding to this NCHRP survey. Send this form to Dr. Conrad Dudek at the address shown at the end of the questionnaire.*

A4. Number of traffic management centers (TMCs) operated by your agency: _____

A5. Location of TMC for which the response to this survey applies.

A6. Name, telephone number, and e-mail address of TMC manager/supervisor to contact for more information (if different from item A2 above).

A7. Number of changeable message signs (CMSs) operated by your TMC:
____urban areas ____rural areas

A8. Days and hours of operation of your TMC:

CURRENT CMS MESSAGE APPLICATIONS

Mark whether you currently display messages for each type of application. Also mark whether the messages are displayed on CMSs located in urban areas, rural areas, or both urban and rural.

B1. Current types of CMS messages and locations of the CMSs (i.e., urban and/or rural)
a. Traffic management and diversion for the following events:

CMS Location

____Incidents (e.g., crashes, stalled vehicles, vehicle fires, spilled loads)	____Urban ____Rural
____Work zones	____Urban ____Rural
____Special high-volume traffic (e.g., weekend holiday traffic, recreational traffic)	____Urban ____Rural
____Planned special events (e.g., sport events, parades, state fairs, bicycle races)	____Urban ____Rural
____Evacuations during major catastrophes	
____Hurricanes	____Urban ____Rural
____Terrorist attacks	____Urban ____Rural
____Chemical spills	____Urban ____Rural
____Wildfires	____Urban ____Rural
____Other (specify): _____	____Urban ____Rural

b. Warning of adverse conditions:
Adverse road conditions:
____Ice ____Urban ____Rural
____Snow ____Urban ____Rural
____Flood ____Urban ____Rural
____High water but passable ____Urban ____Rural
____Other (specify):_____
____Urban ____Rural
Adverse weather and environmental conditions:
____Fog ____Urban ____Rural
____Rain ____Urban ____Rural
____Snow ____Urban ____Rural
____Sand/dust ____Urban ____Rural
____Wind ____Urban ____Rural
____Smog/ozone ____Urban ____Rural
____Other (specify):_____
____Urban ____Rural

c. Control at crossings:
____Bridge control ____Urban ____Rural
____Tunnel control ____Urban ____Rural
____Mountain-pass control ____Urban ____Rural
____International border crossing control ____Urban ____Rural
____Highway/railroad crossing control ____Urban ____Rural
____Highway/light rail transit crossing control____Urban ____Rural

d. Special-use lane and roadway control:
____HOV lanes ____Urban ____Rural
____Contra-flow lanes ____Urban ____Rural
____Exclusive lanes ____Urban ____Rural
____Reversible lanes____Urban ____Rural
____Mixed-flow managed lanes ____Urban ____Rural

e. Special applications:
____Advance parking systems ____Urban ____Rural
____Advance notice of events that may impact traffic operations
____Upcoming roadwork ____Urban ____Rural
____Upcoming planned special events ____Urban ____Rural
____Upcoming holiday or recreational traffic ____Urban ____Rural
____Other (specify):_____
____Urban ____Rural
____AMBER alert ____Urban ____Rural
____Homeland security ____Urban ____Rural
____Inter-modal information (e.g., ferry schedules, Amtrak/HOV parking, etc.)
____Urban ____Rural
____Truck restrictions ____Urban ____Rural
____Hazardous cargo ____Urban ____Rural
____Support of highway advisory radio ____Urban ____Rural

f. Other applications (specify):_____
____Urban ____Rural

POLICY AND MESSAGE PRIORITIES

C1. Do you have a written policy governing the design and/or display of CMS messages?
____Yes ____No

C2. Situations arise when two or more events are present simultaneously. For example, a crash may occur on the freeway during a planned special event. Do you have a policy concerning a priority for displaying CMS message types when two or more events occur?
____Written policy ____Unwritten policy ____No policy

Additional comments:

C3. If a policy exists, list the priority order of message types starting with the highest priority.
1.
2.
3.
4.
5.
6.
7.
8.

STATUS OF CMSs DURING NON-INCIDENT/NON-ROADWORK MESSAGES

D1. What is the status of the CMSs during non-incident/non-roadwork periods?

Peak period
____Leave the CMS blank, or display a single lamp, set of lamps, symbol, etc.
____Routinely display messages other than those marked in B1.

