National Cooperative Highway Research Program

NCHRP Synthesis 186

Supplemental Advance Warning Devices

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

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Synthesis of Highway Practice 186

Supplemental Advance Warning Devices

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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.

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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 of the U.S. Department of Transportation.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to traffic engineers, highway design engineers, and others concerned with the operation, safety, and design of the roadway environment. Information is presented on a variety of advance warning devices that are used by state and local agencies to advise motorists of unusual or dangerous road conditions.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This synthesis describes the state of the art with respect to traffic devices used to provide motorists with advance warning of various roadway situations. This report of the Transportation Research Board describes more than 340 such devices that have been applied and are in keeping with accepted traffic engineering principles, but are not presently included in the *Manual on Uniform Traffic Control Devices* (MUTCD). Both active and passive warning devices are presented in the following general categories: environ-

mental conditions (e.g., snow and ice), heavy vehicles, school zones, pedestrian crossings, rail-highway grade crossings, roadway cross sections, congestion and queues, and others. The purpose and characteristics of each device are described, including any information available on their effectiveness, cost, or other features. A drawing of each device is shown to aid the reader in visualizing the device.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Special appreciation is expressed to Brian L. Bowman, Associate Professor, Auburn University, who was responsible for collection of the data and preparation of the report.

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Richard A. Cunard, Engineer of Traffic and Operations, Transportation Research Board, assisted the NCHRP 20-5 Staff and the Topic Panel.

Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

SUPPLEMENTAL ADVANCE WARNING DEVICES

SUMMARY

A wide variety of advance warning devices has been developed by transportation agencies to address unusual safety, operational, or environmental conditions that cannot be adequately addressed using standard warning devices as found in the *Manual on Uniform Traffic Control Devices* (MUTCD). This synthesis presents the results of a literature review and state-of-the-practice survey conducted to provide useful information on advance warning devices that are not specified in the MUTCD. Both active and passive devices intended for long-term use are included. Short-duration devices, such as those used for construction and maintenance activities, and those used for freeway surveillance and control were not included in the study.

The state of the practice was ascertained by sending a questionnaire to states, Canadian provinces, counties, and large U.S. cities. The 67 survey responses and the literature review provided information on 340 devices. The agencies were asked to send information on device configuration, placement, reasons for installation, effectiveness, and the number of locations at which the device was installed.

The devices were grouped, using a set of key words, into the following categories:

- Environmental conditions
- Heavy vehicles
- Geometric features
- Zones
- Rail-highway crossings
- Roadway cross-section
- Congestion / Stopped Vehicles
- Miscellaneous Hazards

The characteristics of each device are summarized, and a drawing is presented. The majority of the devices encountered in this project were not evaluated by formal effectiveness studies, but are simply perceived to be effective by the responding agency. It is, therefore, recommended that any device described in this synthesis be installed only after careful deliberation, and that effectiveness studies be performed after installation. Agencies that determine a frequent need for a particular type of supplemental device are encouraged to follow the procedures of section 1A-6 of the MUTCD for obtaining approval to experiment on new device types.

CHAPTER ONE

THE NEED FOR SUPPLEMENTAL WARNING DEVICES

INTRODUCTION

Safe and efficient roadway travel depends, to a large extent, on adequate traffic control devices. The majority of motorists drive in an orderly and safe manner, provided they are given reliable regulatory, warning, and guide information. Motorists, through training and experience, develop expectations regarding when and in what manner they will be provided necessary information for safely controlling their vehicles. Motorists expect that similar traffic control devices will always have the same meaning and will require the same motorist action regardless of where they are encountered. This expectation has been enhanced by the use of uniform traffic control devices that enable motorists to consistently interpret the general intent of a device by its message, shape, and color.

The advantages of traffic control device uniformity were recognized long ago. The American Association of State Highway Officials (AASHTO) published specifications of road markers and signs for rural roadways in 1925. A manual for urban roadways was published in 1929 by the National Conference on Street and Highway Safety. The unification of the standards applicable to the different classes of roadways was addressed by a joint committee of the American Association of State Highway Officials and the National Conference on Street and Highway Safety. The joint committee developed, and in 1935 printed, the first *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) (*1*). That joint committee, although subsequently reorganized and named the National Committee on Uniform Traffic Control Devices (NCUTCD), has been in continuous existence and contributes to periodic revisions of the MUTCD.

The benefits of traffic control device uniformity include increasing safety by providing the road user with required information for vehicle guidance or control at the right time and place and in the proper manner. While the advantages of uniformity far outweigh the disadvantages, there are some undesirable effects when complete uniformity is maintained. One of the principal disadvantages is that strict uniformity may result in the failure to adopt an improved device or procedure simply because it is not in common use. In addition, total uniformity would require the specification of a separate traffic control device for every conceivable roadway geometric and traffic operational condition. This would be a monumental task that undoubtedly would still not cover every situation, while simultaneously increasing the size of the MUTCD with devices of limited application.

This difficulty is recognized in the MUTCD, which indicates that warning signs other than those specified in the manual may be required under special conditions (*2,sec 2C-1*). The MUTCD requires exercising good engineering judgment in determining the need for other warning devices. It also mandates that the innovative devices be understood easily by the motorist. Ensuring that warning signs are easily understood necessitates that they be of standard shape and color and that the legends be unambiguous and brief. Establishing the need for distinct warning devices can be accomplished by identifying when standard devices do not properly address unusual conditions. While these conditions are unusual, they can typically be classified into the same use categories that are appropriate for standard warning signs. *The Traffic Control Devices Handbook* (*3*) identifies the following uses of warning devices:

- To indicate the presence of geometric features with potential hazards.
- To define major changes in roadway character.
- To mark obstructions or other physical hazards in or near the roadway.
- To locate areas where hazards may exist under certain conditions.
- To inform motorists of regulatory controls ahead.
- To advise motorists of appropriate actions.

The need to provide advance warning for unusual roadway, roadside, operational, and environmental conditions has resulted in the development of a wide diversity of devices. The majority of these devices can be categorized as warning signs containing different symbols and legends. Other warning devices include flashing beacons, rumble strips, pavement surface treatments, and pavement markings. Device complexity ranges from simple passive warning signs to devices that are activated by vehicle speed, headway, or presence on one or more approaches to a potentially hazardous roadway element.

This synthesis documents supplemental advance warning devices. Supplemental devices are those that have been developed by transportation agencies to address unusual safety, operational, or environmental conditions that cannot be addressed using standard warning devices as found in the MUTCD. The development of these devices is within the provisions of Section 2C-40 of the MUTCD, which requires that they conform with the general specifications for shape, color, and placement of warning signs. The devices of interest for this synthesis consist of both passive and active devices that are intended for long-term use. Short-duration devices, such as those used during construction or maintenance activities, and devices related to freeway surveillance and control are not included in the synthesis.

LEGAL RESPONSIBILITY

Estimates by the Federal Highway Administration (FHWA) indicate an average of 15 signs per mile on the nation's 3.8 million miles of streets and roadways (*4*). The resultant 57 million traffic signs represent a huge investment in materials, labor, equipment, and maintenance costs. While this is a significant investment, im-

provements using standard traffic control signing are reported in *The 1988 Annual Report on Highway Safety Improvement Programs* as having the highest benefit/cost ratio of any highway safety improvement (*5*). Properly designed, located, and maintained standard traffic signs and other carefully conceived devices can be an effective method of increasing traffic and operational efficiency and subsequently decreasing the tort liability exposure of roadway agencies.

The concerns about tort liability judgments are valid, as the number of cases is steadily increasing. In almost every state, the shield of sovereign immunity has either been abolished by judicial decisions or has been eroded by legislative modifications to governmental immunity. In one state, for example, the legislature was instructed to enact comprehensive tort claim procedures in the near future or the doctrine of immunity would be abrogated by the state supreme court. In another state, the concept of sovereign immunity was declared unconstitutional (*6*).

A tort is a civil wrong or injury. The purpose of a tort action is to seek compensation for damages to property and individuals. The following elements must exist for a valid tort action:

- The defendant must owe a legal duty to the plaintiff.
- There must be a breach of duty; that is, the defendant must have failed to perform a duty or performed it in an improper manner.
- The breach of duty must be a proximate cause of the accident that resulted.
- The plaintiff must have suffered damages as a result.

In highway-related tort cases the first element is relatively easy to establish. Roadway authorities have been vested with the responsibility of providing reasonably safe travel opportunity for roadways under their jurisdiction. The failure of the roadway agency to properly perform that duty, and that this breach of duty was the proximate cause of the accident, are more difficult to establish. In most instances, establishing that a breach of the legal duty occurred becomes a major issue in tort liability cases. Plaintiffs typically will attempt to establish that the agency having roadway jurisdiction was negligent in its duty or that a hazardous physical condition was permitted to exist.

Negligence is the failure to exercise such care as a reasonably prudent and careful person would use under similar circumstances. Roadway agencies can be judged negligent in two ways: 1) wrongful performance (misfeasance) or 2) the omission of performance when some act should have been performed and was not (nonfeasance). Roadway agencies can, therefore, be judged negligent either by addressing a safety problem incorrectly or by ignoring it. The critical issue in highway tort liability is the care with which highway agencies perform their responsibilities. If it is judged that a reasonable standard of care was not exercised, then the responsible persons or organizations may be held liable for injuries and damages that resulted.

In an attempt to familiarize roadway agencies and their employees with the potential liability, and to make them aware of their duties and responsibilities to the traveling public, the National Cooperative Highway Research Program (NCHRP) published *Synthesis of Highway Practice 106: Practical Guidelines for Minimizing Tort Liability* (*6*). In particular, this publication advises agencies to supply a consistent highway environment for motorists. The use of standard design features and uniform traffic control devices is also emphasized.

All states are to adopt the standards of the MUTCD as the basis for designing and installing traffic control devices. Some states adopt the MUTCD in its entirety while other states incorporate into their manuals additional devices and practices that address their specific roadway design and driver expectancy needs. The MUTCD provides minimal requirements and states that prepare their own manuals are required to conform to the national standard. Additional devices not included in either a state or the federal MUTCD are frequently developed to provide motorist warning of roadway hazards which, ideally, should be eliminated. The reasons for not eliminating the hazard can include geometric constraints, planned improvements, usefulness of the condition for other purposes, burden of removing the condition, and the lack of a method to correct the situation. When the need to warn motorists involves commonly encountered hazards, such as a stop sign ahead on a rural roadway, then an appropriate warning device can be found in the MUTCD. When the hazard is posed by unusual or unique conditions, however, the highway engineer is placed in the difficult position of identifying, or often designing, a warning device that provides a clear message to the motorist of the potential hazard. It should be emphasized that the installation of a warning device does not remove the agency from liability, especially if it can be shown that it was reasonably possible to eliminate the hazard.

DESIGN OF WARNING DEVICES

Designing a warning device that provides a clear, unambiguous message to the motorist can be a difficult task. The difficulty is due partially to the concern of the engineer to act in a "reasonable and prudent" manner. Increasing motorist safety and minimizing liability requires that the device provide a readily understood and unambiguous message. This synthesis can assist in the design process by providing examples of supplemental warning devices which are, and are not, considered effective by different roadway agencies for similar potentially hazardous conditions.

Care must be exercised in using the contents of this synthesis. The intent of this document is to compile the different types of devices used for unusual conditions. Agencies responding to the questionnaire were asked if their supplemental devices were subjected to an effectiveness evaluation, and if not, whether they were perceived as being effective. In the majority of cases, the devices are merely perceived as being effective, with no formal effectiveness evaluation being performed. It must be realized that this perceived effectiveness can often be the result of personal bias instead of actual effectiveness.

In the design of warning signs, it is important to remember that signs are designed to draw attention to themselves through contrast, color, shape, composition, reflectorization, and illumination, with a simple message providing a clear and understandable instruction to the motorist. Sign size, symbol size, lettering size, and placement should be designed to allow adequate time for proper response. Uniform and reasonable instructions to the motorist will instill respect and develop willing compliance with the sign message. For these reasons, the majority of general warning signs should be designed as diamond shapes with black letters on a yellow background. Standard sign letters are prescribed in the *Standard Alphabets for Highway Signs*, which should be used to develop lettering size and style (*7*). Sections 2C-1, 2C-2 and 2C-40 of the MUTCD contain information that must be followed in the design of warning signs. In addition, section 1A-7 of the MUTCD lists

additional publications and documents that provide requisite information for the proper design of warning signs.

IDENTIFYING THE NEED FOR SUPPLEMENTAL ADVANCE WARNING DEVICES

Locations that would benefit from the installation of supplemental advance warning devices typically exhibit safety or operational problems. Establishing the need for supplemental devices, therefore, requires identifying the problem locations and performing a safety or operational analysis. Deficient locations can be identified by a traffic safety management system, citizen complaints, employee observations, and by safety analysis during a planned resurfacing, restoration, and rehabilitation (RRR) project.

Accident-based studies are used to identify locations that can be considered hazardous because of a large number of accidents. These studies involve the review and analysis of systemwide accident information. To compare the accident experience of several locations, the length of time over which accidents are counted, the traffic volumes and the length of roadway section involved should be the same at each location. If not, accident rates may be compared between locations, provided that a common unit of exposure (e.g., accidents per million vehicle miles for longer roadway sections, or accidents per million entering vehicles for spot locations and intersections) is used.

Potential locations can also be identified by complaints received from citizens and by observations made by employees. Often a combination of accident analysis and investigation of complaints and observations is required for low-volume roadways. Complaints about "near misses" and observations of hazardous roadway elements can be considered indicators of site deficiencies. This type of information is treated by some agencies with the same importance as a documented accident history. Such treatment has the advantage of reducing the number of accidents required to identify hazardous roadway locations.

It should be recognized that maintaining a complaint and employee observation file requires that the agency be responsive to these inputs. Complaints and observations are notifications of hazards that become a matter of public record and are available as evidence should an accident result in litigation. This alone is not a valid reason to fail to maintain a complaint and observation file. If a defect is allowed to remain for an unreasonable period of time, even if no complaints or observations were received, the courts can consider it as constructive notice and assign liability. Maintaining complaint and observation files, establishing a program to respond to all complaints, and documenting facts and engineering decisions can minimize the possibility of lawsuit losses.

An opportune time to identify the need for a device is during the design phase of projects primarily intended to upgrade the physical and operational characteristics of the roadway. This opportunity can be used to detect safety and operational deficiencies and to select appropriate improvements that can be incorporated into the upgrading project.

The identification of potential locations for each of the previous methods should include a field inspection to help establish the cause of the deficiency and appropriate countermeasures. If the site inspection indicates that the deficiency cannot be readily corrected due to cost or physical constraints, then an advance warning device should be installed. If the site conditions are so unusual that an appropriate warning device is not contained in the federal, or appropriate state MUTCD, then a supplemental device may need to be used or developed until the underlying problem can be addressed.

For example, consider a situation where a sag vertical curve was constructed to provide sufficient vertical bridge clearance on a roadway with a posted speed of 45 mph. Analysis of the areawide accidents indicated a higher than expected occurrence of intersection related and rear-end accidents at a signalized intersection immediately downstream of the bridge. A visit to the site indicated that the signal faces were not visible to approaching drivers until they were 400 ft from the stop line. Since this distance is less than the minimum visibility distance of 460 ft specified by section 4B-12 of the MUTCD, a SIGNAL AHEAD sign (W3-3) was installed (*2*). The engineer determined that, although the minimum recommendations of the MUTCD were being met, safety improvements could be achieved by providing real time warning that a stop will be required at the intersection. Since removing the sight obstruction was not possible, the engineer considered lowering the speed limit and providing additional motorist warning. His experience with lowering speed limits indicated that this countermeasure was not an effective long-term solution. The engineer decided to install an active supplemental advance warning device with the legend PREPARE TO STOP WHEN FLASHING configured as device 3C-5A. The device was installed over the roadway, 500 ft in advance of the stop bar, and interconnected with the traffic signal controller. The horizontally mounted beacons were timed to flash yellow 8 seconds prior to the red indication so that drivers passing the beacon at the legal speed limit would have advance warning of the required stop at the intersection. The yellow beacons continued to flash until 3 seconds before the end of the red indication to allow the start of queue dissipation. Motorists not encountering the flashing lights could expect to proceed through the intersection, while still having the signal presence reinforced by the overhead sign. The engineer plans to continue monitoring the location to determine if the active advance warning device is effective in reducing accidents.

CONCERNS REGARDING THE USE OF SUPPLEMENTAL ADVANCE WARNING DEVICES

This synthesis compiles the supplemental advance warning devices that have been used by roadway agencies to inform motorists of unusual geometric, operational, or traffic control features. The inclusion of a device in this synthesis does not imply that it is a viable or desirable device to use for identified deficiencies. The following concerns should be considered prior to the installation of any device not specified in the MUTCD.

- Many warning devices are attempts at political, inexpensive, or quick solutions to totally inappropriate roadway conditions. The proper countermeasure for many of these conditions is correcting the fault rather than installing additional motorist warning. Installing a supplemental warning device should be considered a temporary countermeasure until the inadequate roadway conditions can be corrected.
- The MUTCD provides guidance on the proper placement of traffic control devices to provide adequate time for motorists to perceive, identify, decide on, and perform any necessary maneuver. Section 2C-3 provides guidelines for the minimum placement distances of warning signs, while section 4B-12 specifies the minimum continuous visibility distances that should be present for

motorists approaching a traffic signal. The inability to provide the minimum visibility distance is one indication of the need to install an advance warning sign. Guidelines on the height and lateral location of signs are summarized in Figure 2-1 in the MUTCD (*2*). The guidelines of Parts 1, 2A, and 2C of the MUTCD should be followed for the installation of the majority of devices contained in this synthesis. Those cases where the devices described in this synthesis were installed with exception to standard placement, such as overhead mounting and placement close to the hazard, are clearly identified in the text accompanying each device.

- Section 2C-2 of the MUTCD states that warning signs shall consist of a black legend and border on a yellow background (*2*). With few exceptions, all of the devices in this synthesis comply with the black-on-yellow requirement. Those instances where the black-on-yellow format is not used are identified in the text of each device.
- Section 2C-40 of the MUTCD permits the design of warning signs for special conditions (*2*). These signs, however, should be constructed with clear and concise verbal messages. Letter legibility and size, combined with placement, must provide a clear meaning and provide ample time for response. Sections 1A-2, 1A-6, 2A-13, and 2C-40 of the MUTCD provide an approval process for new symbols and do not permit the use of symbols that are new or unique and, thereby, not readily understandable by the motorist (*2*). The only exception to the provision of nonstandard symbols is where minor modifications to MUTCD symbols are necessary to adequately describe specific design elements of the roadway (Section 1A-2). An example of a permitted symbol modification is displaying a curve on a SIDE ROAD sign (W2-2) if the side road occurs in the vicinity of a horizontal curve. Devices in this synthesis that use symbols not contained in the MUTCD or in *Standard Highway Signs* are designated as nonstandard in the text of each device (*2,8*).
- Warning devices should have the same silhouette shape as device shape. For example a 36-in. × 36-in. diamond warning sign mounted on a 48-in. × 48-in. square piece of plywood would not satisfy the shape requirement. Dawn and dusk light conditions, fog and other poor visibility situations can result in the warning sign being interpreted as a guide sign.
- Section 2A-20 of the MUTCD permits the use of hazard identification beacons to supplement an appropriate warning sign or marker (*2*). The hazard identification beacon consists of one or more sections of the circular yellow traffic signal head indication with a visible diameter of not less than 8 in. The MUTCD prohibits the placement of the beacons within the border of the sign except when used with a School Speed Limit sign (*2,sec 4E-1*). Section 4E-5 states that when flashing beacons are used to supplement warning signs they should be horizontally or vertically aligned. When the beacons are used in conjunction with a sign that is longer horizontally than vertically, they can be horizontally aligned similar to the provision of Section 4E-2. If two beacons are used they should be alternately flashed at a rate of not less than 50 nor more than 60 times per minute.
- Unique situations in the roadway environment can result in the need for changes or additions to the MUTCD. Section 1A-6 provides the procedure to be followed when considering a new device to replace a standard device, for additional devices to be added to the list of standard devices, and for revisions to recommended applications. Agencies that encounter the frequent need of a unique application are encouraged to request permission to experiment from the Federal Highway Administration, Office of Traffic Operations (HTO-30), 400 Seventh St. S.W., Washington, D.C., 20590.

CHAPTER TWO

DEVELOPMENT OF SUPPLEMENTAL ADVANCE WARNING DATA BASE

Information on the supplemental warning devices contained in this synthesis was obtained through a literature review and a state-of-the-practice survey. The survey was forwarded to all 50 states, 10 Canadian provinces, as well as to numerous county and local agencies. The survey requested that the respondent send a copy of the survey to others who use similar supplemental advance warning devices. Responses were received from 64 highway agencies, one university, and two private consulting firms. When combined with the devices identified during the literature review, information on a total of 340 advance warning devices was obtained. A sample of the survey is presented in Appendix A and a tabular summary of the responding agencies by geographical region is presented as Table 1.

Information from the survey forms and literature review was developed into a database. The database included a set of key words so that the devices could be grouped in any number of ways by either the functional need for the device, such as unusual geometrics or rough pavement conditions, or by distinct features, such as illumination or the use of photoelectric beams. Many devices serve a variety of purposes or have a long list of features, so perfect groupings were not possible due to the extent of overlap.

To compensate for the fact that a single device may fall into two or more categories, a list of the key words with a brief explanation, and the devices assigned to that key word are presented as Appendix B. If the user is unable to locate a suitable device under a certain category, then Appendix B can be used as a cross-reference to identify a group of devices with similar purpose.

The key words enabled the grouping of devices and the assigning of a unique identification number to each device, e.g., 1A-1. The first and second positions of the identification number indicate the category and subcategory, respectively. This is followed by a dash and a number that assigns the device a position within the subcategory. The categories and subcategories used to classify the devices are summarized in Table 2.