Off-peak period
____Leave the CMS blank, or display a single lamp, set of lamps, symbol, etc.
____Routinely display messages other than those marked in B1.

If you leave the CMS blank, or display a single lamp, set of lamps, symbol, etc.. either during the peak or off-peak period, CONTINUE TO E1 BELOW.
If you routinely display messages other than those marked in B1 during both the peak and off-peak period, SKIP TO F1.

MESSAGES ARE NOT DISPLAYED DURING NON-INCIDENT/NON-ROADWORK PERIODS

E1. What is the status of the CMSs when messages are not displayed during non-incident/non-roadwork periods?
____Blank CMSs
____Single lamp is illuminated
____Set of lamps is illuminated (specify in comments below)
____Symbol is displayed (specify in comments below)
____Other (specify in comments below)

Comments:

E2. What are the reasons for leaving the CMSs in the status shown in question E1?

E3. The decision to leave the CMSs in the status shown in question E1 is based on (mark all that apply):
____Agency administrative/upper-management preference
____TMC manager/supervisor preference
____Feedback from focus groups
____Feedback from telephone calls
____Feedback from newspapers
____Feedback from television
____Feedback from radio
____Research/surveys conducted by the agency
____Research conducted by others (specify):_____
_____
_____Other specify):_____
_____

E4. What has been the public's reaction to leaving the CMSs in the status shown in question E1?

E5. What have been your experiences with leaving the CMSs in the status shown in question E1?

E6. What lessons have you learned from leaving the CMSs in the status shown in question E1?

E7. Do you plan to change your policy in the near future?
____Yes ____No

Please provide comments.

If you display other types of messages during the peak or off peak period but not both periods, CONTINUE TO F1 BELOW.
If you do not display messages during both the peak and off-peak periods, SKIP TO 35.

MESSAGES DURING NON-INCIDENT/NON-ROADWORK PERIODS

F1. If messages are routinely displayed during non-incident/non-roadwork periods, what are the reasons for displaying messages rather than leaving the CMSs blank?

F2. The decision to display messages during non-incident, non-roadwork periods is based on (mark all that apply):
____Agency administrative/upper-management preference
____TMC manager/supervisor preference
____Feedback from focus groups
____Feedback from telephone calls
____Feedback from newspapers
____Feedback from television
____Feedback from radio
____Research/surveys conducted by the agency
____Research conducted by others (specify):_____
_____
_____Other (specify):_____
_____

F3. What has been the public's reaction to displaying messages during non-incident/non-roadwork periods?

F4. What have been your experiences with displaying messages during non-incident/non-roadwork periods?

F5. What lessons have you learned from displaying messages during non-incident/non-roadwork periods?

F6. Do you plan to change your policy concerning displaying messages during non-incident/non-roadwork periods in the near future?
____Yes ____No

Please provide comments.

TRAVEL-TIME MESSAGES

G1. Do you display travel times during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display travel time during the peak or off-peak period, SKIP TO G3.
If you do not display travel time during both the peak and off-peak periods, CONTINUE TO G2 BELOW.

G2. Give reasons why travel time is not displayed during either the peak or off-peak period as indicated in G1.

G3. Display of travel-time messages:

Period	Travel time is displayed				Travel time is displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

G4. What has been the public's reaction to travel-time messages? (Mark only one.)

____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

G5. What have been your experiences, concerns, and challenges with displaying travel-time messages?

G6. What lessons have you learned from displaying travel times?

G7. Give two or more examples of typical travel-time messages.

SPEED MESSAGES

H1. Do you display speed messages during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display speed messages during the peak or off-peak period, CONTINUE TO H2 BELOW.
If you do not display speed messages during both the peak and off-peak periods, SKIP TO I1.

H2. Display of speed messages:

Period	Speed messages are displayed				Speed messages are displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

H3. What has been the public's reaction to displaying speed messages? (Mark only one.)

____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

H4. What have been your experiences, concerns, and challenges with displaying speed messages?

H5. What lessons have you learned from displaying speed messages?

H6. Give two or more examples of typical speed messages.

CONGESTION MESSAGES

I1. Do you display congestion messages during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display congestion messages during the peak or off-peak period, CONTINUE TO I2 BELOW.
If you do not display speed messages during both the peak and off-peak periods, SKIP TO J1.