The identification number also indicates whether a device is passive or active. Signs, either alone or with flashing beacons that operate continuously, are classified as passive devices in this synthesis. Active devices are those with components that operate

TABLE 1
TYPE AND GEOGRAPHICAL LOCATION OF RESPONDING AGENCIES

Agency Type	No. of Responses	Region			
		Northeast	Midwest	West	South
State	31	6	8	6	11
County	17	1	5	5	6
Local	16	0	5	5	6
Other	3	1	1	0	1
Total	67	8	19	16	24

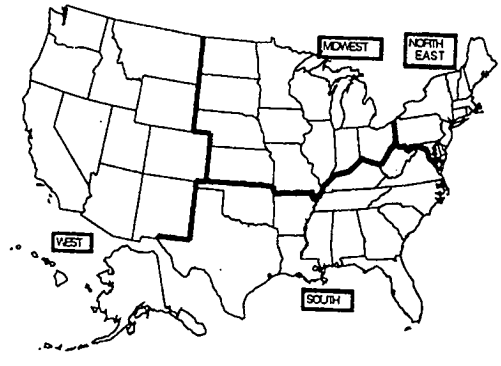


TABLE 2
CATEGORIES AND SUBCATEGORIES

Category	Description	Subcategory	Description
1	Environmental Conditions	A	Ice and Snow
		B	Water
		C	Fog and Smoke
		D	Other (Wind, Sand, Landslides, etc.)
2	Heavy Vehicles	A	Vertical Clearance
		B	Grades
		C	Other (Width, Bridge Loads, Turning, etc.)
3	Geometrics	A	Unusual Geometrics
		B	Restrictive Geometrics
		C	Signal Change Warning and Dilemma Zone Elimination
		D	Merging
		E	Movements
		F	Side Road/Crossroad Traffic
		G	Stop Sign/Signal Warning
		H	Intersection Approach Flow
		I	Motorist Information
4	Zones	A	Pedestrian Crossings
		B	Handicapped Areas
		C	Miscellaneous Crossings
		D	School Zones
		E	Emergency Vehicles
		F	Other (Church, Grazing, Slow-moving Vehicles, etc.)
5	Rail-Highway Crossings	A	Approaching Trains
		B	Light Rail Transit Crossings
6	Roadway Cross-Section	A	Pavement Conditions
		B	Shoulders
		C	Rumble Strips
7	Congestion/ Stopped Vehicles		
8	Miscellaneous Hazards		Tunnels, Drawbridges, Freeway Ends, etc.

or are activated due to (1) a signal from a detector or sensing device such as the presence or speed of a vehicle, (2) a traffic signal controller, (3) a timer set for periods of changing traffic conditions, or (4) manual operations by agency personnel for changing traffic conditions or a pedestrian push button. Active devices are identified by the letter "A" after the last identification digit. Brief descriptions of the device purpose for each subcategory, as well as general characteristics are presented below.

1A Passive and active devices that warn motorists of icy bridges and roads or of snow on the roadway. All devices in this category are diamond-shaped warning signs, with several being installed or displayed only as conditions warrant or during the winter season.

1B Passive devices to warn motorists of water on the roadway surface. The majority of these signs deal with roadways that usually flood during heavy rain; some are installed on a temporary basis as conditions warrant.

1C Primarily active devices to warn of low visibility conditions ahead due to fog or smoke. Flashing beacons, installed in conjunction with the warning signs, are activated by roadside fog/smoke detection devices.

1D Passive devices to warn motorists of miscellaneous transient atmospheric and roadway conditions such as high winds and landslides.

2A Passive, active, and mechanical devices to warn overheight vehicles of vertical clearance restrictions. The majority of these devices are activated by infrared sensors.

2B Primarily passive devices to warn heavy vehicle operators of steep grades, stop requirements at the end of a steep downgrade, the need for brake checks, and low gear operations.

2C Passive devices to warn heavy vehicle operators of lateral clearance restrictions at tunnels and bridges and of load restrictions on bridges. Also included in this category are devices that warn all motorists of trucks entering, exiting, and crossing the highway.

3A Primarily passive devices to warn motorists of unusual geometric configurations. The main groupings include: (1) changes occurring in the major roadway alignment with no intersecting roads, (2) no change in the major roadway alignment with unusual minor roadway intersections, (3) changes in the major roadway alignment occurring in conjunction with unusual minor roadway intersections, and (4) a change in the major roadway alignment with a minor roadway continuing straight.

3B Passive and active devices to warn motorists of restrictive roadway geometrics. The major situations covered are sudden changes in roadway alignment, excessive speeds on the approach to a curve, and insufficient sight distance.

3C Active devices that warn motorists of a signalized intersection. All the devices are activated by a tie-in with the traffic signal controller.

3D Passive devices to warn motorists of merging situations ahead.

3E Passive devices to warn motorists of vehicle guidance maneuvers required by unusual intersection geometrics and traffic circles.

3F Active and passive devices to warn motorists of traffic on other approaches of the intersection and of vehicles entering, crossing, or leaving the roadway. The majority of the active devices are activated by loop detectors on the minor roads.

3G Passive devices to warn motorists of impending intersection stop or signal controls and of recently installed signals.

3H Primarily passive devices to warn motorists of lane use restrictions and intersection lane use. Most of the devices comprise standard signs with supplemental plaques.

3I Standard signs supplemented with flashers and plates bearing street names and distances.

4A Active and passive devices that warn motorists to watch for pedestrians at crosswalks, in the roadway, and in other locations. Some devices also advise pedestrians of permitted movements at the crosswalk.

4B Passive devices to warn motorists of handicapped crossing zones.

4C Miscellaneous warning signs pertaining to crossing zones. All the devices in this category are passive and the majority of them deal with golfers or horse riders crossing the roadway.

4D Active and passive warning devices for school zones consisting primarily of standard school crossing signs with supplemental speed plates or flashers.

4E Active and passive devices for use in advance of fire stations to warn of the possible presence of emergency vehicles.

4F Passive devices to warn motorists of slow-moving vehicles.

5A Active and passive devices used at railroad crossings to warn motorists of stop control at the crossing, rough and uneven crossing surfaces, unusual crossing geometrics, and approaching trains.

5B Passive devices to warn motorists of light rail transit crossings.

6A Passive devices used to warn motorists of unusual pavement conditions such as rough roadway surfaces, bridge deck surfaces, traffic islands, rumble strips, and grooved pavements.

6B Passive devices used to warn motorists of deficient shoulder widths and abrupt shoulder dropoffs.

6C Rumble strips that are used to control speeds, warn of intersections ahead, alert drivers to pedestrian crosswalks, and warn of stop signs at intersections.

7 Passive and active devices to warn motorists of traffic conditions such as congestion and vehicles stopped on the roadway.

8 Passive and active miscellaneous devices to warn motorists of tunnels, roadways ending, speed limits, drawbridges, and other hazards.

CHAPTER THREE

SUPPLEMENTAL ADVANCE WARNING DEVICES IN USE BY AGENCIES

To reduce repetition, the supplemental devices are presented as members of a subcategory of devices which all have a common purpose. Information for each subcategory includes the identification number and a figure for each device, the subcategory purpose and relevant comments. The device number is assigned for identification purposes and to allow cross referencing using the key word index provided as Appendix B. For each grouping, passive devices are presented first, followed by active devices, designated "A."

The figure of each device is based on information provided by the responding agency. As requested, the majority of responses included photographs or sketches of the devices, but many devices were described verbally and not accompanied by a visual representation. To provide a consistent format for this synthesis, each device was redrawn on a computer using available information and sketches or photographs as a guide. While the computer figures may not duplicate a device in complete detail, they provide a reasonable representation of device configuration. Additional text messages for each category and subcategory are given in Tables 3 through 25 in Chapter Four.

The Purpose section within each subcategory states why the devices were developed and installed. The Comments section provides information for each device that is not readily evident from inspection of the figure. This includes information on how active devices are activated, and unusual mounting, size, and placement characteristics. It also provides information on whether a formal effectiveness evaluation was conducted and identifies nonstandard devices. Available information on the installation, operations and maintenance costs for active devices is also included. Cost information on passive signs was not included due to their relatively low cost and the variability that exists among agencies in the manufacturing and installation costs of such devices.

Information on rumble strips is not provided in the same detail as that presented for the other device types. The information on rumble strips concentrates on providing data pertaining to the reasons for installation and their perceived effectiveness. A relatively large number of agencies are using various versions and combinations of grooved pavement, raised pavement surface, raised pavement markers, and mushroom buttons to provide motorist advance warning. A comprehensive coverage of the various device design and construction techniques is provided in *NCHRP Synthesis of Highway Practice 191: Use of Rumble Strips to Enhance Safety* (*9*).

CAVEATS ON THE ADOPTION OF SUPPLEMENTAL ADVANCE WARNING DEVICES

This synthesis presents a compilation of information on supplemental advance warning devices that have been used by roadway agencies to inform motorists of unusual geometric, operational, or traffic control features. The inclusion of a device in this synthesis does not imply that it is a viable or desirable device to use for identified deficiencies. The following comments, in addition to the overall concerns previously presented, apply to the devices described in this synthesis.

- The survey requested that respondents provide information on all devices that were tried by their agencies whether they were effective or not. The majority of respondents indicated that the devices they used were effective. In the majority of cases this was based on a perceived effectiveness, not on the results of a statistically valid effectiveness evaluation. The text accompanying each device states the results of those rare cases when a formal effectiveness evaluation was performed and also those cases where the device was considered ineffective. Where statements on device effectiveness are not provided, the devices were merely perceived as being effective.
- The devices in this synthesis are identified as passive or active. Devices that remain in steady state condition are classified as passive while those that change operational mode due to vehicle detection devices or timers are classified as active devices. For example, a SIGNAL AHEAD sign (W3-3) installed with continuously flashing yellow beacons would be classified as a passive device. The same device, however, interconnected to the traffic signal controller to provide flashing operation only when the approaching driver would need to stop for the red indication is classified as an active device.
- The majority of the devices in this synthesis are standard devices meeting the general diamond shape and black-on-yellow background design requirements of the MUTCD. Those devices that violate the guidelines of the MUTCD, such as improper background and legend color, improper shape and color, improper silhouette, improper use of symbols, and improper use, design or placement of flashing beacons are identified as nonstandard devices. This synthesis also contains a relatively large number of devices that are rectangular shaped with black legend and border on a yellow background; these are not identified as nonstandard.
- References are provided for supplemental devices that were identified through the literature review.

SUBCATEGORY 1A: ICE AND SNOW

Icy Bridges
Device ID Numbers: 1A-1 to 1A-7

Purpose

To warn motorists of localized icing on bridges when the approach roadways may not be icy.

Comments

The majority of the devices in this subsection are either removed or folded up during the warmer months. A before-and-after accident study conducted by Hanscom for 1A-1 indicated that it's use resulted in a statistically significant reduction of 2.1 accidents/million vehicle miles during icy conditions (*10*). Device 1A-1 also provided better results, during the same study, than did 1A-7. These devices are occasionally used at standard placement in advance of a bridge in conjunction with an active device located at the bridge. A number of different verbal messages have been used to provide the same motorist information and the devices presented below are the most popular and least ambiguous.

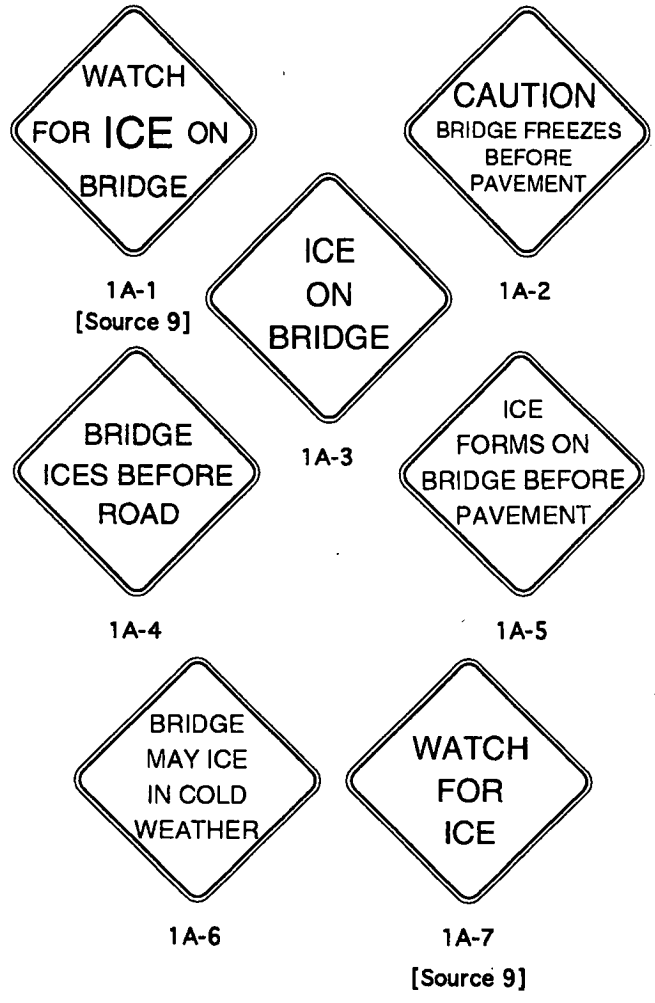


FIGURE 1 Icy bridges, passive devices.

Icy Bridges
Device ID Numbers: 1A-8A and 1A-9A

Purpose

To warn motorists of localized icing on bridges when the roadway approaches may not be icy.

Comments

The devices are activated by temperature and relative humidity conditions conducive to ice formation. A number of state agencies have performed studies of ice detection and warning systems (*11,12,13*). Device 1A-8A is activated by an ice detection device and is mounted at the standard distance in advance of the bridge. A study of device effectiveness indicated a statistically significant reduction in speeds when 1A-8A was used in advance of 1A-9A, which was mounted at the bridge (*10*). The combination of mounting 1A-1 in advance of 1A-9A displayed an even greater reduction in speed.

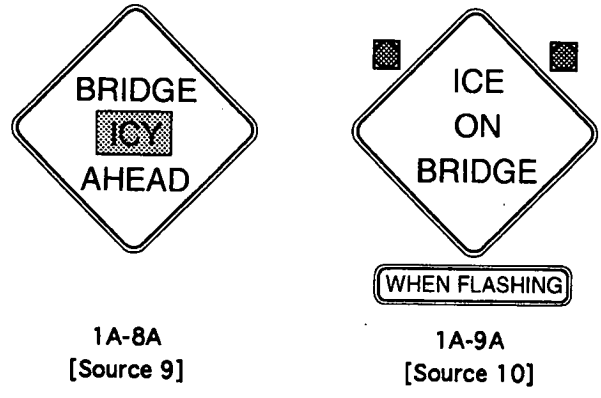


FIGURE 2 Icy bridges, active devices.

Ice on Road
Device ID Number: 1A-10

Purpose

To warn motorists of localized icy roadway conditions that may be present when the remainder of the roadway is ice free.

Comments

Typical applications can include instances where prevalent shade inhibits roadway deicing or where roadway superelevation and a high water table result in water flowing across the roadway and freezing. This device is also used where roadside operations, such as auto washes or tracking from unimproved side roads result in icy conditions.

1A-10

FIGURE 3 Ice on road.

Freezing Spraying Water
Device ID Number: 1A-11

Purpose

To warn motorists of a condition where water frequently splashes onto windshields and freezes.

Comments

This device is used where inadequate drainage on the inside lane results in water being splashed onto the windshields of opposing direction vehicles.

1A-11

FIGURE 4 Freezing spraying water.

Snow on Roadway
Device ID Number: 1A-12

Purpose

To warn of a condition where snow may be present on the roadway.

Comments

This device is placed in advance of areas where snow may be on the roadway but chains are not yet required. It is used intermittently where such conditions may exist for long sections of highways. The device is displayed when weather conditions are such that it is reasonable to assume that snow is a possibility and removed when such conditions are no longer present.

1A-12

FIGURE 5 Snow on roadway.

Snow Slides
Device ID Number: 1A-13

Purpose

Used in areas of known avalanche activity.

Comments

Device 1A-13 is often used with a supplemental mileage plate.

1A-13

FIGURE 6 Snow slides.

Slippery When Wet
Device ID Numbers: 1A-14A to 1A-16A

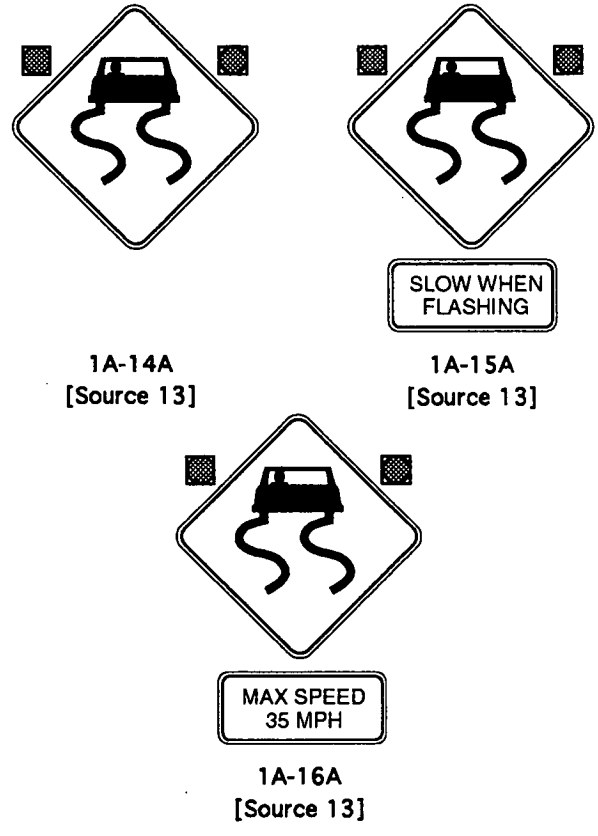
Purpose

To warn of the same pavement conditions for which the standard SLIPPERY WHEN WET sign (W8-5) is designed.

Comments

These active advance warning devices are variations of the standard SLIPPERY WHEN WET sign (W8-5). It is believed that adding a supplemental text plate reinforces the message of the standard sign and that adding flashers increases conspicuity and credibility for the motorist. All of the devices use flashers and two use supplemental text plates to provide different levels of information to the motorist. The flashers are activated by moisture detection devices.

An effectiveness study was conducted by measuring mean speeds at critical curve locations (*14*). Signing that employed flashing beacons and the use of supplemental advisory speed limits generally resulted in reduced speed. The most pronounced reductions were observed for 1A-16A, which has flashers and a supplemental speed plate.



1A-14A
[Source 13]

1A-15A
[Source 13]

1A-16A
[Source 13]

FIGURE 7 Slippery when wet.

SUBCATEGORY 1B: WATER

Water on Roadway
Device ID Numbers: 1B-1 to 1B-9

Purpose

To warn motorists of dips and depressions in the roadway that may lead to ponding and temporary flooding of the road.

Comments

Device 1B-3 is normally posted only when water is actually over the roadway.

Device 1B-5 is used along sections of roadway with high water problems rather than in advance of each roadway spot with possible problems.

Device 1B-6 is erected immediately when a high water situation exists, even if there is only a thin sheet of water on the roadway.

It is normally erected at standard advance placement, but additional signs are also erected at locations where traffic can select an alternate route during persistent high water conditions.

Device 1B-7 is erected in advance of depressions in the roadway alignment that are subject to flash flooding.

Device 1B-9 is used where the extent of flooding could be so severe as to submerge the vehicle or to cause the road to wash away.

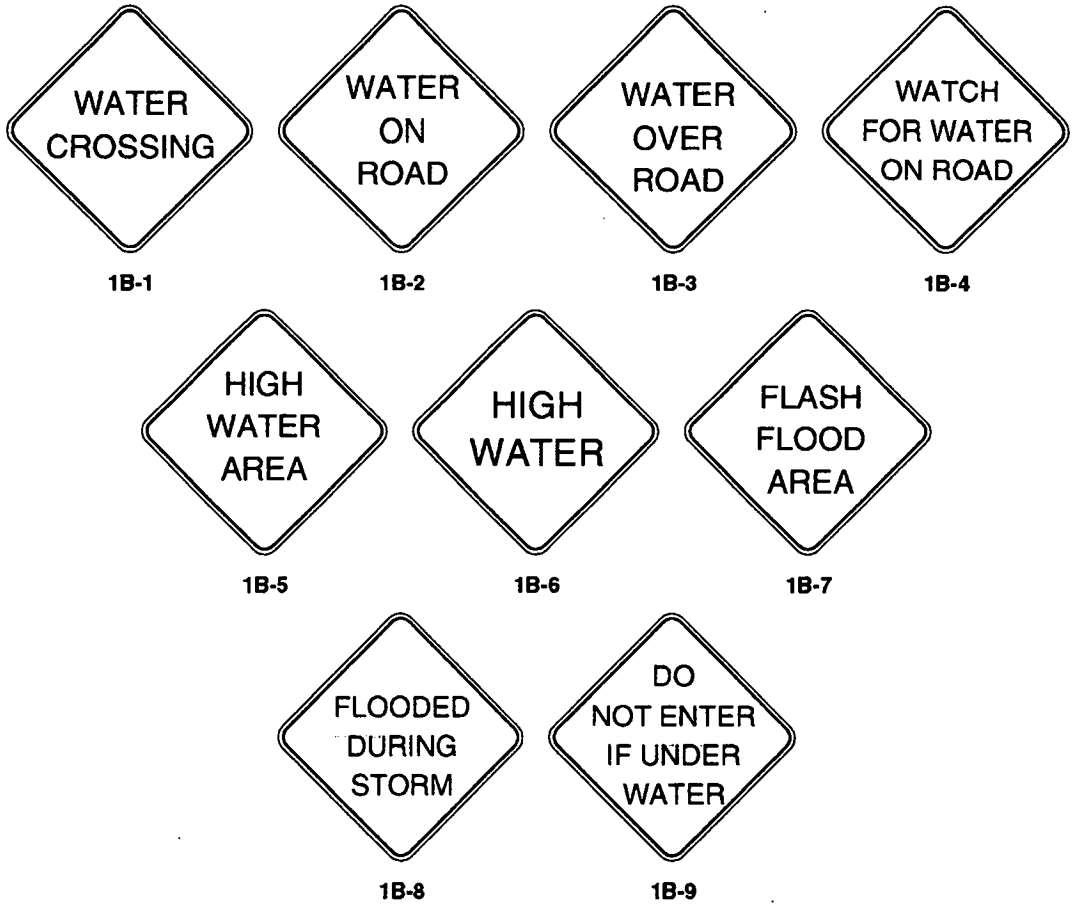


FIGURE 8 Water on roadway, passive devices.

Water on Roadway
Device ID Number: 1B-10A

Purpose

To provide real time warning of a condition where water temporarily covers the roadway ahead.

Comments

Device 1B-10A is a blankout type changeable message device with the text ROAD FLOODED AHEAD. The blankout sign opens up and the beacon is activated when the water level reaches a certain height on a roadside detector.

FIGURE 9 Water on roadway, active devices.

SUBCATEGORY 1C: FOG OR SMOKE

Limited Visibility Due to Fog or Smoke
Device ID Number: 1C-1

Purpose

To warn motorists of areas that are prone to fog, particularly near industrial plants that generate large amounts of steam.

Comments

This device may be supplemented by a plate presenting the length of roadway affected. It is used in the vicinity of industrial plants that produce large quantities of steam, resulting in extremely foggy conditions depending on plant activity and wind direction.

1C-1

FIGURE 10 Limited visibility due to fog or smoke, passive devices.

Limited Visibility Due to Fog or Smoke
Device ID Numbers: 1C-2A to 1C-5A

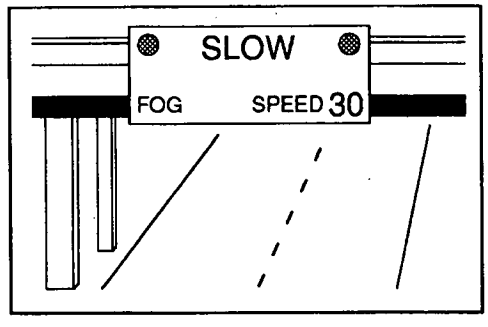
Purpose

These devices are used primarily to warn of low-visibility conditions ahead, although the bridge-mounted device may be adapted to warn of other hazards such as ice, construction, or an accident.

Comments

Devices 1C-2A and 1C-3A are used in areas prone to fog, such as low-lying river valleys and near industrial plants that generate large amounts of steam. Device 1C-4A is used in areas where controlled burning occurs frequently. The changeable message sign is used in similar locations, plus in other areas where conditions warrant. These three devices each consist of diamond-shaped signs

1C-2A 1C-3A 1C-4A



1C-5A

[Source 14]

FIGURE 11 Limited visibility due to fog or smoke, active devices.

with a flashing yellow beacon mounted above and are activated automatically by a fog or smoke detection device or manually by highway department or police personnel.

Device 1C-5A is a 7-ft × 32.5-ft variable message sign with 0.39 in. high-intensity red neon tubing forming all letters and numerals. Whenever activated by the state police or the highway agency, the word SLOW is displayed along with the reason for the required speed reduction. An advisory speed is also displayed, while alternately flashing yellow beacons are used to increase the target value. A study performed by the responding agency determined that in the five-year periods before and after installation, accidents were reduced from 36 to 5, respectively (*15*). Device 1C-5A has a reported installation cost of $150,000 and an annual maintenance and operation cost of $200. It is typically mounted over limited-access roadways on a bridge overpass.

For all of the devices in this subcategory, passive fixed-message signs were used as previous countermeasures, but were considered to be less effective.

SUBCATEGORY 1D: OTHER

High Winds
Device ID Numbers: 1D-1 to 1D-4

Purpose

To warn motorists of high profile vehicles of areas with strong prevalent crosswinds.

Comments

These devices are installed in areas where the prevalent crosswinds can be so strong that high profile vehicles are redirected from their travel path. The strong crosswinds create a problem for any vehicle with a large longitudinal surface area. The problem is especially severe with truck bed camping units and camper trailers, which are often relatively unstable and typically are driven by motorists with little large-vehicle experience. An inflated fluorescent wind sock emphasizes the strength of the crosswind to the motorists. The diamond-shaped signs used with the wind socks are 48 in. × 48 in. and device 1D-1 is 130 in. × 48 in.

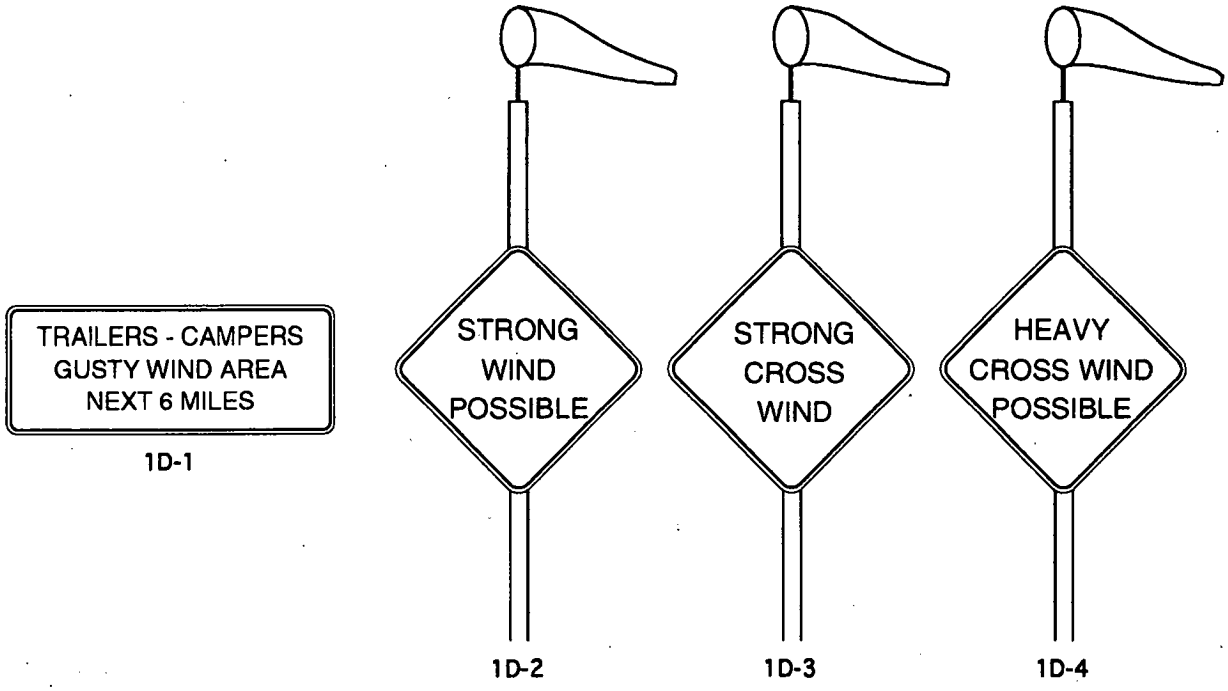


FIGURE 12 High winds.

Limited Visibility Due to Sand or Dust
Device ID Numbers: 1D-5 and 1D-6

Purpose

To warn motorists of blowing sand or top soil which may accumulate on the roadway or obscure motorist vision.

Comments

Blowing and drifting debris is primarily a problem along beaches or in arid regions, but can also occur adjacent to farming areas or large earthwork projects.

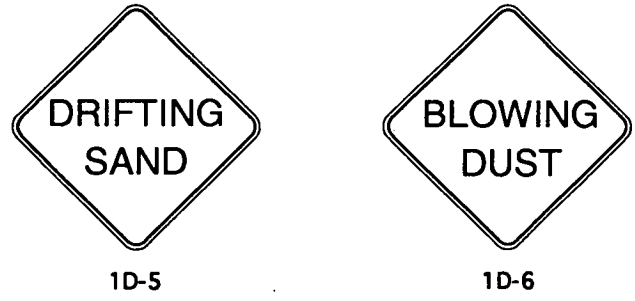


FIGURE 13 Limited visibility due to sand or dust.

Fallen Rock
Device ID Numbers: 1D-7 to 1D-10

Purpose

Devices 1D-7 and 1D-9 are used in advance of rock cuts where fallen rock or rock slides may be a hazard, and device 1D-10 is used at locations where a high occurrence of land slides exists.

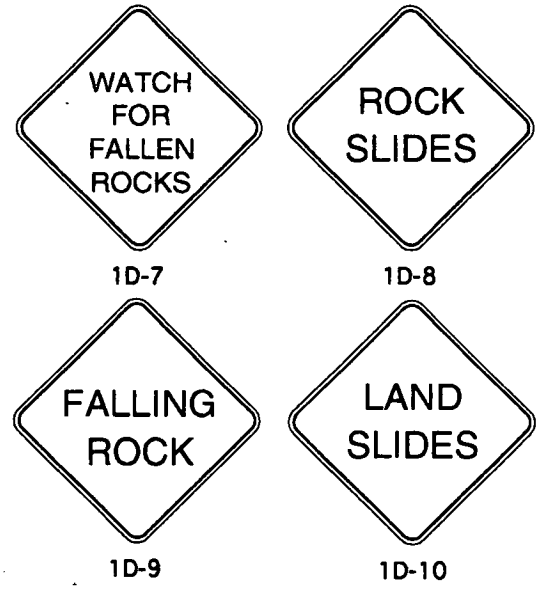


FIGURE 14 Fallen rock.

SUBCATEGORY 2A: VERTICAL CLEARANCE

Vertical Clearance
Device ID Numbers: 2A-1 to 2A-5

Purpose

To provide information to drivers of heavy vehicles of downstream low-clearance obstructions.

Comments

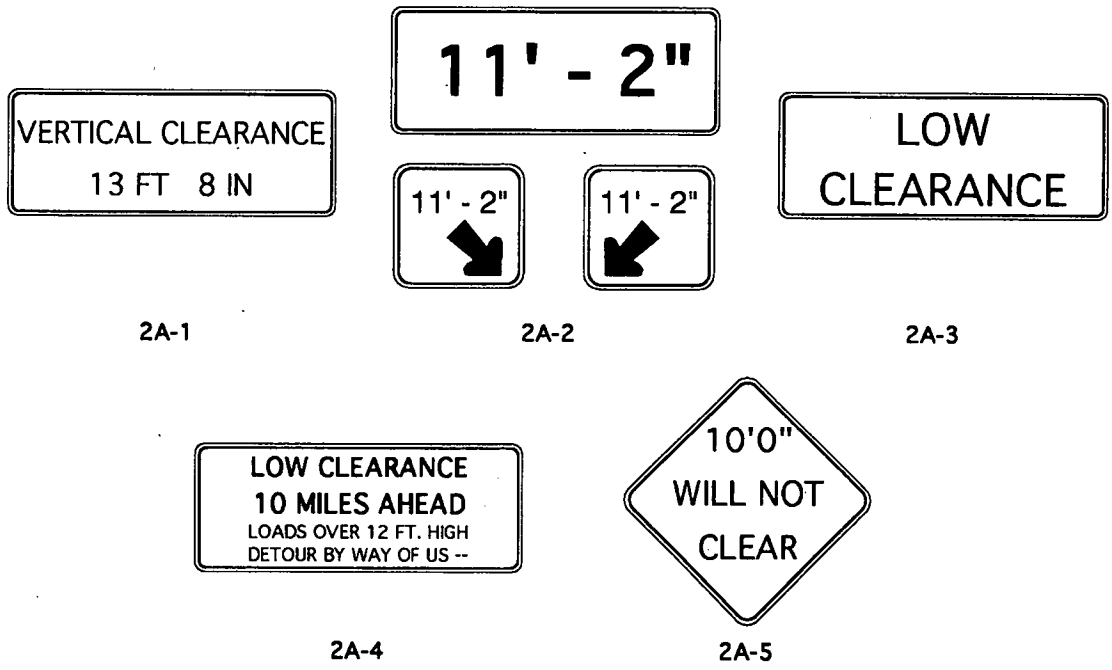
Device 2A-1 is a 96-in. × 30-in. sign which is either roadside or overhead mounted.

Device 2A-2 is used at bridges that have variable clearance, such as arch bridges. The large clearance sign is placed in the middle of the traveled way, with the arrow plates identifying the specific points of low clearance.

Device 2A-3 is used in addition to the standard clearance signs when the vertical clearance is less than 14 ft 6 in.

Motorists are provided information on an appropriate detour to avoid a section of highway with a structure having a vertical clearance less than 13 ft 6 in. by device 2A-4.

Device 2A-5 is used in locations of extremely low clearance, primarily at arched bridge overpasses. The device is placed over the right lane so that heavy-vehicle drivers will move toward the center of the bridge where sufficient clearance exists.



2A-1 2A-2 2A-3

2A-4 2A-5

FIGURE 15 Vertical clearance, passive devices.

Vertical Clearance
Device ID Number: 2A-6A to 2A-17

Purpose

To reduce the incidence of tall vehicles and loads impacting overhead spans.

Comments

These are mechanical and activated devices designed to identify vehicles too tall to clear overhead structures. Device 2A-6A is a mechanical device that employs aluminum or plastic tubes suspended under a sign with the text TRUCKS THAT HIT THIS WILL HIT BRIDGE. Overheight vehicles will strike the tubes, producing noise. This device may be preceded by a passive warning sign with the text LOAD HEIGHT GAUGE AHEAD. Several agencies use variations of this device. Its effectiveness is unclear and depends on the driver's ability to discern the sound produced by the device over other noises. Costs reported for this device ranged from $2,000 to $35,000.

Device 2A-7A is an active LED sign with the text VEHICLE TOO HIGH/STOP. It is activated by an infrared sensing device. The sensing device is located 500 to 700 ft before the sign, with the sign being roadside mounted 2,000 ft prior to the vertical obstruction. This device was installed at two locations, with a reported installation cost of $57,000 each.

The text of device 2A-8A is supplemented by horizontally mounted flashers. The flashers are activated whenever a special sensing device detects a vehicle with a height greater than one ft less than the maximum clearance available at the vertical obstruction. Prior to the installation of this device, a variation of 2A-6A using metal chains was employed. The device is mounted over the roadway with a reported installation cost of $13,000 and an annual maintenance and operation cost of $210.

Device 2A-9A is a nonstandard illuminated device with the text OVERHEIGHT followed by a directional command such as STOP, TURN LEFT, or TURN RIGHT. Above and below the message are alternating flashing arrows. In addition to the vehicle height detection system, the device employs two audible alarms—one mounted with the warning sign and another mounted separately. The device is activated by an infrared detector installed upstream of the sign and the alarms. Standard advance vertical clearance warning signs were used prior to this device. All components are roadside mounted, with a reported installation cost of $7,000.

Device 2A-10A is a sign with the text STOP supplemented by two flashing beacons mounted above. It is installed on a roadway, and the arrow points to a turnout constructed to permit overheight vehicles to turn around. The flashers are activated by a height-measuring infrared detection device. To prevent accidental activations by blowing debris or birds, a pair of detector loops verifies the presence of a vehicle and, in some installations, its direction of travel along the roadway. A device similar to 2A-6A was used before this system was installed.

Device 2A-13A is activated by an infrared sensing device and is part of a signing system. The first sign in the system is a 48-in. × 48-in. LOW CLEARANCE sign (W12-2) with a supplemental mileage plate. A 48-in. × 48-in. size 2A-11 and a 96-in. × 48-in. size 2A-12 are the next signs in the series with the 2A-12 located at the point where the height detection occurs. Beyond the sensor, an active 96-in. × 120-in. sign with the text WHEN FLASHING/

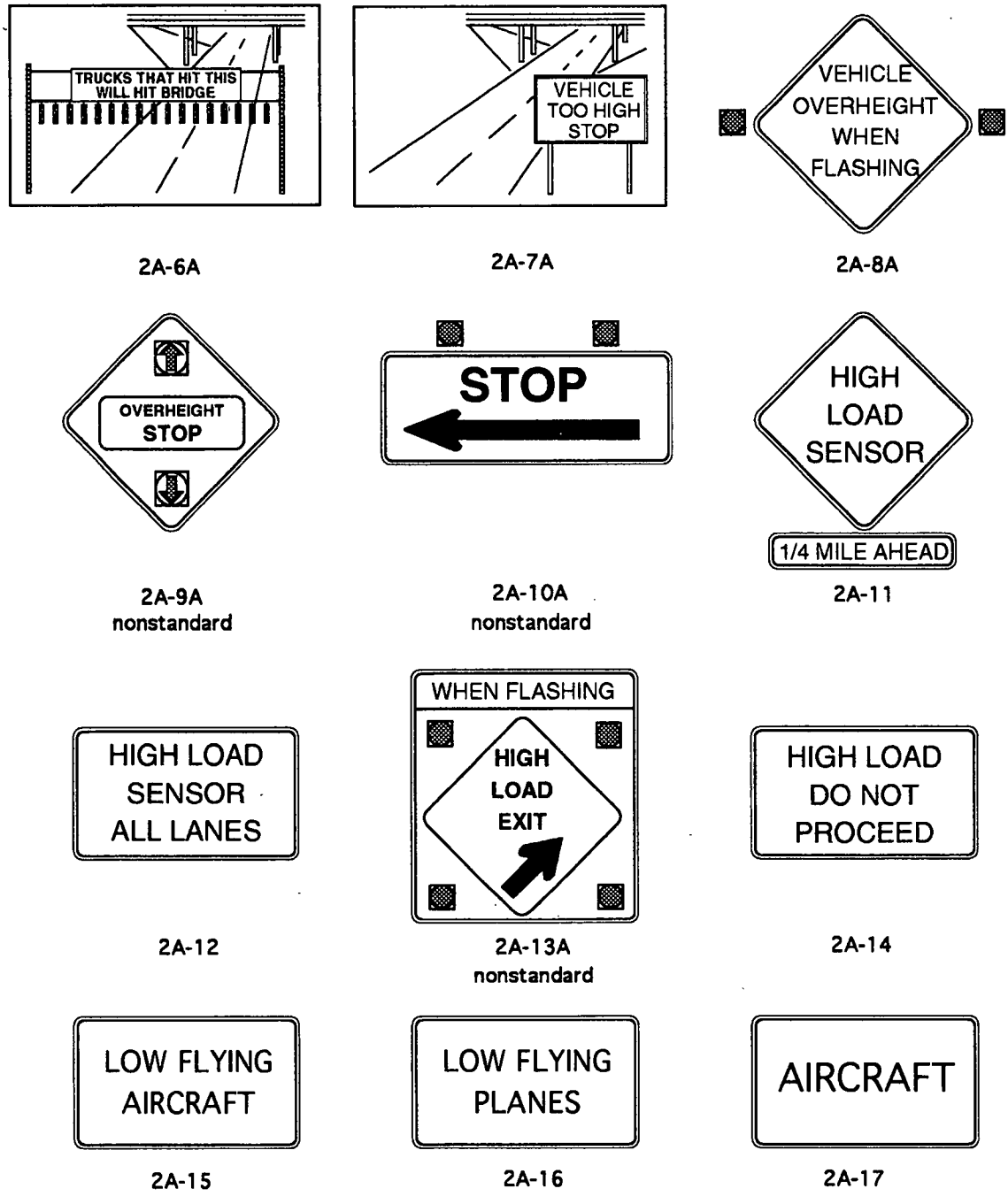


FIGURE 16 Vertical clearance, active devices.

HIGH LOAD EXIT advises overheight vehicles to exit the roadway. The placement of the flashing beacons within the sign body of 2A-13A results in it being a nonstandard device. The 96-in. × 48-in. device 2A-14 is installed on entrance ramps to prevent overheight vehicles from entering between the vehicle detector and the low overpass. Additional W12-2 with mileage plates are used to inform motorists of the distance to the low overpass. A hard copy recorder provides documented proof of activation, which is used in prosecuting offenders who ignore the device. The effectiveness of this device is unknown as problems have been reported with dirty lenses and false activation by birds. An installation cost of $10,000 was reported, with an annual maintenance and operation cost of $1,500.

Devices 2A-15 to 2A-17 are installed in the vicinity of airport runways to reduce the startling impact of low-flying aircraft on motorist behavior.

SUBCATEGORY 2B: DOWNGRADES

Downgrades
Device ID Numbers: 2B-1 to 2B-13

Purpose

To provide drivers of heavy vehicles with information that can help prevent brake fade and failure due to increased braking activity required by severe downgrades.

Comments

Device 2B-4 advises heavy-vehicle drivers that an area is provided ahead for them to check their brakes prior to proceeding down a severe downgrade. The flashing beacons of 2B-7 and 2B-11 operate continuously (*16*). Device 2B-12 is used to warn drivers of a T-intersection located at the end of a long downgrade.

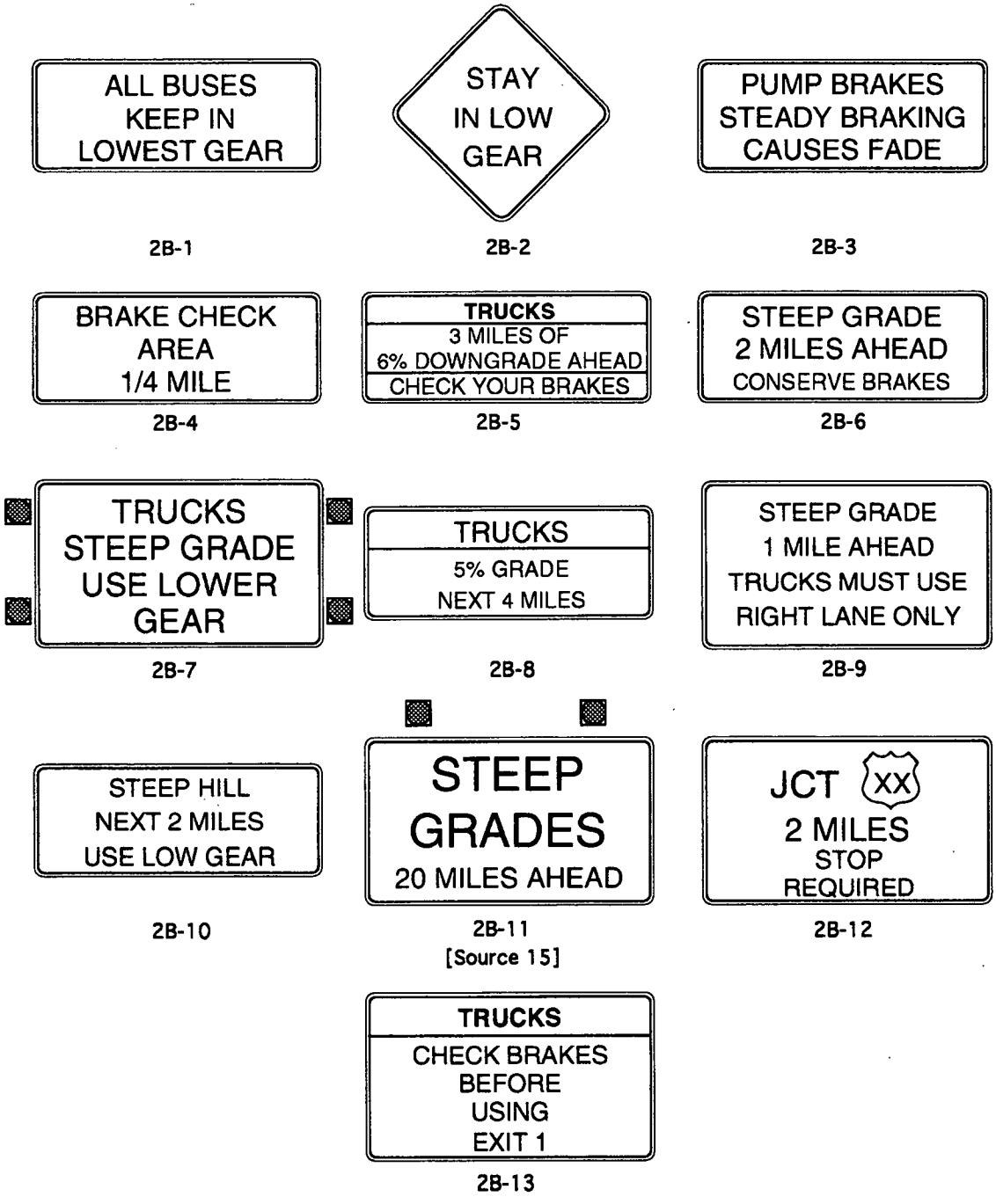


FIGURE 17 Downgrades.

Downgrades
Device ID Numbers: 2B-14 to 2B-16

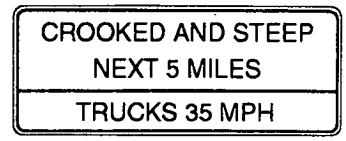
Purpose

To warn heavy-vehicle operators of long, steep, winding downgrades.

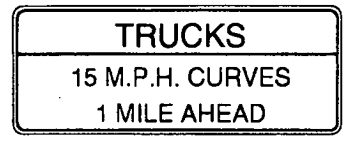
Comments

Devices 2B-14 and 2B-15, which exhibit recommended truck speeds, are installed at numerous locations within the jurisdiction of responding agency.

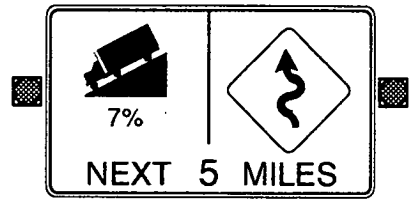
Device 2B-16 is essentially a combination of two standard signs, the HILL sign (W7-1b) and the WINDING ROAD sign (W1-5). The device is illuminated and the flashing beacons operate continuously.



2B-14



2B-15



2B-16

FIGURE 18 Winding downgrades.

Downgrades
Device ID Numbers: 2B-17 and 2B-18

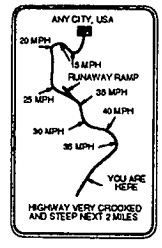
Purpose

These passive devices are used to provide heavy-vehicle drivers with detailed information about the roadway geometrics ahead or recommended downgrade speeds.

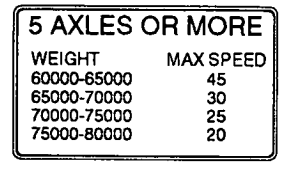
Comments

Device 2B-17 provides detailed information regarding the geometrics of the roadway ahead. The length of the grade, the location of the sign, the location of a runaway truck ramp and the maximum safe curve speeds are contained on the sign. This device is placed at a brake check area near the top of the downgrade. In some cases, a regulatory sign with the text ALL TRUCKS, RVs, VEHICLES WITH TRAILERS MUST STOP and READ SIGN/ TURNOUT AHEAD is also used. Where the regulatory sign was used, approximately half of the vehicles required to stop actually did. Out-of-state drivers likely to be unfamiliar with the route were more compliant (*16*).

Device 2B-18 provides the maximum safe descent speeds for different categories of truck weight. The gross truck weight and physical characteristics of the downgrade are entered into a computer program to predict the temperature of the truck's brakes, which is then used to determine maximum safe speeds to post on the signs (*17*). The sign is mounted one mile in advance of a downgrade, at intervals on the downgrade, and at truck turnout and brake inspection areas.



2B-17
[Source 15]



2B-18
[Source 16]

FIGURE 19 Details on downgrades.

SUBCATEGORY 2C: OTHER HEAVY VEHICLE WARNINGS

Lateral Clearance
Device ID Numbers: 2C-1 to 2C-5

Purpose

To warn heavy-vehicle drivers of conditions where the clear roadway width is less than the approach pavement width.

Comments

Device 2C-5 was installed after accidents continued to occur when the standard NARROW BRIDGE sign (W5-2) was in place. Device 2C-5 does not provide a clear and unambigious message since it assumes that drivers know the standard width of traffic lanes.

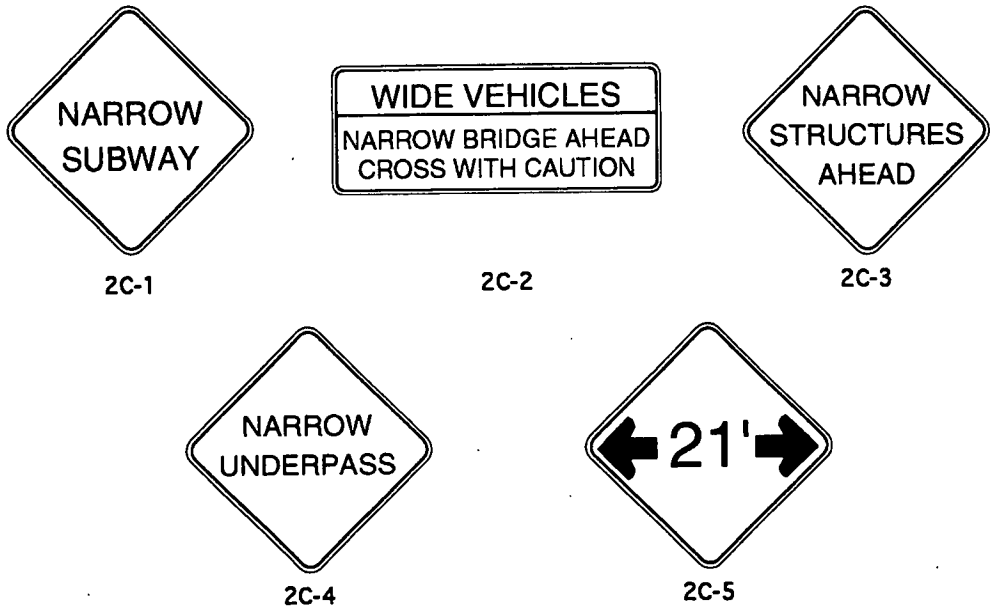


FIGURE 20 Lateral clearance.

Bridge Weight Restrictions
Device ID Number: 2C-6

Purpose

To warn heavy-vehicle drivers that they are approaching a bridge with a low weight restriction.

Comments

This sign is installed at approach road intersections to reduce heavy vehicle delay and backtracking. The regulatory weight limit signs (R12-1 to 5) are used as appropriate in addition to device 2C-6.

FIGURE 21 Bridge weight restrictions.

Logging Trucks
Device ID Number: 2C-7

Purpose

To advise other motorists that logging trucks may be leaving the highway ahead.

Comments

This device was installed because logs beyond the length of the trailer will swing out over the lane line and into the adjacent lane when the truck turns. Prior attempted countermeasures included a passive warning sign with the text WATCH FOR TRUCK. It is roadside mounted 1,000 feet in advance of the turn. When possible, a special lane or turning ramp is provided for the turning trucks to reduce the danger posed to motorists.

FIGURE 22 Logging trucks.

Truck Movements
Device ID Numbers: 2C-8 to 2C-11

Purpose

These passive devices are used to warn motorists that trucks are entering, leaving, or crossing the roadway ahead.

Comments

Device 2C-8 contains a truck symbol that is used as one of the symbols on the weight limit sign R12-5. Device 2C-9 uses different text messages depending on the nature of the maneuvers. Device 2C-10 is a standard (W8-6) sign used with a single continuously flashing beacon mounted above the sign. Three different text messages are prevalent: TRUCKS ENTERING HIGHWAY, TRUCKS EXITING HIGHWAY, and TRUCKS CROSSING HIGHWAY. These devices are used where insufficient sight distance exists because of horizontal curves, vertical curves, or physical obstructions, or if the truck entrance is unexpected and has relatively high volume.

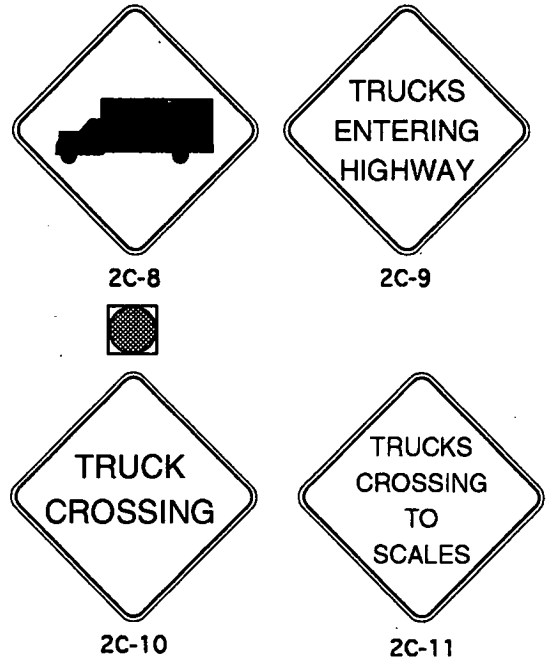


FIGURE 23 Truck movements.

Truck Rollover Potential
Device ID Numbers: 2C-12 to 2C-14

Purpose

To warn truck drivers of sharp horizontal curves.

Comments

All of these devices are installed at locations where trucks were either losing their loads or rolling over due to sharp horizontal curves. Standard chevron alignment signs were used before the installation of these devices. The reporting state indicated that each of three locations was experiencing three to five truck rollovers per year prior to installation of 2C-12. In the two years since installation, there have been no rollover accidents reported. Device 2C-13 and 2C-14 are installed at a number of ramp locations and they are often supplemented with advisory speed plates. All of these devices are nonstandard due to the use of a symbol not contained in the MUTCD.

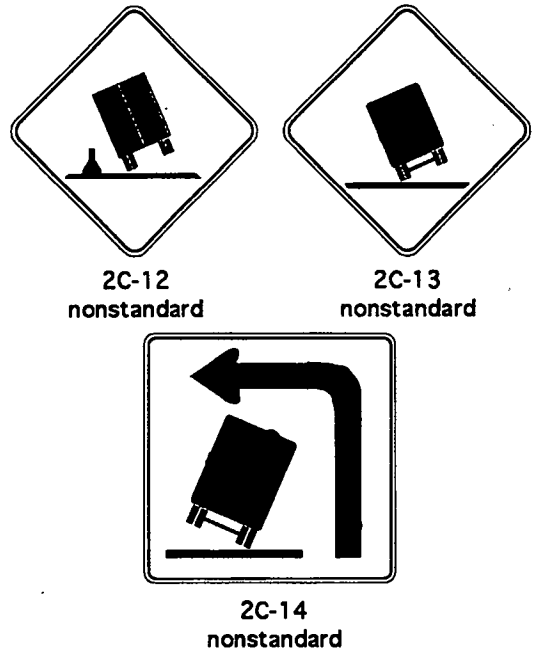


FIGURE 24 Truck rollover potential.

SUBCATEGORY 3A: UNUSUAL GEOMETRICS

Extreme Alignment Changes
Device ID Numbers: 3A-1 to 3A-8

Purpose

To warn motorists of a severe change in alignment.

Comments

These devices are often installed at locations that have a history of truck rollover accidents and are often supplemented with advisory speed plates. Devices 3A-1 and 3A-2 are similar, with the exception that the square sign is black for 3A-1 and yellow for 3A-2. Both devices have four flashing beacons in the body of the square sign, making them nonstandard applications of the MUTCD

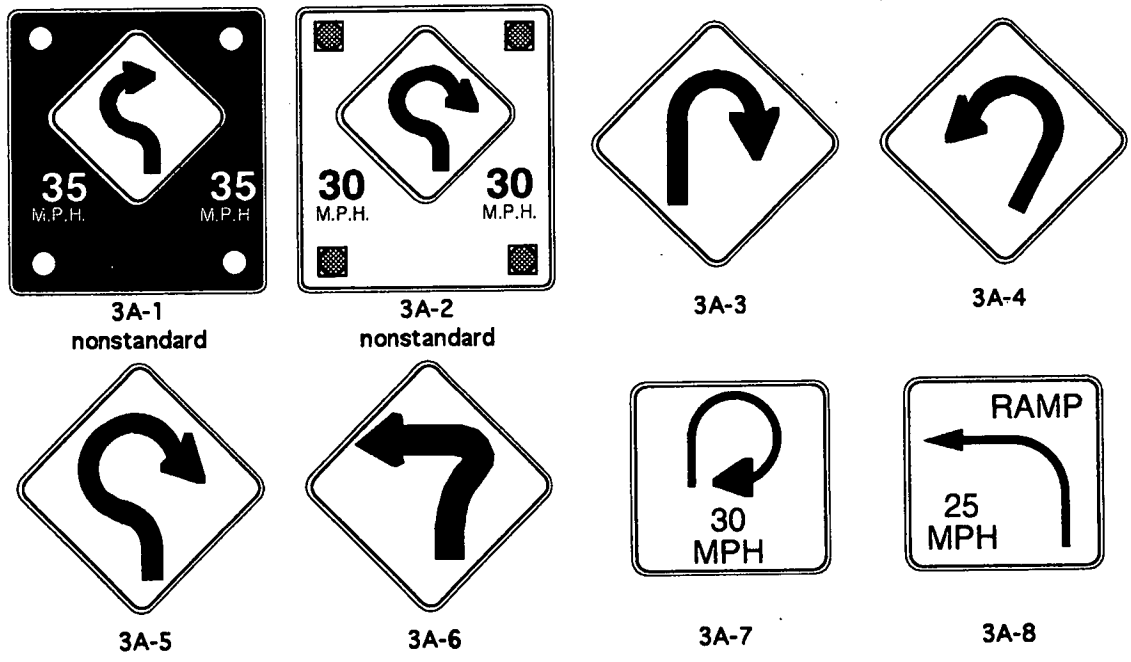


FIGURE 25 Extreme alignment changes.

guidelines. The flashing beacons operate continuously. One location, prior to the installation of device 3A-2, had three fatalities in one year resulting from truck rollover accidents. In the two years since its installation, there have been no accidents. Similarly, no accidents have been reported in three years at the locations where device 3A-1 is installed. Devices 3A-1 and 3A-2 have an estimated installation cost of $2,000 and an annual maintenance and operation cost of $400.

Devices 3A-7 and 3A-8 were installed after accidents continued to occur with standard signing in place. Devices 3A-7 and 3A-8 are typically mounted on an overpass, but may also be roadside mounted.

Unusual Intersection Geometrics
Device ID Numbers: 3A-9 to 3A-17

Purpose

To warn motorists of unusual intersection geometrics or of the presence of an obscured intersection or a series of intersections.

Comments

The relative importance of the intersecting roads on these devices may be shown by different widths of line in the diagram. Section 2C-12 of the MUTCD permits variations of the standard SIDE ROAD signs (W2-2 and W2-3) to depict roadway conditions.

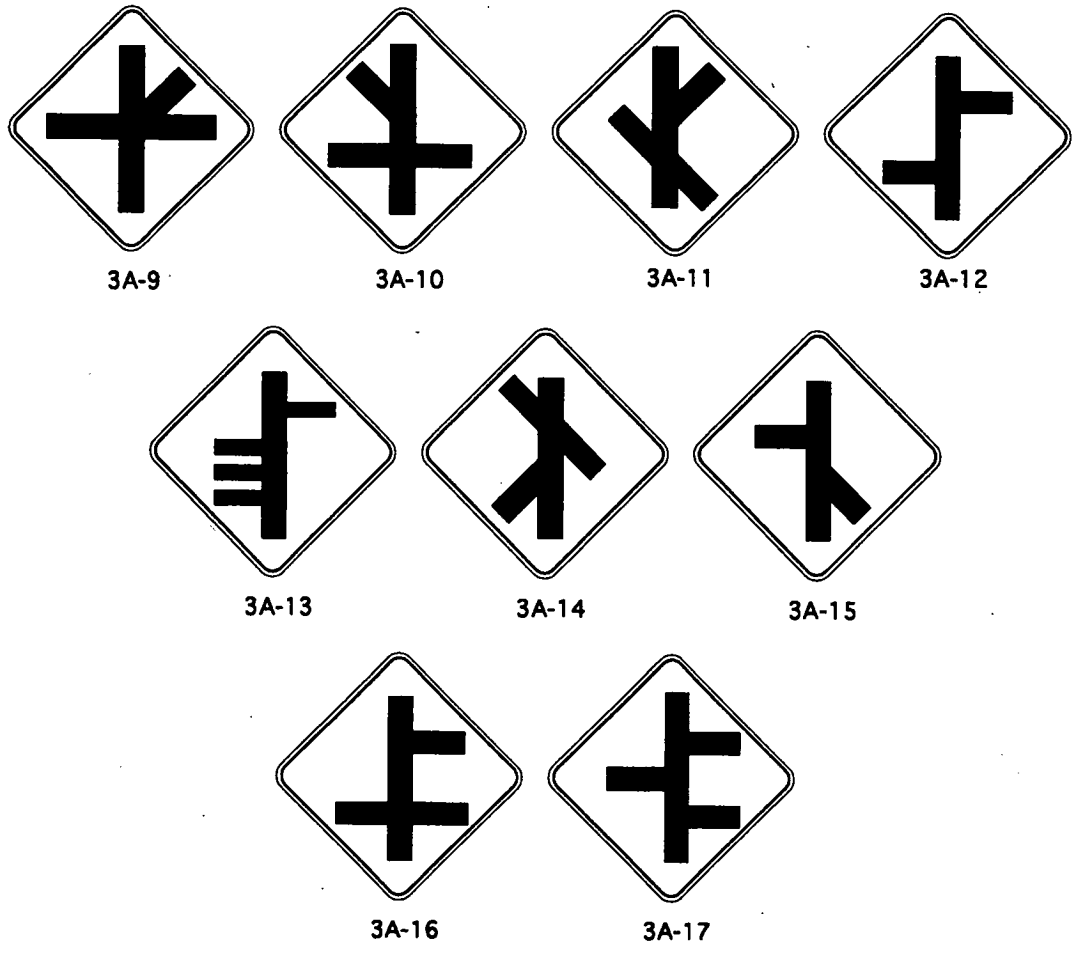


FIGURE 26 Unusual intersection geometrics.

Alignment Changes with Unusual Intersection Geometrics
Device ID Numbers: 3A-18 to 3A-37

Purpose

To warn motorists of a change in roadway alignment that occurs at or near the location of intersecting roads.

Comments

The relative importance of the intersecting roads on these devices may be shown by different widths of line in the diagram. Section 2C-12 of the MUTCD permits symbols to represent the presence of side roads in the vicinity of a horizontal curve. The signs of this subcategory are often supplemented with an advisory speed plate.

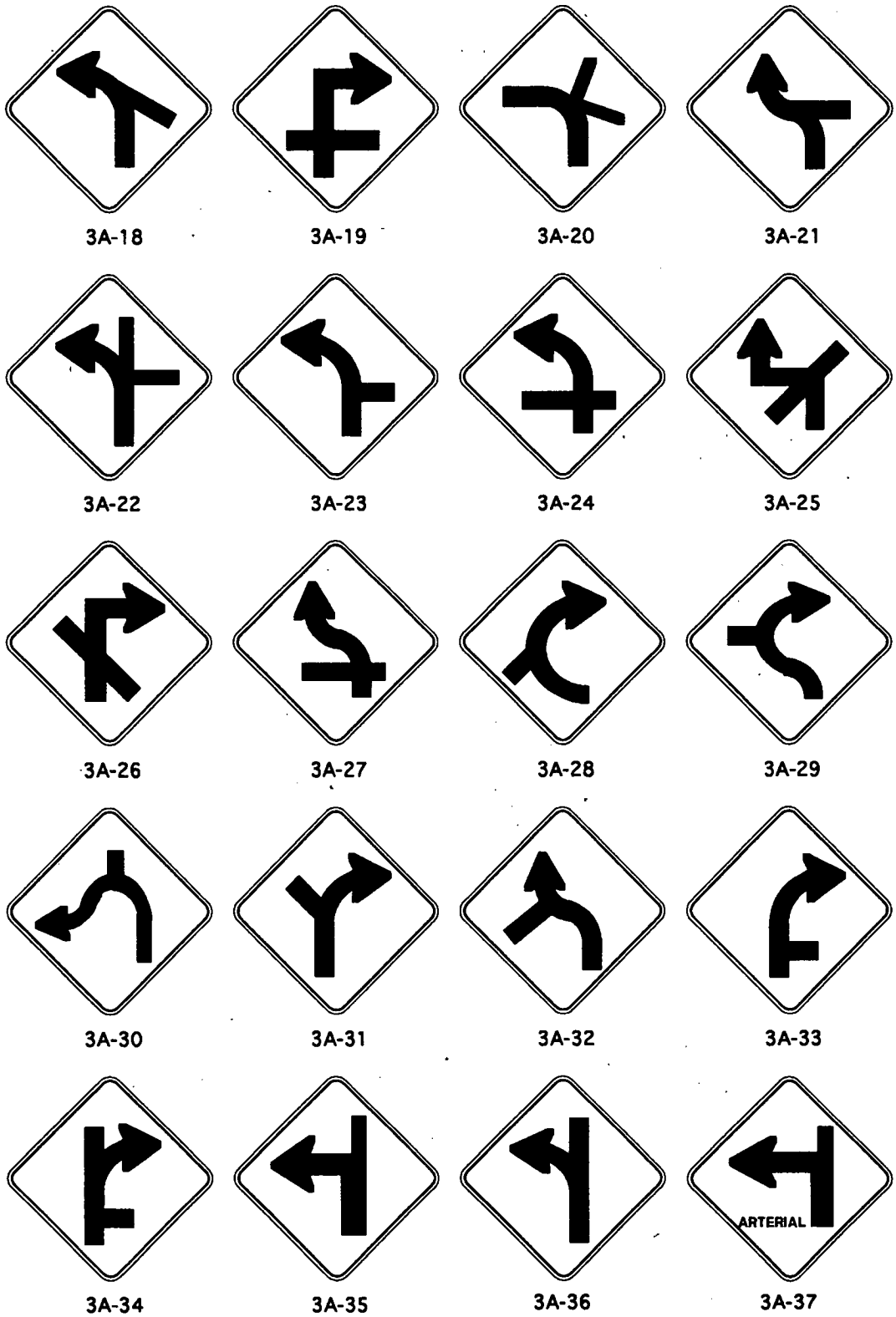


FIGURE 27 Alignment changes with unusual intersection geometrics.

Turn Signals
Device ID Numbers: 3A-38 and 3A-39

Purpose

To instruct motorists to use their turn signals or to check them for unintended activation.

Comments

Device 3A-38 is used when the major route continues to the left with a minor road continuing straight, similar to the geometrics displayed by 3A-36. Motorists are requested to signal for the left turn even though they are following the primary road. The intent of the sign is to reduce accidents with motorists who are stopped on the minor road and are waiting for a gap to enter the primary route.

Device 3A-39 is used at an intersection with a turning radius so large that a vehicle's turn signal may not automatically switch off when the maneuver is completed. An erroneously activated turn signal was cited as a contributing cause in several accidents with vehicles at a downstream intersection with a minor roadway. Motorists stopped at the minor intersection mistakenly thought that the vehicle on the major road was going to turn, resulting in right-angle accidents.

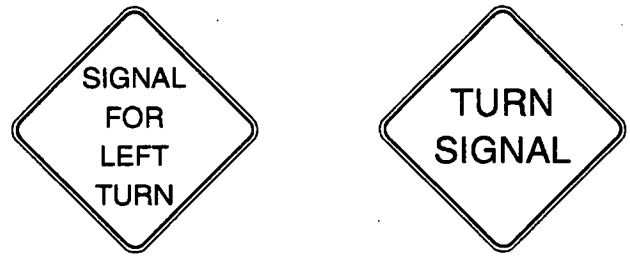


FIGURE 28 Turn signals.

SUBCATEGORY 3B: RESTRICTIVE GEOMETRICS

Limited Sight Distance
Device ID Numbers: 3B-1 to 3B-7

Purpose

To warn of limited sight distance resulting from roadway geometrics, particularly vertical curvature.

Comments

Devices 3B-1 through 3B-5 were evaluated for their effectiveness as a substitute for the LIMITED SIGHT DISTANCE sign (3B-6) (*18*). Of the verbal signs, the one with the text SLOW/ HILL BLOCKS VIEW was determined to be the most easily recognized and understood. Of the symbolic signs, the one depicting two vehicles approaching each other from opposite sides of a hill was determined to be the best overall. On an overall basis, the currently used LIMITED SIGHT DISTANCE sign was found to be the worst in terms of recognition, comprehension, and compliance. However, the effectiveness of each of the new signs was determined to be only minimal (*18*). Devices 3B-3 through 3B-5 are nonstandard devices due to the use of symbols not contained in the MUTCD.

Device 3B-6 was previously a standard sign (W14-4) designed for use on vertical curves that do not have adequate safe stopping distance available. Device 3B-6, or any of the limited sight distance devices, are not intended as a substitute for sound engineering judgement that would warrant improving the sight distance by an engineering solution. Device 3B-6 was dropped from the current MUTCD under ruling II-67.

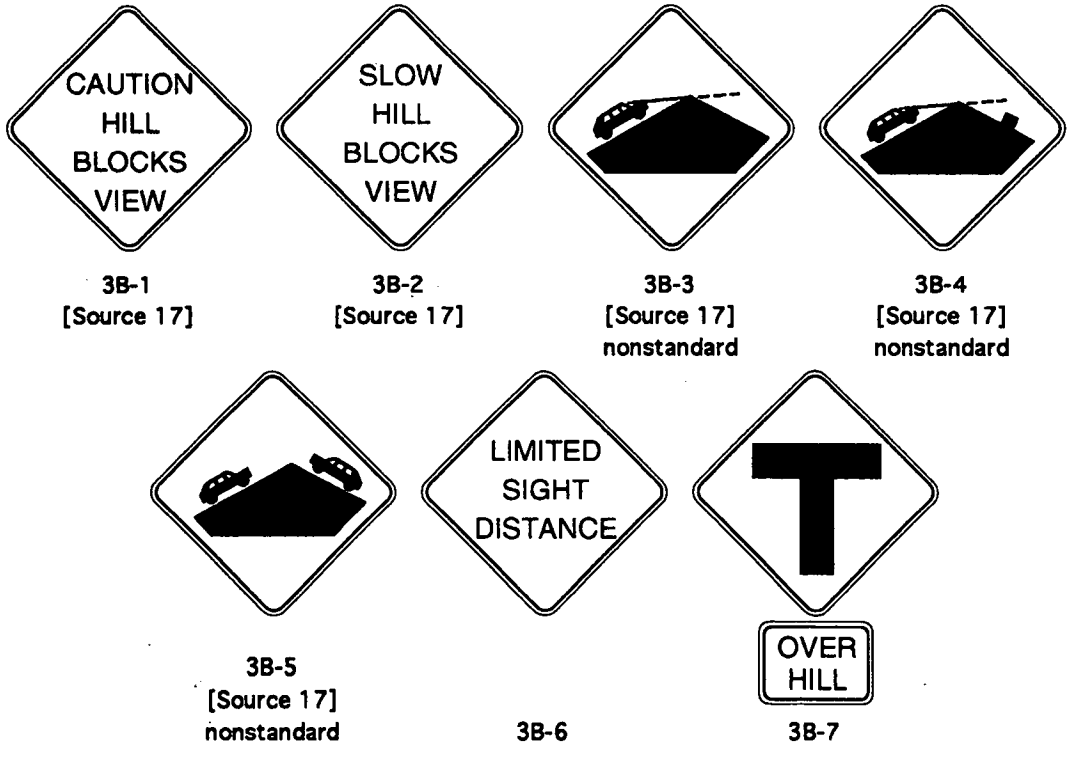


FIGURE 29 Limited sight distance.

Device 3B-7 is a supplemental plate placed with an appropriate standard sign. It warns motorists that an intersection ahead is not visible due to a vertical curve.

Alignment Changes
Device ID Numbers: 3B-8 and 3B-9

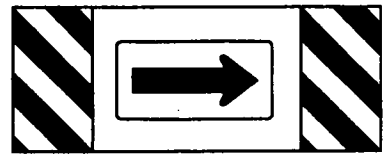
Purpose

To give additional emphasis to the motion required when there is a sharp change of alignment in the direction of travel.

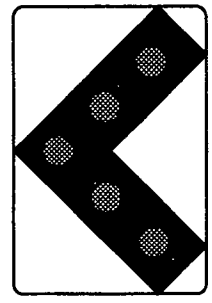
Comments

Device 3B-8 is a combination of two standard signs, the large arrow sign (W1-6) supplemented with object marker signs on both sides. This device is intended to be used where a field study has determined that additional emphasis is needed to give notice of a sharp change in alignment in the direction of travel.

Device 3B-9 consists of five yellow flashers arranged within the shape of a chevron. The device is on continuous 24-hour operation, with the arrow flashing sequentially. An informal study of 3B-9 showed that accidents at the site, which had averaged two per month prior to installation, were reduced to only two a year. The agency reported an installation cost of $1,000 and annual maintenance and operation costs of $200 and $150. The use of flashing beacons embedded in the face of the sign results in this device being nonstandard by MUTCD guidelines.



3B-8



3B-9
nonstandard

FIGURE 30 Alignment changes.

Excessive Speed in Horizontal Curve
Device ID Numbers: 3B-10A and 3B-11A

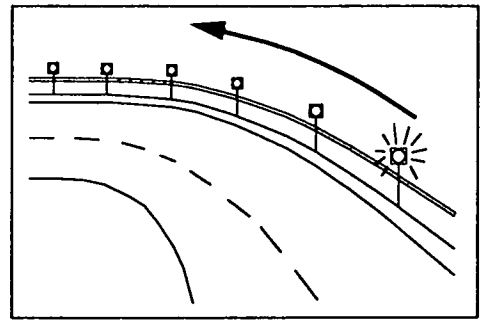
Purpose

To warn motorists that they are traveling at a speed that is too fast for a horizontal curve ahead.

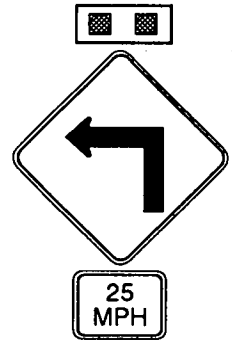
Comments

Device 3B-10A consists of flashing yellow beacons located on a bridge railing in advance of and throughout a sharp curve. Loops detect vehicle speeds greater than a certain level and activate the beacons, which flash in sequence. Motorists traveling at a speed greater than the safe limit will be alerted that a speed reduction is required. Previous countermeasures included passive warning signs and overhead signs with flashers.

Device 3B-11A consists of a curve warning sign with an advisory speed plate supplemented by a hazard beacon. The device is nonstandard due to the configuration of the flashing beacons. Loop detectors activate the flasher for five seconds when the vehicle speed exceeds a certain safe threshold. Previous countermeasures tried were standard arrows and chevron alignment signs. Device 3B-11A has an installation cost of $1,600 and annual maintenance and operation costs of $100 and $65, respectively.



3B-10A



3B-11A
nonstandard

FIGURE 31 Speed in horizontal curve.

SUBCATEGORY 3C: SIGNAL CHANGES

Traffic Signal Phasing
Device ID Numbers: 3C-1A to 3C-18A

Purpose

To warn motorists that a stop is required at a signalized intersection ahead where the approach has insufficient sight distance to the signal heads or where high speeds create excessively large dilemma zones.

Comments

Device 3C-1A consists of a fiber optic STOP AHEAD sign programmed into the signal sequence. The lead time for activation is determined by dividing the 85th percentile speed into the distance from the sign to the stop bar. SIGNAL AHEAD warning signs (W3-3) without flashers and signal timing adjustments were tried as prior countermeasures before this device was installed. This device has an estimated installation cost of $20,000 and an annual operating and maintenance cost of $1,100.

Device 3C-2A is a fiber optic (RED)/SIGNAL AHEAD sign in advance of a signalized intersection. During the green phase, only the words SIGNAL AHEAD are steadily illuminated. Near the end of green phase, the word RED flashes alternately with the words SIGNAL AHEAD. SIGNAL AHEAD warning signs (W3-3) mounted overhead with continuously flashing beacons were tried as prior countermeasures. Device 3C-2A is used at three locations, with a reported installation cost of $15,000.

Device 3C-3A is a sign with the text PREPARE TO STOP WHEN FLASHING span-wire mounted over the roadway. The flashers are activated near the end of the green phase and go off near the end of the red interval. Timing is set based on the distance between the sign and signal and the available sight distance to the sign. Standard ground-mounted and overhead-mounted SIGNAL AHEAD signs (W3-3) were tried as prior countermeasures. Device 3C-3A is used by the reporting agency at two locations, with an installation cost of $4,000.

Device 3C-4A consists of a flashing beacon mounted above a sign with the message PREPARE TO STOP WHEN FLASHING. The beacon flashes 8 seconds before the yellow interval begins and continues until the end of the red interval.

Device 3C-5A consists of two flashing beacons mounted horizontally with a PREPARE TO STOP WHEN FLASHING sign. The beacons are activated in advance of the yellow and red intervals for the approach. This device is suspended over the roadway and timed in conjunction with the posted speed limit. Those vehicles traveling at the posted speed limit that pass the sign before activation occurs will be able to clear the intersection without stopping. This device is used at locations where there is insufficient sight distance to the intersection and also at actuated traffic signal locations that do not cycle frequently. Near and far side traffic signal heads were tried as prior countermeasures. Device 3C-5A has an estimated installation cost of $1,500, with an annual operating and maintenance cost of $85.

Device 3C-6A consists of two flashing beacons above a standard SIGNAL AHEAD warning sign (W3-3) or a sign reading PREPARE TO STOP WHEN FLASHING. The beacon flashes during the yellow and red intervals. This device is timed by the length of the flashing DON'T WALK interval of the pedestrian crossing signal, with the beacons not being activated during the WALK interval. Standard SIGNAL AHEAD signs (W3-3) with flags were tried as a prior countermeasure. The device is mounted on the right side of two-lane roadways and on both sides of a roadway with four or more lanes. Device 3C-6A has an estimated installation cost of $2,000.

Device 3C-7A consists of two flashing beacons above a black square board with the message PREPARE TO STOP WHEN FLASHING on a standard yellow diamond. The device is nonstandard because the silhouette shape is not the same as the device shape. Beacons are activated at the end of the green interval and go off at the beginning of the green interval. Standard SIGNAL AHEAD signs (W3-3) at 1 /2 mile, 1 /4 mile, and 1,000 ft before the intersection were used as a countermeasure before this device was installed. Device 3C-7A has an estimated installation cost of $10,000 and an annual operating and maintenance cost of $1,000.

Device 3C-8A consists of two vertically mounted flashing beacons with a PREPARE TO STOP WHEN FLASHING warning sign. A tie-in to the signal controller activates the device, which flashes for a set number of seconds before the end of the green interval. The timing is determined by the distance from the intersection and the 85th percentile speed. The SIGNAL AHEAD sign (W3-3) was tried as a prior countermeasure before this device was installed. The reporting agency uses 3C-8A at 50 locations, with an installation cost of $2,500 and an annual operating and maintenance cost of $1,800.

Device 3C-9A consists of two flashing beacons mounted above a sign with the text PREPARE TO STOP WHEN FLASHING. A driver passing the sign at 55 mph when the lights are not flashing will be able to proceed through the intersection on a green signal indication. The device is mounted on a mast arm over the roadway. SIGNAL AHEAD signs (W3-3) were tried as a prior countermeasure before this device was installed. Device 3C-9A has an estimated installation cost of $10,000 and an annual operating and maintenance cost of $1,000.

Device 3C-10A consists of a sign with the text BE PREPARED TO STOP supplemented by horizontally flashing beacons and a WHEN FLASHING plate. The beacons are activated at the end of the green interval and flash during the yellow and red intervals. Signal system improvements and speed limit adjustments were tried as prior countermeasures. Device 3C-10A has an estimated installation cost of $5,000.

Device 3C-11A consists of a sign with the text BE PREPARED TO STOP WHEN FLASHING supplemented with a flashing yellow beacon above the sign. The beacon is activated when the traffic signal changes to red and flashes until the green indication begins. Device 3C-11A has an estimated installation cost of $2,000.

Device 3C-12A consists of the text STOP AHEAD WHEN FLASHING on a sign which is supplemented with horizontally mounted flashing beacons activated by the traffic signal controller. SIGNAL AHEAD (W3-3) signs mounted 1 /2 mile, 1 /4 mile, and 1,000 ft prior to the intersection were tried as prior countermeasures. The reporting agency uses this device at six locations, with an installation cost of $10,000 and annual operating and maintenance costs of $1,000 each.

Device 3C-13A consists of a SIGNAL AHEAD/PREPARE TO STOP WHEN FLASHING sign supplemented by horizontally mounted flashing beacons. The flashers are activated at the beginning of the clearance interval. Device 3C-13A has an estimated installation cost of $1,900.

Device 3C-14A is a span-wire mounted sign with the text RED SIGNAL AHEAD WHEN FLASHING and flashing beacons mounted on both sides. The flashers are activated by the traffic signal controller prior to the signal red interval. Device 3C-14A has an estimated installation cost of $1,000.

Device 3C-15A consists of a sign with the text WHEN FLASHING STOP AHEAD supplemented by two flashing beacons. The beacons are activated prior to the red interval. SIGNAL AHEAD signs (W3-3) were tried as a prior countermeasure. Device 3C-15A has an estimated installation cost of $5,000 and an annual operation and maintenance cost of $100.

Device 3C-16A is an internally illuminated PREPARE TO STOP sign. This device is activated during the red interval by the traffic signal controller. Device 3C-16A has an estimated installation cost of $1,000 and an annual maintenance and operation cost of $300.

Device 3C-17A is mast-arm mounted and consists of two signs and two flashing beacons. The beacons are horizontally mounted with a 96-in. × 48-in. PREPARE TO STOP sign. The second sign is a 48-in. × 48-in. symbolic SIGNAL AHEAD sign (W3-3). The flashers are controlled by the traffic signal controller and are activated in advance of the red interval. The reporting agency stated that the device is used at two locations with an installation cost, including controller and underground wiring, of $40,000.

Device 3C-18A consists of two span-wire mounted warning signs. One sign has a traffic signal symbol that is modified to emphasize the red indication by radiating lines. The other sign has the text WHEN FLASHING. Both signs have a flashing beacon embedded in the upper face of the sign, which makes them nonstandard applications of the MUTCD guidelines.

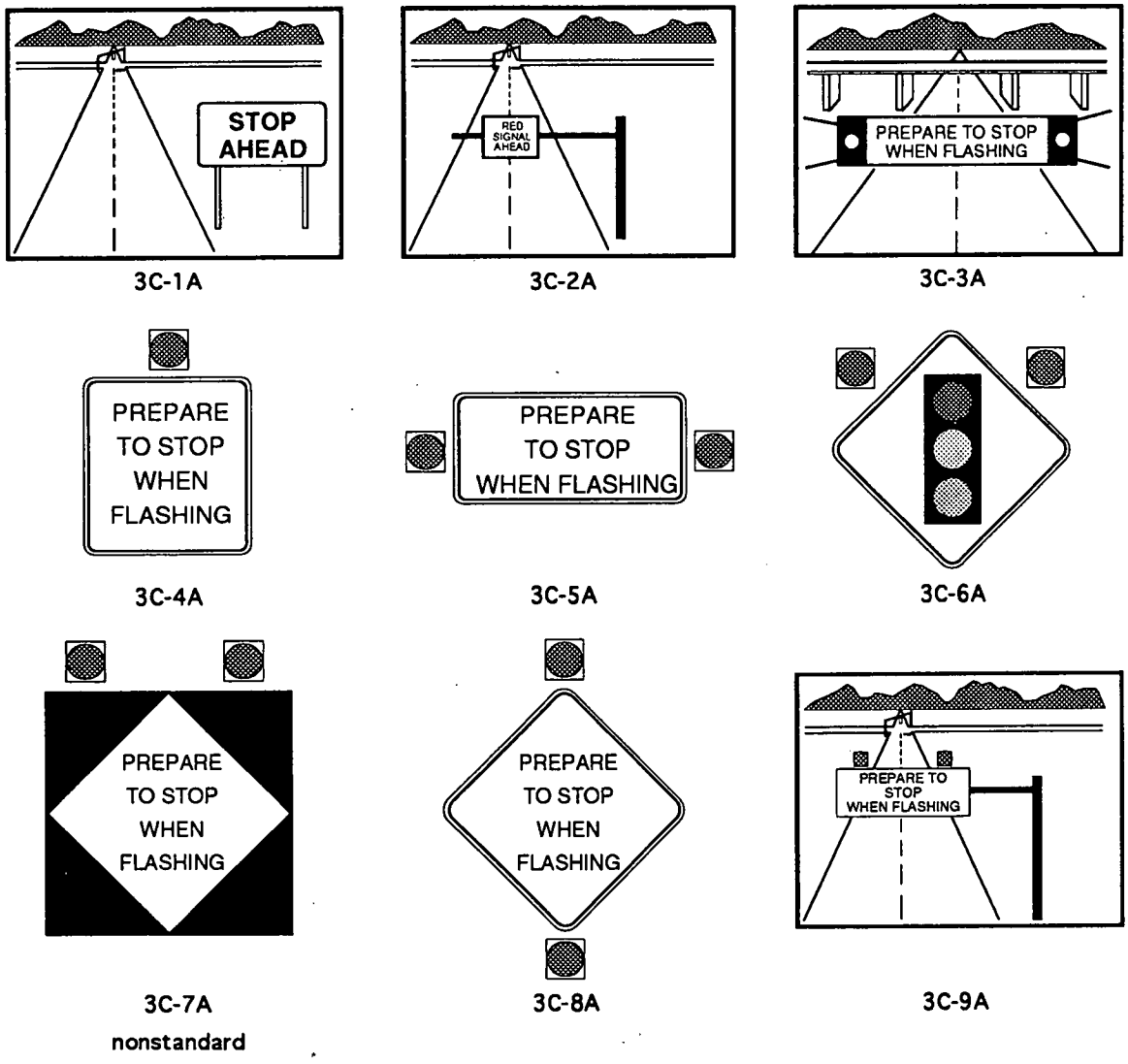
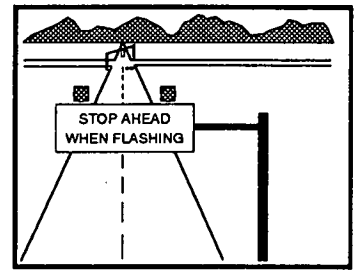


FIGURE 32 Traffic signal phasing.

3C-10A

3C-11A

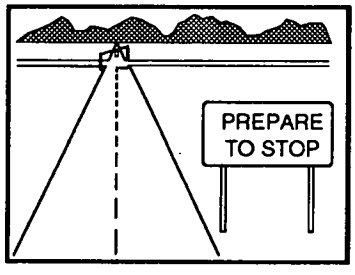


3C-12A

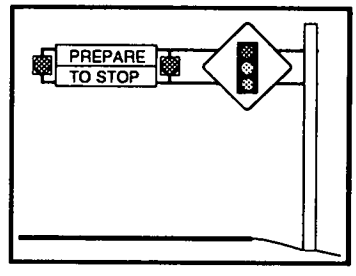
3C-13A

3C-14A

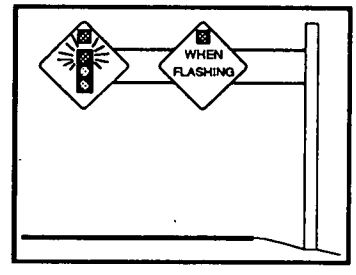
3C-15A



3C-16A



3C-17A



3C-18A
nonstandard

FIGURE 32 (*Continued*)

SUBCATEGORY 3D: MERGING

Merging Traffic and Lane Use
Device ID Numbers: 3D-1 to 3D-6

Purpose

To warn motorists of merging traffic, special lane use, or lane drops.

Comments

Device 3D-1 is installed to provide advance warning that a through lane becomes an exclusive turn lane at or near an intersection. One agency reports using shorter turn pockets and mounting standard LANE REDUCTION TRANSITION signs (W4-2) as prior attempted countermeasures.

Device 3D-3 is a pair of signs that warn of a lane drop and are used either separately or together in 1/4-mile increments to a maximum distance of 3/4 mile. Overhead mounting is preferred.

Device 3D-4 is a supplemental plate with the text GIVE GAP/TAKE GAP mounted below a standard MERGE sign (W4-1). It is placed at freeway entrance ramps to encourage proper merging behavior. The sign is visible to motorists on the ramp as well as to those on the highway. It instructs freeway traffic to provide a safe gap to allow entering traffic to merge.

Device 3D-6 consists of a sign with the text MERGING TRAFFIC supplemented by flashing yellow beacons on either side operating continuously. It is used on a freeway in advance of an entrance ramp on an upgrade with a short merging taper, resulting in erratic and slow merging maneuvers. Prior attempted countermeasures included a 48-in. × 48-in. standard MERGE warning sign (W5-9) and the placing of a 36-in. × 36-in. size W5-9 on the ramp. Device 3D-6 is mounted on a mast arm over the roadway, and its installation has resulted in little change in the number or types of accidents occurring at the location. Device 3D-6 has an estimated installation cost of $5,000 and an annual maintenance and operation cost of $200.

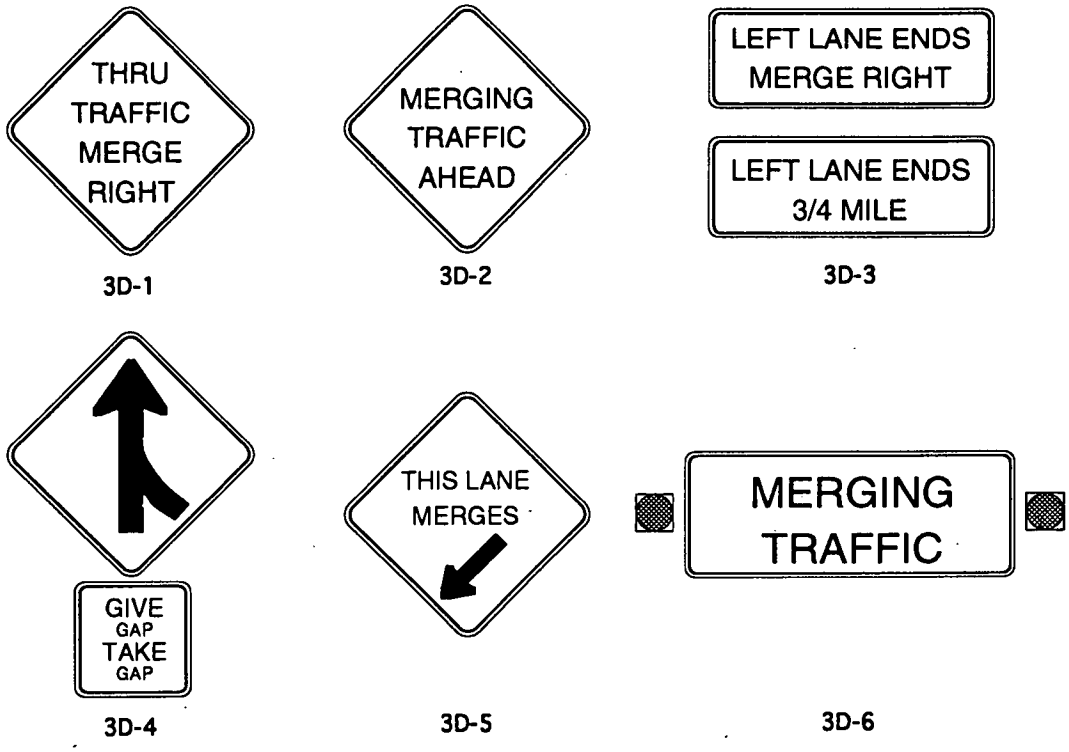


FIGURE 33 Merging traffic and lane use.

SUBCATEGORY 3E: MOVEMENTS

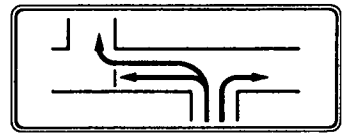
Movements at an Intersection with Unusual Geometrics
Device ID Number 3E-1

Purpose

To indicate permitted traffic movements at locations with unusual geometric configurations.

Comments

Device 3E-1 is a rectangular sign erected to indicate what movements are permitted when a green indication is displayed on an approach to an offset, signalized intersection. It is mounted on the far side of the intersection and faces each approach of the offset roadway.



3E-1

FIGURE 34 Movements at an intersection with unusual geometrics.

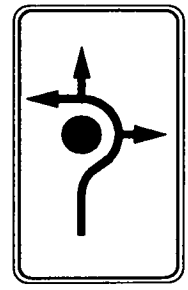
Movements Around a Traffic Circle
Device ID Numbers: 3E-2 to 3E-3

Purpose

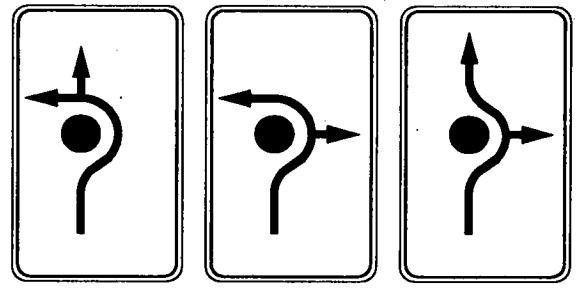
To identify permitted movements at an intersection that features a traffic circle and to keep drivers from turning left in front of the circle.

Comment

Device 3E-2 depicts permitted movements at a traffic circle with four approaches while 3E-3 comprises three signs showing allowable maneuvers for circles with three approaches. All of these signs are black-on-white, giving them a regulatory aspect. The agency reported numerous inquiries from the public regarding how to negotiate the intersection prior to the installation of these signs. The signs are used at 40 locations and, since their installation, no inquiries have been received from confused drivers. Standard symbolic and verbal KEEP RIGHT signs were used before the installation of these devices.



3E-2
nonstandard



3E-3
nonstandard

FIGURE 35 Movements around a traffic circle.

Traffic Circles
Device ID Number 3E-4

Purpose

To inform and warn motorists that a traffic circle is ahead.

Comments

The reporting agency noted that traffic circles are not common in the area and, as such, represent an unusual situation to many drivers.

3E-4

FIGURE 36 Traffic circles.

SUBCATEGORY 3F: SIDE ROAD AND CROSSROAD TRAFFIC

Crossing or Turning Traffic
Device ID Numbers 3F-1 to 3F-9

Purpose

To warn motorists of vehicles entering or exiting the roadway in an area where turning movements may be unexpected, such as in an area of restricted sight distance or where the type of entering or exiting traffic is primarily heavy vehicles.

Comments

The majority of devices in this subcategory are used in addition to standard advance side road and crossroad signs. Device 3F-7 is used at locations where vehicles may be entering from or exiting onto driveways in an area of limited sight distance. Device 3F-9 is used in advance of a boat ramp access roadway to warn motorists of potentially slow-moving vehicles entering the roadway ahead.

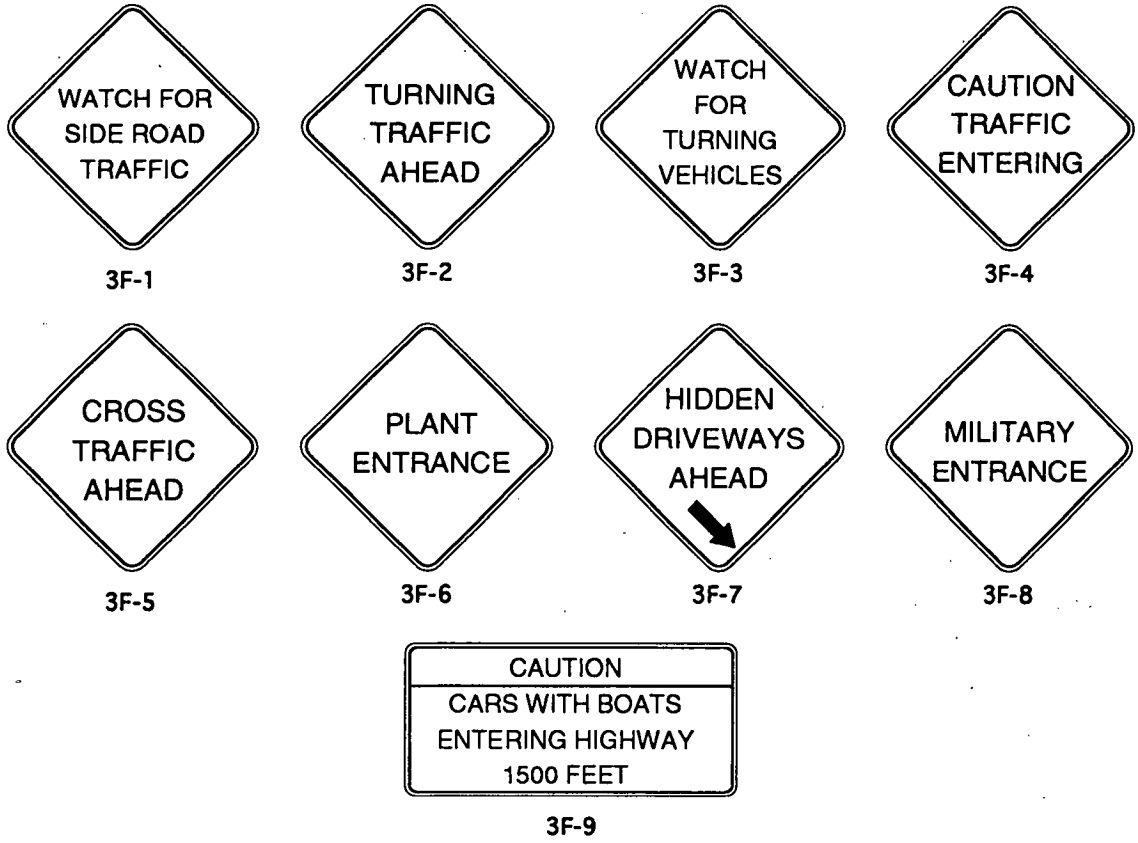


FIGURE 37 Crossing or turning traffic, passive devices.

Crossing or Turning Traffic
Device ID Numbers: 3F-10A to 3F-19A

Purpose

To warn motorists of crossroad traffic at intersections formed by low-volume minor roadways and high-volume, high-speed arterials where sight restrictions may exist.

Comments

Device 3F-10A consists of a sign with the text TRAFFIC ENTERING INTERSECTION WHEN FLASHING supplemented by a flashing yellow beacon mounted above. The flasher is activated by detectors placed at the stop bar on the minor road approaches. The device is suspended over the roadway facing each approach of the major road in locations with insufficient sight distance. Prior to the installation of this device, standard CROSSROAD and SIDE ROAD signs (W2-1 and W2-2) were used. The reporting agency indicates that right-angle accidents have been reduced since installation, but that motorists frequently do not trust the flashers. The device is mounted in conjunction with 3F-11A, which is located on the minor road approaches, at a total cost of $2,000, with an annual maintenance and operation cost of $460.

Device 3F-11A consists of a sign with the text TRAFFIC APPROACHING INTERSECTION WHEN FLASHING supplemented by alternately flashing red beacons. The flashers are activated by detectors placed on the major roadway approaches some 300 to 400 ft away from the intersection. They operate for a period of time sufficient to allow the vehicle on the major roadway to pass through the intersection. The device is roadside mounted on each approach of the minor road, with device 3F-10A installed on the major road approaches.

Device 3F-12A consists of 12-in. span-wire mounted flashing beacons placed over the center of each major road approach lane. The distance of beacon placement from the intersection is based on the posted speed limit on the major roadway. The device is activated by the presence of a vehicle on the minor road and the flashers operate during vehicle presence and for 20 sec after the vehicle leaves the detection area. The device is installed at intersections that do not warrant traffic signals, but where the width of the major roadway and high vehicle speeds result in a high accident potential. Device 3F-12A has an estimated installation cost of $800 and an annual operation and maintenance cost of $75.

Device 3F-13A consists of a black-on-white sign with the text TRAFFIC COMING FROM LEFT (RIGHT) WHEN FLASHING supplemented by two flashing red beacons. The flashers are activated by loop detectors on the major intersecting roadway. A supplemental yellow-on-black plate with the text IF LIGHTS OUT/NO POWER/SIGNAL NOT WORKING with two permanently illuminated lights informs motorists if the device is operating. This device is used at intersections with restricted sight distance and is mounted opposite the minor approach at a T-intersection.

Device 3F-14A consists of a black-on-white sign with the text TRAFFIC COMING FROM RIGHT (LEFT) WHEN FLASHING supplemented with two red flashing beacons. The device, which is span-wire mounted, is activated by loop detectors on the major

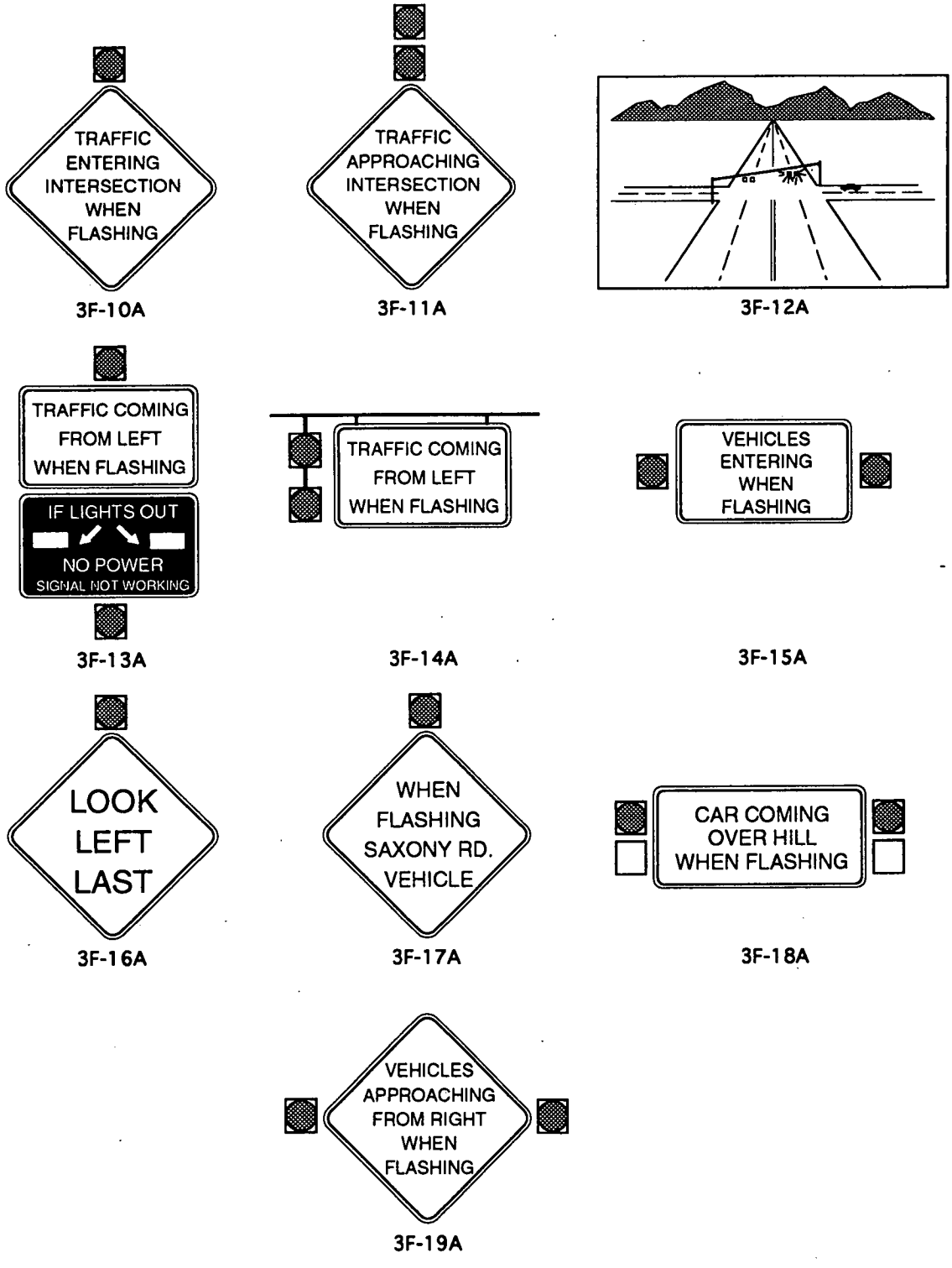


FIGURE 38 Crossing or turning traffic, active devices.

roadway and is used at intersections with restricted sight distance.

Device 3F-15A consists of a sign with the text VEHICLES ENTERING WHEN FLASHING supplemented by two flashing yellow beacons. The beacons are activated by loop detectors on the intersecting minor roadway. This device is span-wire mounted over the major roadway at intersections with high approach speeds or on an approach with insufficient sight distance for drivers on the primary roadway to identify vehicles entering from a minor road. This device has an estimated installation cost of $3,500 and an annual maintenance and operation cost of $370.

Device 3F-16A consists of a sign with the text LOOK LEFT LAST supplemented by a flashing yellow beacon. The flasher is activated by a loop detector on the crossroad and operates for a period of time sufficient to allow the vehicle to clear the intersection. It is used to warn motorists on the minor road of high-speed vehicles approaching an intersection in an area of restricted sight distance. The device is roadside mounted at the intersection on the minor road approach. Device 3F-16A is installed in conjunction with 3F-17A, which is mounted on the major roadway, at a total cost of $16,100.

Device 3F-17A consists of a sign with the text WHEN FLASHING ___ RD. VEHICLE supplemented by a flashing yellow beacon. The text includes the name of the side road or crossroad from which a motorist is attempting to enter. The flasher is activated by a loop detector placed at the stop bar on the minor approach and operates for an additional 3 seconds after the vehicle enters the intersection. Device 3F-16A is installed in conjunction with 3F-17A at a total cost of $16,100.

Device 3F-18A consists of a sign with the text CAR COMING OVER HILL WHEN FLASHING supplemented by two flashing yellow beacons. The device is mast-arm mounted, with the text and beacons facing both directions on a single mount. The flashers are activated by loop detectors placed in the roadway. The device is used to warn motorists entering the roadway from a side street or driveway near a vertical curve that a vehicle is approaching.

Device 3F-19A consists of a sign with the text VEHICLES APPROACHING FROM RIGHT (LEFT) WHEN FLASHING supplemented with two flashing yellow beacons. The beacons are activated by loop detectors on the major roadway and operate for a period of time sufficient to allow the mainline traffic to clear the intersection. Further actuations will extend the call. The device is installed on the minor approach to intersections with restricted sight distance. Traffic investigations for multi-way stop warrants, vegetation trimming, and standard CROSSROAD and SIDE ROAD warning signs (W2-1 and W2-2) were attempted countermeasures before the installation of this device. It is either pole- or span-wire mounted on the minor approach. The device is installed at 25 locations by the reporting agency with an estimated installation cost of $1,200 and an annual operation and maintenance cost of $150.

SUBCATEGORY 3G: STOP SIGN AND SIGNAL WARNING

Traffic Control Devices
Device ID Numbers: 3G-1 to 3G-5

Purpose

These devices are used to warn motorists of traffic control devices ahead or of recent changes to traffic control at an intersection.

Comment

Device 3G-1 consists of a YIELD AHEAD sign (W3-2a) with the text YIELD and a supplemental plate with the text ___ FEET. The sign is overhead mounted, has a black background and is supplemented by flashers on continuous 24-hour operation. It was installed when a left-hand freeway entrance ramp was modified from being an add lane to a merge condition. This device is nonstandard since the silhouette shape is not the same as the device shape. Device 3G-1 has an estimated installation cost of $1,000 and an annual maintenance cost of $100.

Device 3G-2 is a two-way illuminated case sign consisting of a STOP sign facsimile mounted on span wire over an intersection. It is installed in conjunction with 48-in. roadside mounted stop signs and is on continuous 24-hour operation. The device was installed after a previously through street was changed to stop control. It is also used at locations with limited sight distance on

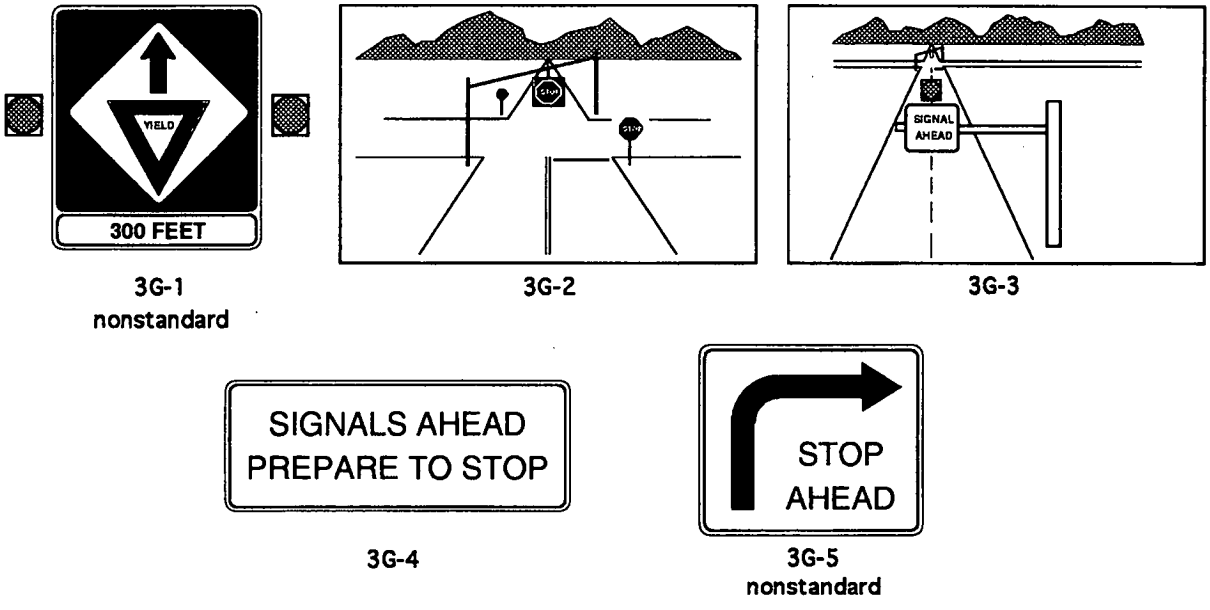


FIGURE 39 Stop sign and signal warning.

the approach. One location with an average frequency of five right-angle accidents per year has had its accident experience reduced to one per year since installation of this device.

Device 3G-3 consists of an overhead mounted illuminated case sign with the text SIGNAL AHEAD supplemented with a yellow flashing beacon above the sign. The device is on continuous 24-hour operation. It is installed on a high-speed roadway approach to warn of a signal ahead. Previous countermeasures included standard passive roadside mounted SIGNAL AHEAD signs (W3-3). The agency has installed 3G-3 at three locations and reported an average installation cost of $2,000 and an annual operation cost of $250.

Device 3G-4 is a rectangular sign with the text SIGNALS AHEAD/PREPARE TO STOP. The device is roadside mounted to warn motorists of a signalized intersection ahead on a high-speed roadway entering a developed area.

Device 3G-5 is a sign with a graphic representation of a sharp turn and the text SIGNAL AHEAD or STOP AHEAD. It is installed on a short ramp with insufficient sight distance due to a horizontal curve. The STOP sign is located immediately downstream of the curve. Standard STOP AHEAD signs (W3-1a) were used as a previous countermeasure, but were considered misleading since the arrow on the standard sign points straight ahead and did not adequately represent the ramp's geometrics.

Traffic Control Changes
Device ID Numbers: 3G-6 to 3G-10

Purpose

To warn motorists that a recent change in traffic control devices has occurred at an intersection ahead.

Comments

Device 3G-6 is a sign with the text BE PREPARED TO STOP supplemented with a plate reading NEW STOP SIGN. Flags may be used to increase the device's visibility. This device is installed when the stop controls at an intersection were changed due to increasing minor road volumes and accident experience.

Device 3G-7 consists of two signs with the text SIGNAL OPERATION CHANGED. The square sign is used on roadways with posted speed limits up to and including 40 mph, while the diamond sign is used in advance of the other on roadways with speed limits greater than or equal to 45 mph.

Device 3G-8 is a sign with the text BE PREPARED TO STOP, and a supplemental plate reading NEW SIGNAL or NEW STOP SIGN. The sign is supplemented with battery operated flashing warning lights or red flags. An alternative supplemental plate reads NEW SIGNAL (STOP SIGN) AHEAD. The device is installed on each approach of an intersection to warn motorists of a change in traffic control. Previous countermeasures included standard SIGNAL AHEAD signs (W3-3) with flashing lights and flags. The reporting agency indicates that 3G-8 reduces rear-end accidents.

Device 3G-9 is installed in advance of a new signal where sufficient sight distance does not exist. Previous countermeasures included standard SIGNAL AHEAD signs (W3-3).

Device 3G-10 is a sign with the text TRAFFIC CHANGE supplemented with two 18-in. aluminum flags. It is installed to warn of a newly changed right-of-way assignment or of a new signal or STOP sign. Previous countermeasures included multiple STOP or SIGNAL AHEAD signs (W3-1a or W3-3), battery operated red beacons on STOP signs, and 3-day flashing operation of new signals.

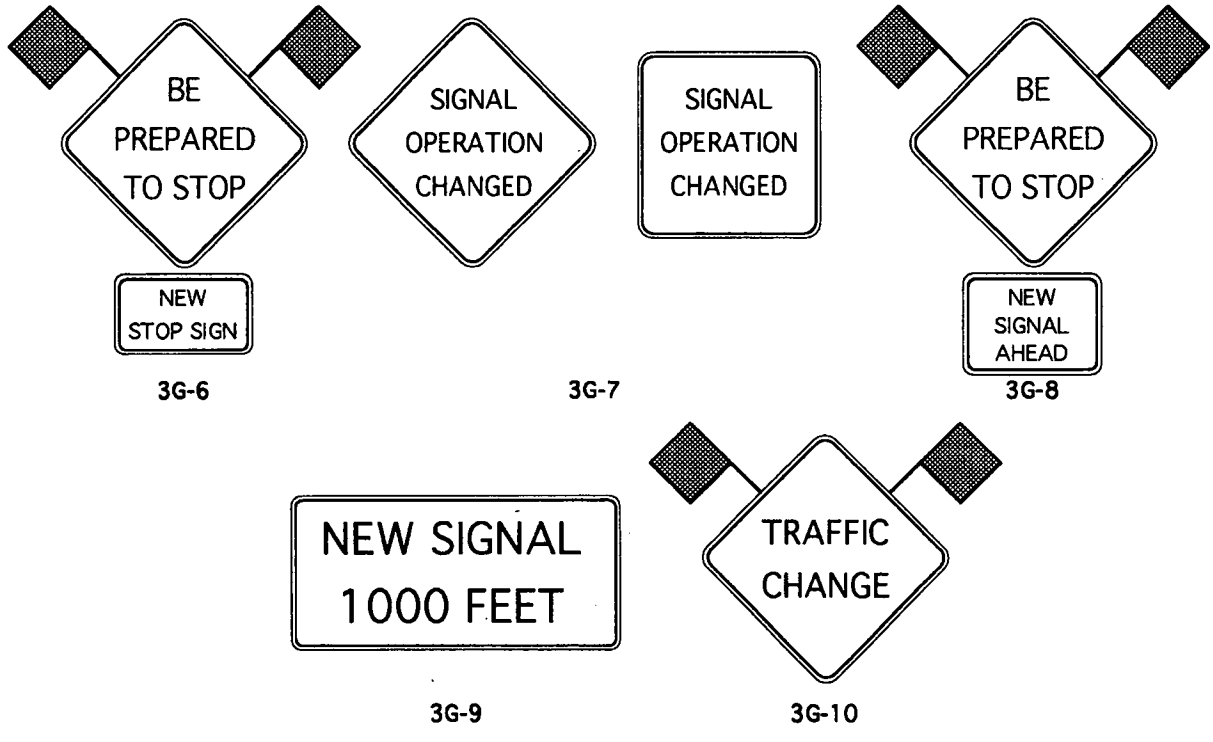


FIGURE 40 Traffic control changes.

SUBCATEGORY 3H: INTERSECTION APPROACH FLOW

Lane Use and Traffic Flow
Device ID Numbers: 3H-1 to 3H-9

Purpose

To inform motorists of proper lane use and traffic flow conditions.

Comments

Device 3H-1 is a rectangular black-on-white sign with the text THIS LANE NO STOP REQUIRED and an arrow pointing down to the appropriate lane. Mounted to the left of the sign is a continuously flashing green arrow. The sign is nonstandard due to color and shape.

Device 3H-2 is a rectangular black-on-white sign with the text CONTINUOUS LANE and an arrow pointing down to the lane. It was installed because motorists were stopping at the top of an exit ramp from a freeway in an add lane where geometrics gave the appearance of a merge condition. It is nonstandard due to its shape and color. The reporting agency indicated a drop in rear-end accidents at this location after installation.

Device 3H-3 is a sign with the text WATCH FOR CROSS TRAFFIC. It is installed to warn motorists of vehicles exiting a driveway opposite an approach at what appears to be a T-intersection. The driveway has sufficient volumes to be included in the intersection signal phasing. The device is mounted across the intersection from the approach that faces the driveway.

Device 3H-4 is a typical TWO-WAY TRAFFIC sign (W3-3) rotated 90°. It consists of two arrows pointing in opposite directions and is installed to warn that the cross street is two-directional. It is used in areas with a large number of one-way streets. The device is installed when a one-way cross street is converted to two-way. It is nonstandard since the 90° rotation of a standard device may be confusing to motorists.

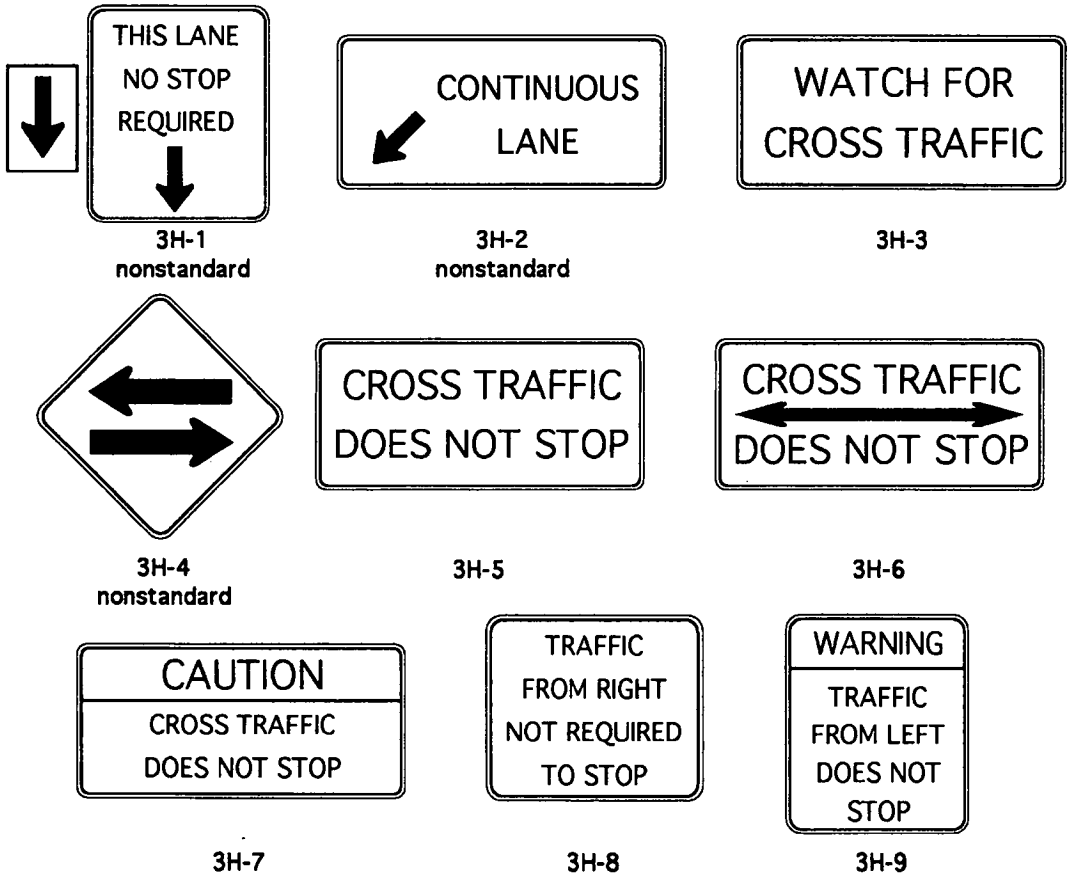
Device 3H-5 is a supplemental plate with the text CROSS TRAFFIC DOES NOT STOP mounted beneath a standard STOP sign (R1-1). It is installed on the minor approach at an intersection to inform motorists that the major road traffic does not stop.

Device 3H-6 is a supplemental plate mounted under a STOP sign (R1-1) and has the text CROSS TRAFFIC DOES NOT STOP and a double-headed arrow. It is installed to inform motorists that crossroad traffic at an intersection is not required to stop. Previous countermeasures included larger STOP signs (R1-1).

Device 3H-7 is a supplemental plate with the text CAUTION/ CROSS TRAFFIC DOES NOT STOP mounted under a STOP sign at an intersection. It is installed where cross traffic previously had to stop but now does not, or to inform motorists that cross traffic at an intersection is not required to stop.

Device 3H-8 is a plate with the text TRAFFIC FROM RIGHT (LEFT) NOT REQUIRED TO STOP. It is installed at intersections with four approaches, one of which has the right-of-way and is not required to stop. The device warns motorists that traffic on the designated approach is not required to stop as might be expected.

Device 3H-9 is a supplemental plate with the texts WARNING/ ONCOMING TRAFFIC DOES NOT STOP or WARNING/ TRAFFIC FROM LEFT (RIGHT) DOES NOT STOP. It is installed to warn motorists of the type of stop control in place at unsignalized intersections where it might be assumed by a motorist that traffic on all approaches is required to stop.



3H-1 nonstandard | 3H-2 nonstandard | 3H-3

3H-4 nonstandard | 3H-5 | 3H-6

3H-7 | 3H-8 | 3H-9

FIGURE 41 Lane use and traffic flow.

SUBCATEGORY 3I: MOTORIST INFORMATION

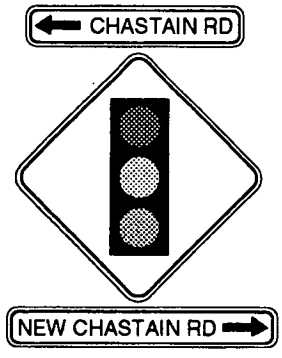
Intersecting Roadway Names
Device ID Numbers: 3I-1 and 3I-2

Purpose

To assist motorists unfamiliar with an area by providing them with the names of approaching intersecting roads.

Comments

Device 3I-1 consists of black-on-yellow name plates installed in conjunction with standard SIDE ROAD (W2-2), CROSSROAD (W2-1), and SIGNAL AHEAD (W3-3) signs. This device is part of a comprehensive program to assist drivers, with the intent of reducing accidents caused by sudden braking to turn or by weaving on multi-lane roads when approaching an intersection. Device 3I-2 consists of an advance street name sign with a logo of a signal face to the left of the street name. The reporting agency uses these signs at five locations.



3I-1

3I-2

FIGURE 42 Intersecting roadway names.

SUBCATEGORY 4A: PEDESTRIAN CROSSINGS

Pedestrians
Device ID Numbers: 4A-1 to 4A-14

Purpose

To warn motorists of the possible presence of pedestrians and to advise pedestrians of permitted movements.

Comments

Device 4A-1 is a modified PEDESTRIAN CROSSING sign (W11A-2), with the pedestrian depicted with a cane in one hand. Due to the symbol change, it is a nonstandard sign. It is installed to warn drivers of slow-moving elderly pedestrians.

Device 4A-2 is a combination of an advisory speed plate (W13-1) below a PEDESTRIAN CROSSING sign (W11A-2). The advisory speed is 5 mph below the posted speed limit. It is used to increase the target value of the crossing sign, to encourage drivers to drive slower near crosswalks, and to lower the tolerance level police give when issuing speeding citations near the crosswalk.

Device 4A-3 is an example of a sign first used 30 years ago. Most of these signs have been removed. It was used as a supplement to standard PEDESTRIAN CROSSING signs (W11A-2). The device is considered to be ineffective since it gives pedestrians a false sense of security, and has remained installed at a few locations only because of citizen requests.

Device 4A-4 is used to increase motorist awareness of pedestrians crossing an intersection where no painted crosswalks are present.

Device 4A-5 is placed in advance of crosswalks to alert drivers of the possible presence of pedestrians.

Device 4A-6 is a black-on-white sign with the text STATE LAW/YIELD TO PEDESTRIANS IN CROSSWALK. It is used to give a regulatory aspect to the crosswalks. Standard PEDESTRIAN CROSSWALK signs (W11A-2) were tried as a prior countermeasure before this sign was installed.

Device 4A-7 is a supplemental plate with the text YIELD TO PEDESTRIANS mounted below a PEDESTRIAN CROSSING sign (W11A-2). The intent of the plate is to give a regulatory aspect to the pedestrian crossing sign, although the plate's color scheme is black on yellow. Standard signs and police enforcement were tried as prior countermeasures before this device was installed.

Devices 4A-8 and 4A-9 are installed to warn motorists that pedestrians may be using the roadway due to a lack of sidewalks or adequate shoulders.

Device 4A-10 is used to designate an area within the roadway for the exclusive use of pedestrians. The area must be protected or marked or indicated by adequate signs so as to be plainly visible at all times. Pedestrian safety zones are defined in the responding agency's MUTCD. The safety areas may be refuge islands formed by curbs, precast devices, pavement edges, posts and other physical means. The safety zone may also be formed by painted lines to outline areas from which vehicles are restricted.

Device 4A-11 is used to inform drivers that a university area is ahead and that pedestrians are likely, while 4A-12 and 4A-13 are used where special types of land use could result in increased pedestrian and vehicle traffic.

Device 4A-14 is installed on local streets and neighborhood collectors leading into residential areas. The device is not considered effective, but installation of the sign satisfied parents and

political leaders. Generally, the residents and homeowner's organization must pay to have this sign installed. The use of this sign and its variations has been discouraged by many agencies because the message implies that it is acceptable for children to be playing in the street. It is nonstandard due to the use of a symbol not contained in the MUTCD.

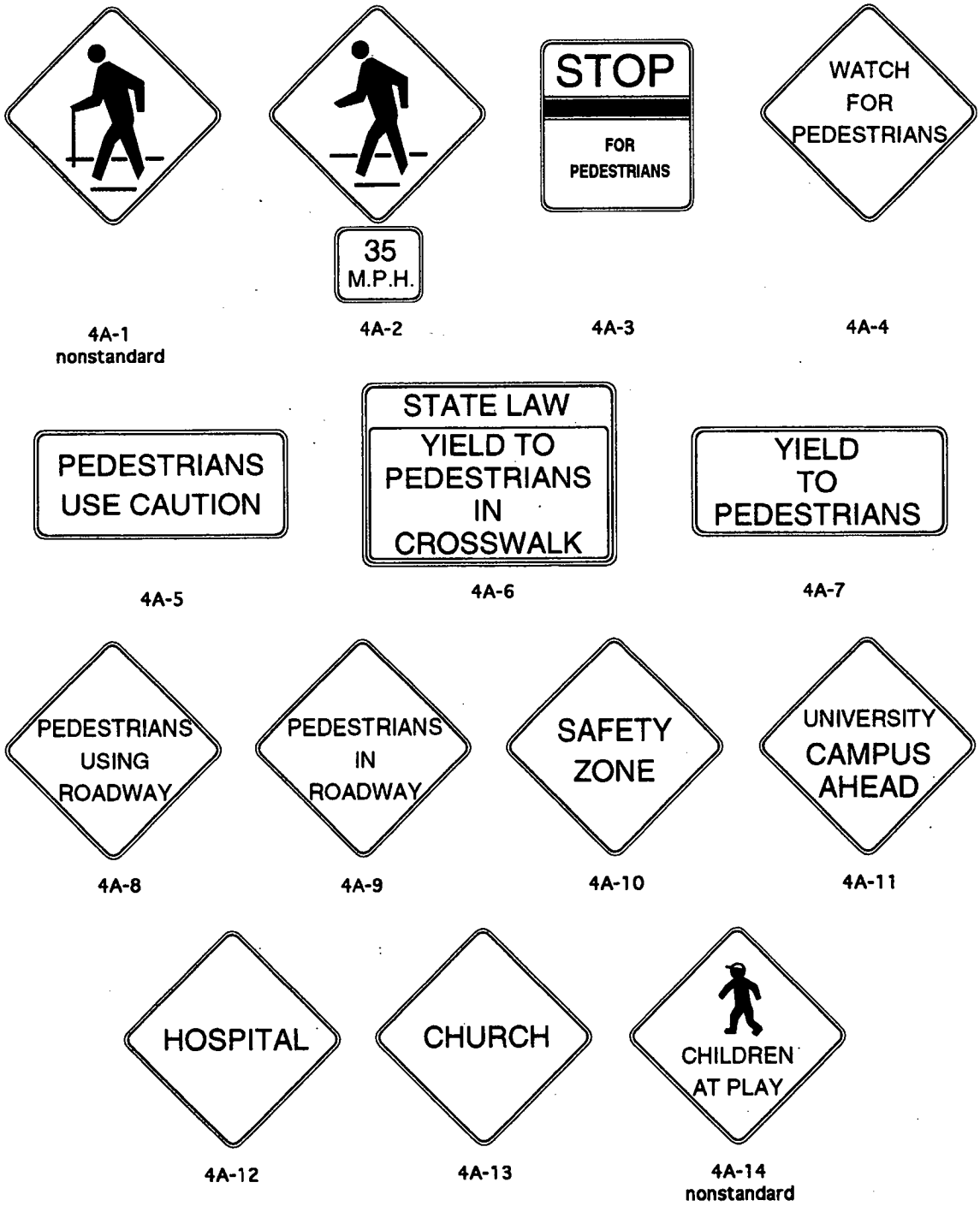


FIGURE 43 Presence of pedestrians.

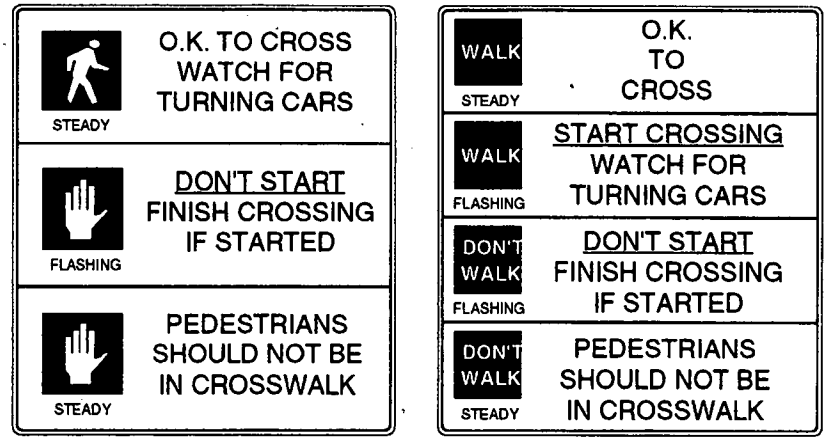
Pedestrian Signal Information
Device ID Number: 4A-15

Purpose

To increase pedestrian compliance to pedestrian signal indications.

Comments

Device 4A-15 consists of supplemental black-on-white pedestrian crossing signs to explain the standard symbolic and verbal pedestrian crossing signals. They are placed on the pedestrian signal pole, above a standard R10-4B sign (*19*).



4A-15
[Source 18]

FIGURE 44 Pedestrian signal information.

Pedestrians
Device ID Number: 4A-16A

Purpose

To inform motorists that pedestrians are present and that the motorist must yield.

Comments

Device number 4A-16A consists of a sign with the text YIELD TO PEDESTRIANS supplemented by flashers. It is intended to provide active warning to motorists of a crosswalk serving a retirement home. The flasher is activated by a pedestrian push button and operates for 25 seconds. Secondary red pilot lights mounted on the pole operate simultaneously to inform the pedestrian that the device is functioning properly. This sign is an alternative to the request for an unwarranted traffic signal and it is suspended over the roadway from span wire. A standard PEDESTRIAN CROSSING sign (W11A-2) and a heavy thermoplastic marked crosswalk were tried as prior countermeasures before this device was installed. A conflict study was performed before and after installation, and the results indicated a significant improvement in driver reaction to a pedestrian in the crosswalk. The reporting agency uses this device at an installation cost of $3,600.

4A-16A

FIGURE 45 Active pedestrian yield device, with text.

Pedestrians
Device ID Numbers: 4A-17A and 4A-18A

Purpose

To warn motorists of pedestrians crossing the roadway.

Comments

Devices 4A-17A and 4A-18A consist of flashing yellow beacons supplementing a roadside mounted PEDESTRIAN CROSSING sign (W11A-2). The flashers are activated by pedestrian push buttons. Both devices are occasionally installed in school areas. Although the devices are not considered effective, the pedestrians and parents of school children "feel safer" with them present. The devices are considered by the reporting agency to have severe liability drawbacks. The agency reported an installation cost of $5,000 and an annual operating and maintenance cost of $1,500.

4A-17A

4A-18A

FIGURE 46 Active pedestrian yield device, with symbols.

SUBCATEGORY 4B: HANDICAPPED AREAS

Handicapped Pedestrians
Device ID Numbers: 4B-1 to 4B-4

Purpose

To warn motorists of handicapped pedestrian crossing zones.

Comments

Device 4B-1 consists of a sign representing a pedestrian with a white cane. The sign is supplemented with a plate bearing the text BLIND AND DEAF CROSSING. This device is installed near an industry that employs blind and deaf people. It is nonstandard due to the change in the symbol.

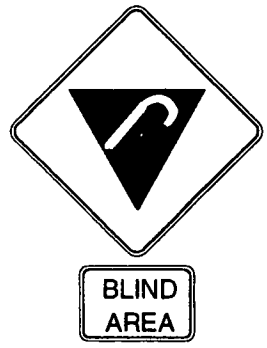
Device 4B-2 is a sign with the recognized handicapped symbol that is installed at locations where handicapped persons frequently cross the roadway. This sign is designated as W11-9 in *Standard Highway Signs* (*8*).

Device 4B-3 consists of a sign with a black inverted triangle superimposed with a graphic of a white cane. A supplemental plate with the text BLIND AREA is mounted beneath. This device is installed in areas with a high number of blind people, such as near a center for the visually impaired. This device is also nonstandard because of the symbol.

Device 4B-4 is installed by the reporting agency on city streets or on county roads to indicate that deaf children live in adjacent housing.

4B-1
nonstandard

4B-2



4B-3
nonstandard

4B-4

FIGURE 47 Handicapped pedestrians.

SUBCATEGORY 4C: MISCELLANEOUS CROSSINGS

Miscellaneous Crossings
Device ID Numbers: 4C-1 to 4C-13

Purpose

To warn motorists of unexpected entries onto the roadway by bicycles, animals, farm equipment, and other unusual potential conflicts.

Comments

Device 4C-1 is installed where there is either a high amount of commuter bike traffic or where bicycle facilities run across or near the roadway.

Device 4C-2 is used at locations where the use of all-terrain vehicles may present an unexpected hazard to motorists on a roadway.

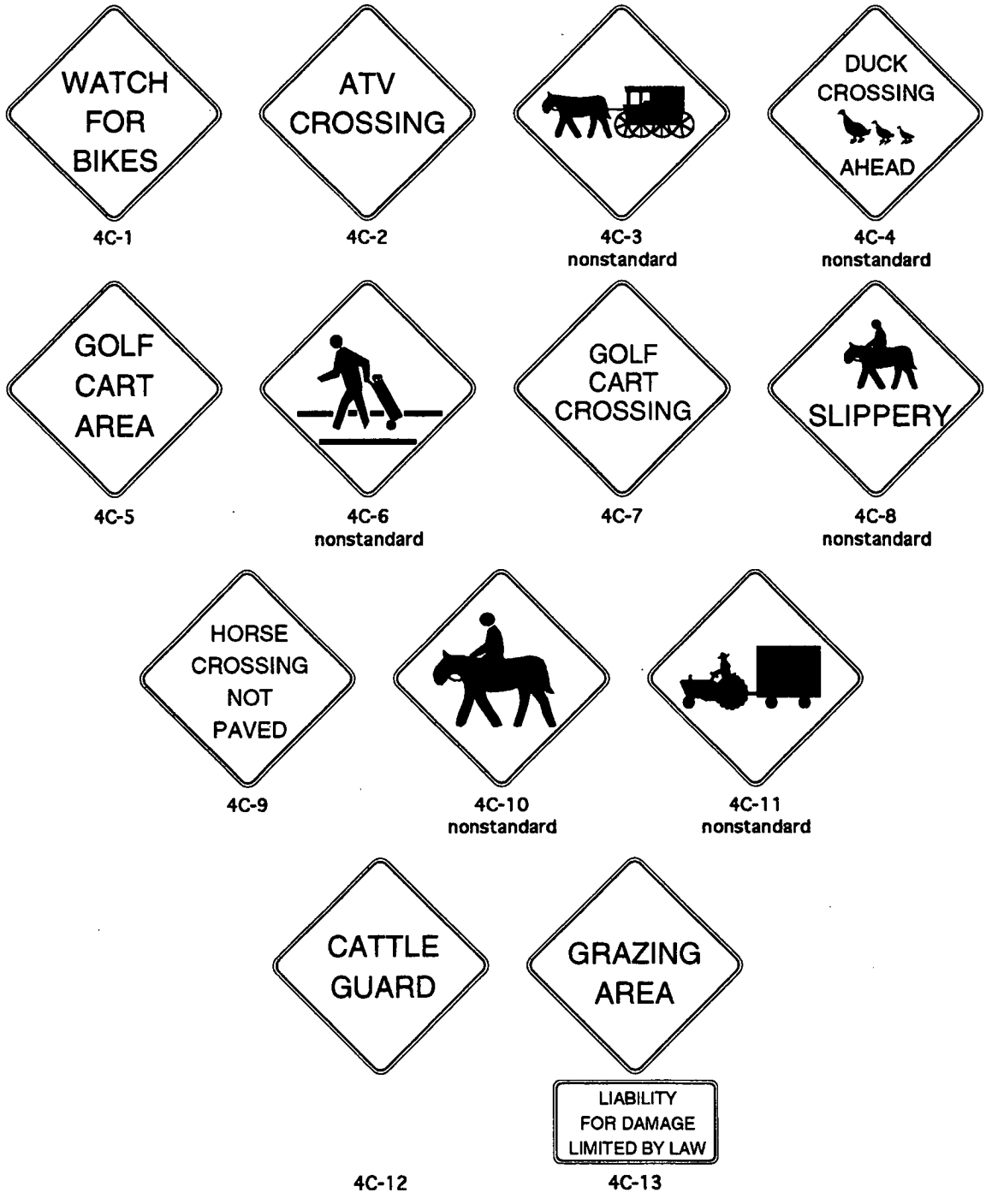


FIGURE 48 Miscellaneous crossings.

Device 4C-3 is installed in areas with a high number of slow-moving Amish carriages. A text warning sign bearing the message WATCH FOR HORSE DRAWN VEHICLES was not effective in alerting motorists. The use of a symbol not contained in the MUTCD makes it nonstandard.

Device 4C-4 consists of a sign with the text DUCK CROSSING AHEAD and a graphic representation of a family of ducks. It is installed at a location where ducks use a handicap ramp crossing to gain access between a water course and a park on opposite sides of a roadway. It is nonstandard due to the use of a symbol not contained in the MUTCD.

Devices 4C-5, 4C-6 and 4C-7 are installed at locations where golf carts or golfers frequently cross the roadway. Device 4C-6 is nonstandard due to the use of a symbol that is not contained in the MUTCD.

Device 4C-8 is installed facing established bridle paths to warn those on horseback that the roadway surface may be slippery and is also nonstandard due to the symbol used.

Device 4C-9 is installed on secondary roads where the pavement has been eliminated in an area where horses cross frequently.

Device 4C-10 is used to warn motorists of horseback riders in the area. This device is nonstandard due to the use of a symbol that is not contained in the MUTCD.

Device 4C-11 consists of a symbol depicting a farmer on a tractor pulling a trailer. The signs are cut in half horizontally and hinged so that they can be displayed only during the harvesting season. They are installed on four-lane highways near cotton gins, where a significant amount of farm equipment with trailers crosses. Previous countermeasures included standard FARM EQUIPMENT CROSSING signs (W11-5). It is nonstandard due to the use of a symbol not contained in the MUTCD.

Device 4C-12 is installed in locations where cattle guards are located in the roadway. Cattle guards are widely spaced metal grates that extend across the entire roadway. The grates act as a barrier to cattle since their hooves will slip into the spaces. Cattle guards can pose a stability problem to motorcycles.

Device 4C-13 consists of a sign with the text GRAZING AREA and a supplemental information plate with the text LIABILITY FOR DAMAGE LIMITED BY LAW. It is installed in open range locations where grazing livestock may wander onto the roadway.

SUBCATEGORY 4D: SCHOOL ZONES

School Zones
Device ID Numbers: 4D-1 to 4D-6

Purpose

To warn motorists of school zones, school crossings, and school bus routes and stops.

Comments

Devices 4D-1 and 4D-2 are the School Advance (S1-1) and the School Crossing (S2-1) signs with the appropriate text added to the bottom of the signs. These devices are used in place of the standard S1-1 and S2-1 signs. The same purpose could be achieved by using the standard signs with supplementary text plates.

Device 4D-5 is installed in areas where insufficient sight distance exists for motorists to see buses that have stopped to pick up or drop off children, or have slowed significantly to negotiate a turn.

Device 4D-6 is installed in advance of a signal used exclusively for access to and from a school. The reporting agency currently discourages the use of this sign, favoring the standard SIGNAL AHEAD sign (W3-3).

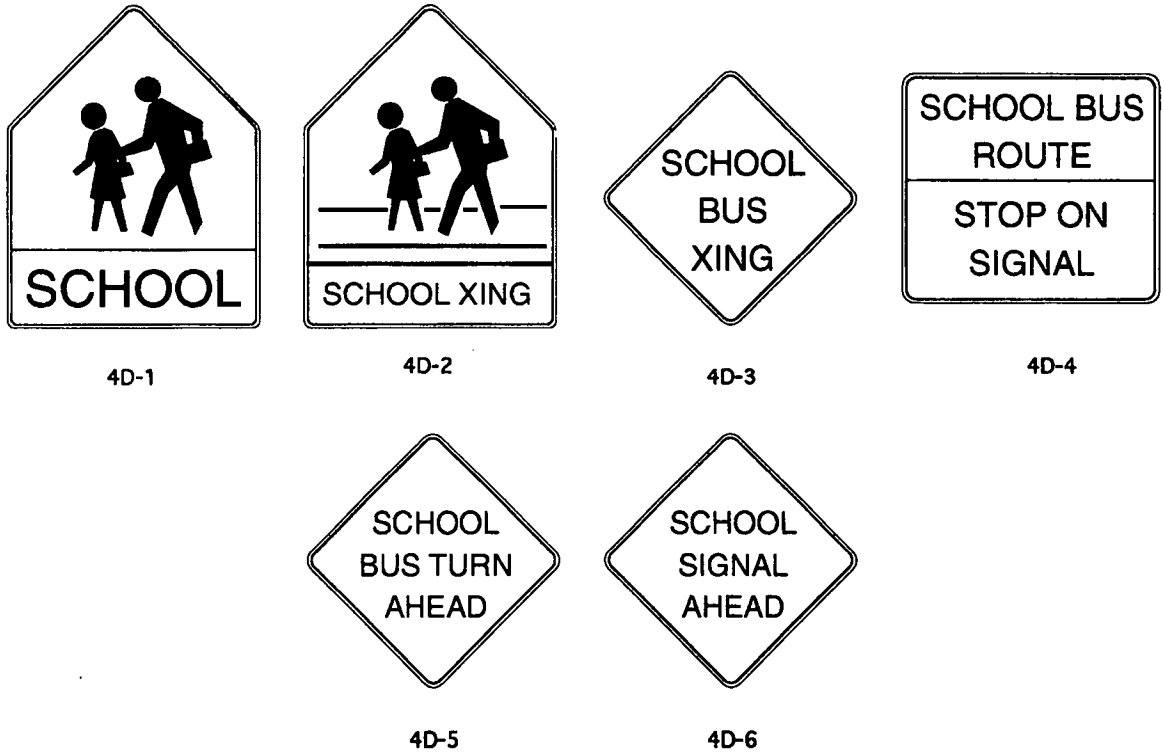


FIGURE 49 School zone, passive devices.

School Zones
Device ID Numbers: 4D-7A to 4D-12A

Purpose

To indicate the presence of students going to and from school, the presence of school buildings or grounds adjacent to the roadway and to indicate a reduced speed zone for a school area.

Comments

Device 4D-7A consists of regulatory signs of varying configurations with flashers and the text SCHOOL/SPEED LIMIT __ WHEN FLASHING. The main body of the devices are black and white, with the SCHOOL portion being black on yellow. The speed limit is changeable and the device is activated by a time clock. These devices are used by many agencies across the country.

Device 4D-8A consists of a standard CROSSROAD sign (W2-1) or SCHOOL CROSSING sign (S2-1) with a supplemental plate reading 40 M.P.H. WHEN FLASHING and flashers mounted above. The device is activated by a time clock and comes on before and after school hours. It is installed in fog prone areas on high-speed highways at intersections used by school buses. Previous countermeasures included standard CROSSROAD signs (W2-1) mounted alone. The effectiveness of this device is unknown, but the public is satisfied. The agency reported installation costs of $7,500, with an annual maintenance and operation cost of $550.

Device 4D-9A consists of a SCHOOL CROSSING sign (S2-1) supplemented with a flasher and a speed limit plate. The device is time-clock activated and operates only during school crossing hours. An effectiveness study determined that the device was ineffective. Drivers pay no attention to the flashers, but parents feel safer. The agency reported an installation cost of $5,000 and an annual maintenance and operation cost of $1,500.

Device 4D-10A consists of a sign with the text SCHOOL supplemented with flashing beacons. The device is time-clock activated, operating during school hours, and is suspended from a mast arm over the roadway. An effectiveness study concluded that motorists pay no attention to the flashers, but pedestrians and parents feel safer. The agency reported an installation cost of $5,000 and an annual maintenance and operation cost of $1,500.

Device 4D-11A consists of a sign with illuminated text SCHOOL CROSSING on a black background with supplemental flashers. The sign itself also flashes. The device is manually activated by a push button in the school. The yellow beacons flash for two hours and the SCHOOL CROSSING sign flashes for one minute when independently activated by pedestrians. It is installed on a wide, high-speed arterial at a school crossing and suspended from a mast arm over the roadway. The agency reported an installation cost of $30,000 and an annual maintenance and operation cost of $500.

Device 4D-12A consists of a sign with the text SCHOOL BUS STOP AHEAD WHEN FLASHING and two flashers operated by a time clock. It is installed in locations with restricted visibility.

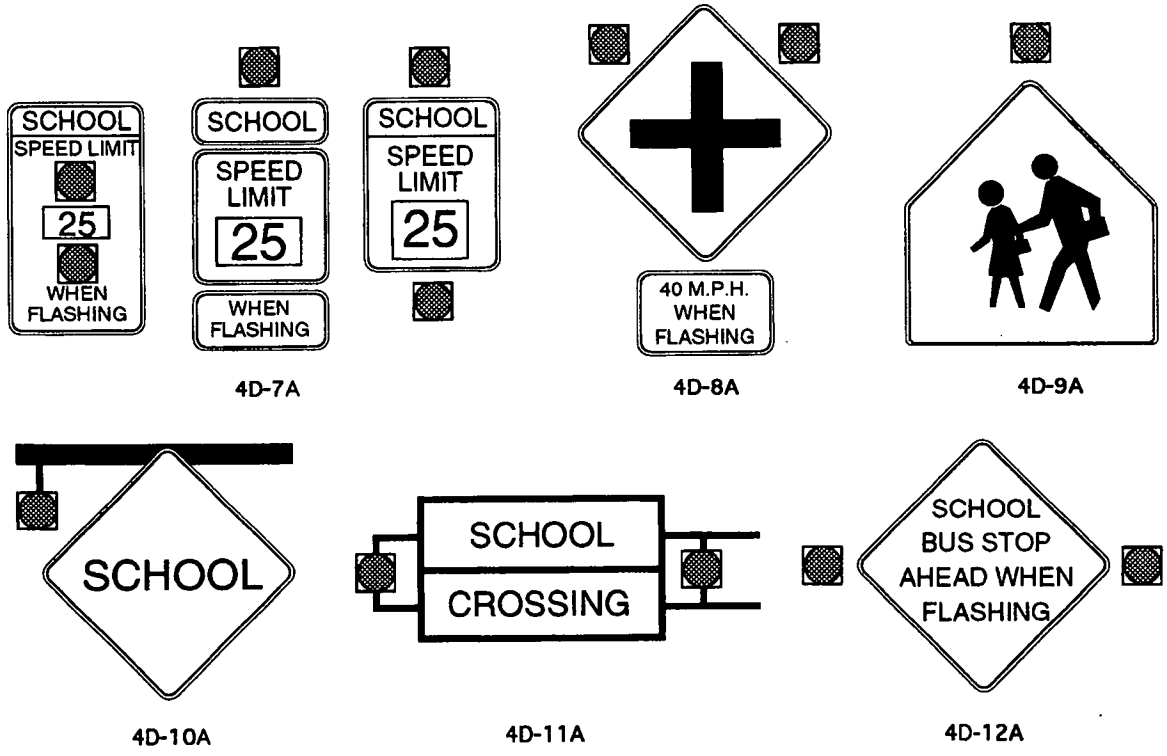


FIGURE 50 School zone, active devices.

SUBCATEGORY 4E: EMERGENCY VEHICLES

Emergency Vehicles
Device ID Numbers: 4E-1 to 4E-5

Purpose

To warn motorists that fire engines or other emergency response vehicles may be entering the roadway.

Comments

Devices 4E-1 to 4E-4 are installed in locations where emergency vehicles may experience difficulty entering the roadway due to high traffic volumes or limited sight distance.

Device 4E-5 is placed in advance of a traffic signal used at a fire station. The reporting agency stated that they now encourage use of the standard symbolic SIGNAL AHEAD sign (W3-3) instead of device 4E-5.

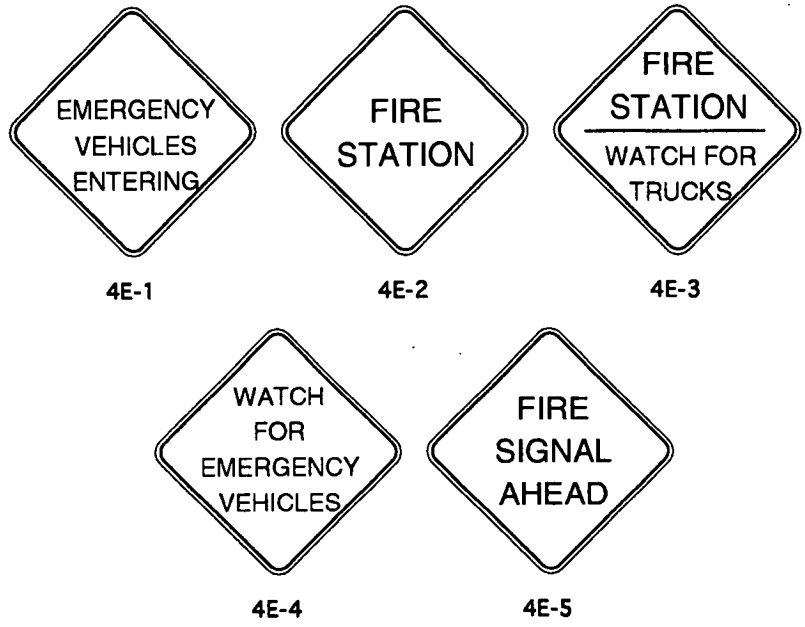


FIGURE 51 Emergency vehicles, passive devices.

Emergency Vehicles
Device ID Numbers: 4E-6A to 4E-10A

Purpose

To clear a path for emergency vehicles attempting to enter the roadway and to warn motorists of the hazard.

Comments

Device 4E-6A consists of a black-on-white sign with the text STOP ON RED supplemented by red and amber lights mounted on each side. The flashers are activated by fire department personnel. Once activated, the amber light flashes for four seconds, followed by four seconds of steady amber, and then 30 to 40 seconds of steady red. It is suspended over the roadway from span wire. This is a nonstandard device due to the arrangement of the red beacons. The reporting agency uses this device at three locations with an installation cost of $1,500 and an annual operation and maintenance cost of $120.

Device 4E-7A consists of a sign with the text EMERGENCY VEHICLE supplemented with a solar powered, radio-activated, flashing beacon assembly. The flashers are activated by fire department personnel and the device is roadside mounted on each approach to the fire station. Overhead span-wire mounted signals were tried as a prior countermeasure before this device was installed. Fire chiefs expressed satisfaction with the installation and the agency reports the installation cost is one-third that of conventional overhead traffic signals.

Device 4E-8A consists of two yellow flashing lights with an internally illuminated sign that displays the word FIRE on activation from the fire station. The reporting agency uses this device at 80 locations.

Device 4E-9A consists of a double-sided internally illuminated sign accompanied by two 8-in. yellow signal heads. The firehouse has a manual switch that is connected to the controller as a preemption circuit. When activated, nearby signals begin flashing or go to green to favor the emergency vehicle. This device is used extensively in the CBD where emergency vehicles are frequent and where fire houses are adjacent to major and minor thoroughfares. This device is considered effective in suburban areas, but not in the CBD area. The reporting agency uses this device at an installation cost of $1,000 and an annual operating and maintenance cost of $100.

Device 4E-10A consists of a sign with a fire engine symbol supplemented with amber flashing beacons that are activated by fire department personnel. An additional plate with the text FIRE STATION may also be used. The reporting agency uses this device at an installation cost of $3,000 and an annual operating and maintenance cost of $120. This device is designated as advance warning sign W11-8 in *Standard Highway Signs* (*8*).