I2. Display of congestion messages:

Period	Congestion messages are displayed				Congestion messages are displayed on				
	Regularly	**Often**	**Occasionally**	**Rarely**	**All CMSs**	**Most CMSs**	**About 50% of CMSs**	**Some CMSs**	**Very few CMSs**
Peak									
Off-peak									

I3. What has been the public's reaction to congestion messages? (Mark only one.)
____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

I4. What have been your experiences, concerns, and challenges with displaying congestion messages?

I5. What lessons have you learned from displaying congestion messages?

I6. Give two or more examples of typical congestion messages.

PUBLIC SERVICE ANNOUNCEMENTS

J1. Do you display public service announcements (PSAs) (e.g., *VOTE TODAY*) during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display PSAs during the peak or off-peak period, CONTINUE TO J2 BELOW.
If you do not display PSAs during both the peak and off-peak periods, SKIP TO K1.

J2. Display of PSAs:

Period	PSAs are displayed				PSAs are displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

J3. What has been the public's reaction to displaying PSAs? (Mark only one.)
____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

J4. What have been your experiences, concerns, and challenges with displaying PSAs?

J5. What lessons have you learned from displaying PSAs?

J6. Give two or more examples of typical PSA messages.

SAFETY CAMPAIGN MESSAGES

K1. Do you display safety campaign messages (e.g., *BUCKLE SEAT BELTS*) during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display safety campaign messages during the peak or off-peak period, CONTINUE TO K2 BELOW.
If you do not display safety campaign messages during both the peak and off-peak periods, SKIP TO L1.

K2. Display of safety campaign messages:

Period	Safety campaign messages are displayed				Safety campaign messages are displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

K3. What has been the public's reaction to displaying safety campaign messages? (Mark only one.)
____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

K4. What have been your experiences, concerns, and challenges with displaying safety campaign messages?

K5. What lessons have you learned from displaying safety campaign messages?

K6. Give two or more examples of typical safety campaign messages.

TRAFFIC LAW AND/OR ORDINANCE MESSAGES

L1. Do you display traffic laws and ordinances messages during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display traffic laws and ordinances messages during the peak or off-peak period, CONTINUE TO L2 BELOW.
If you do not display traffic laws and ordinances messages during both the peak and off-peak periods, SKIP TO M1.

L2. Display of traffic laws and ordinances messages:

Period	Traffic laws and ordinances messages are displayed				Traffic laws and ordinances messages are displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

L3. What has been the public's reaction to displaying traffic laws and ordinances messages? (Mark only one.)
____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

L4. What have been your experiences, concerns, and challenges with displaying traffic laws and ordinances messages?

L5. What lessons have you learned from displaying traffic laws and ordinances messages?

L6. Give two or more examples of typical traffic laws and ordinances messages.

OTHER TYPES OF MESSAGES

M1. Excluding the types of messages mentioned earlier and the current messages you previously marked in question B1, do you display other types of messages during non-incident/non-roadwork periods?

Peak Period
____Yes ____No

Off-Peak Period
____Yes ____No

If you display other types of messages during the peak or off-peak period, CONTINUE TO M2 BELOW.
If you do not display speed messages during both the peak and off-peak periods, SKIP TO N1.

M2. Specifically, what other types of messages are displayed during non-incident/non-roadwork periods?

M3. Display of other types of messages:

Period	Other types of messages are displayed				Other types of messages are displayed on				
	Regularly	Often	Occasionally	Rarely	All CMSs	Most CMSs	About 50% of CMSs	Some CMSs	Very few CMSs
Peak									
Off-peak									

M4. What has been the public's reaction to displaying other types of messages? (Mark only one.)
____Very favorable
____Favorable
____Somewhat favorable
____Neutral
____Somewhat unfavorable
____Unfavorable
____Very unfavorable
____We have insufficient information to judge the public's reaction

M5. What have been your experiences, concerns, and challenges with displaying other types of messages?

M6. What lessons have you learned from displaying other types of messages?

M7. Give two or more examples of other types of messages.

CMS MESSAGE DISPLAY DECISIONS AND RESOURCES

N1. The decisions to display messages during non-incident/non-roadwork periods are based on public feedback obtained from (mark all that apply; mark "NOT DISPLAYED" if the specific message is not displayed):

CMS Message Type	Source										
	Agency administrative/upper-management preference	TMC manager/supervisor preference	Focus groups	Telephone calls	Newspapers	Television	Radio	Research/surveys conducted by the agency	Research conducted by others (specify in comments)	Other (specify in comments)	NOT DISPLAYED
Travel time											
Speed messages											
Congestion messages											

Public service announcements											
Safety campaign messages											
Traffic laws and ordinances											
Others (specify below)											

Comments:

N2. Details of public feedback about CMS messages can be obtained from the agency's:

CMS Message Type	Source		
	Survey reports	**Focus group reports**	**Other (specify below)**
Blank CMSs			
Travel time			
Speed messages			
Congestion messages			
Public service announcements			
Safety campaign messages			
Traffic laws & ordinances			
Others (specify below)			

Comments:

AMBER ALERT MESSAGES

O1. Do you display AMBER alert messages?
____Yes, *CONTINUE TO O2 BELOW*
____No, *SKIP TO E1*

O2. AMBER alert messages contain (mark all that apply):
____Vehicle make ____Vehicle model ____Vehicle color
____License plate number ____Telephone number ____Radio station

O3. What has been the public's reaction to AMBER alert messages?

O4. What have been your concerns, experiences, and challenges with displaying AMBER alert messages?

O5. What lessons have you learned from displaying AMBER alert messages?

O6. Give two or more examples of typical AMBER alert messages that include the descriptors identified in question O2 above.

Thank you for your response to this NCHRP survey.

Please send the following information:
1. This completed survey,
2. Copy of CMS message design and display policy, and
3. Library of CMS messages

to: Conrad L. Dudek
Professor Emeritus
Texas A&M University
2301 Oxford St. (979) 823-5106
Bryan, TX 77802 cdudek22@verizon.net

APPENDIX B

Summary of Traffic Management Centers and Number of Changeable Message Signs Operated by State DOTs and Agencies Operating Toll Roads That Responded to the Survey

	State DOT and TMC	Reported No. of Agency TMCs	No. of TMCs Responding	Reported No. of CMSs per TMC		Reported No. of CMSs in State	
				Urban	Rural	Urban	Rural
1	Alabama	2				9	5
	Birmingham (1)		1	9	5		
2	Arizona	1				66	58
	Phoenix (1)		1	66	58		
3	California	12				512	100
	Bishop (1)		1	0	7		
	Eureka (1)		1	0	35		
	Fresno (1)		1	84	0		
	Irvine–Orange County (1)		1	56	0		
	Los Angeles (1)		1	112	0		
	Oakland (1)		1	90	0		
	Redding (1)		1	0	30		
	Sacramento (1)		1	48	0		
	San Bernardino (1)		1	54	0		
	San Diego (1)		1	44	0		
	San Luis Obispo (1)		1	4	7		
	Stockton (1)		1	20	21		
4	Colorado	3	3	60	140	60	140
	Golden (1)						
	Colorado Springs (1)						
	Hanging Lake (1)						
5	Connecticut	2				70	50
	Division (2)		2	70	50		
6	Delaware	1	1	7	1	7	1
7	Florida	7				273	18
	Broward/Palm Beach Counties (2)		2	100	0		
	Fort Lauderdale/W Palm Beach (2)		2	31	0		
	Jacksonville (1)		1	23	0		
	Miami (1)		1	44	7		
	Orlando (1)		1	75	11		
8	Georgia	2				95	15
	Atlanta (1)		1	95	15		
9	Idaho	0	0	6	22	6	22
10	Illinois	2				32	0
	Chicago District 1 (1)		1	32	0		
11	Iowa	1	1	24	2	24	2
12	Kansas	1	1	36	0	36	0
13	Kentucky	4				15	0
	Louisville and Southern Indiana (1)		1	15	0		
14	Louisiana	2				20	15
	Baton Rouge and Shreveport (2)		2	20	15		

	State DOT and TMC	Reported No. of Agency TMCs	No. of TMCs Responding	Reported No. of CMSs per TMC		Reported No. of CMSs in State	
				Urban	Rural	Urban	Rural
15	Maine	1	1	7	0	7	0
16	Maryland	4	4	70	3	70	3
	Statewide Hanover (1)						
	College Park (1)						
	Baltimore (1)						
	Frederick (1)						
17	Minnesota	10				95	25
	Minneapolis–St. Paul (1)		1	95	25		
18	Missouri	3				21	24
	St. Louis (1)		1	21	24		
19	Montana	0	0	0	7	0	7
20	Nevada	3				20	11
	Reno (1)		1	9	0		
	Elko (1)		1	0	8		
	Las Vegas (1)		1	11	3		
21	New Hampshire	1	1	3	3	3	3
22	New Mexico	1	1	15	3	15	3
23	New York	7				175	0
	Long Island (1)		1	175	0		
24	North Carolina	3				107	26
	Charlotte (1)		1	31	0		
	Raleigh (1)		1	25	0		
	Greensboro (1)		1	41	0		
	Ashville Field Office			4	0		
	Fayetteville Field Office			0	7		
	North Wilkesboro Field Office			0	3		
	Sylva Field Office			0	8		
	Wilson Field Office			0	8		
	Wilmington Field Office			6	0		
25	North Dakota	2	2	3	20	3	20
	Bismarck (1)						
	Fargo (1)						
26	Oklahoma	1	1	18	0	18	0
27	Oregon	4	4	22	36	22	36
	Division (4)						
28	Pennsylvania	6				28	44
	Allentown (1)		1	4	0		
	Harrisburg (1)		1	1	0		
	Hollidaysburg (1)		1	4	20		
	Indiana (1)		1	3	8		
	Oil City (1)		1	0	8		
	Pittsburgh (1)		1	16	8		
	District 12-0 (0)		0	0	0		
29	Rhode Island	1	1	37	0	37	0

	State DOT and TMC	Reported No. of Agency TMCs	No. of TMCs Responding	Reported No. of CMSs per TMC		Reported No. of CMSs in State	
				Urban	Rural	Urban	Rural
30	South Carolina	5	5	54	10	54	10
	Charleston (1)						
	Columbia (1)						
	Greenville (1)						
	Myrtle Beach (1)						
	Rock Hill (1)						
31	South Dakota	1				10	20
	Pierre (1)		1	10	20		
32	Tennessee	3				38	0
	Nashville (1)		1	22	0		
	Knoxville (1)		1	16	0		
33	Texas	14				434	35
	Atlanta (1)		1	1	1		
	Austin (1)		1	14	0		
	Beaum		1	4	4		
	Corpus Christi (1)		1	18	4		
	El Paso (1)		1	44	0		
	Fort Worth (1)		1	62	4		
	Pharr (1)		1	8	2		
	Houston (1)		1	119	12		
	Laredo (1)		1	12	0		
	San Antonio (1)		1	150	0		
	Tyler (1)		1	0	2		
	Waco (1)		1	0	4		
	Wichita Falls (1)		1	2	2		
34	Utah	1				67	7
	Salt Lake City (1)		1	67	7		
35	Vermont	0	0			0	0
36	Virginia	5				390	10
	Hampton Roads (1)		1	170	0		
	Northern Region (1)		1	220	10		
37	Washington	6				82	47
	Seattle & Bellingham (2)		2	64	0		
	Spokane (1)		1	6	0		
	Tacoma (1)		1	9	6		
	Wenatchee (1)		1	0	9		
	Yakima (1)		1	3	32		
38	West Virginia	0	0			0	0
39	Wisconsin	1				45	0
	Milwaukee (1)		1	45	0		
40	Wyoming	0	0	0	8	0	8
	Subtotal	123	95	2966	765	2966	765

	Agency Operating Toll Road and TMC	Reported No. of Agency TMCs	No. of TMCs Respond	Reported No. of CMSs per TMC		Reported No. of CMSs in Agency	
				Urban	Rural	Urban	Rural
1	Harris County Toll Road Authority	1	1	1	1	1	1
2	Illinois State Toll Highway Authority	1	1	19	19	19	19
3	Ohio Turnpike Commission	0	0	0	0	0	0
4	Pennsylvania Turnpike Commission	1	1	5	13	5	13
5	NJ Turnpike Authority (Parkway)	1	1	22	23	22	23
6	NJ Turnpike Authority (Turnpike)	1	1	11	0	11	0
	Subtotal	5	5	58	56	58	56
	GRAND TOTAL	128	100	3024	821	3024	821

Abbreviations used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation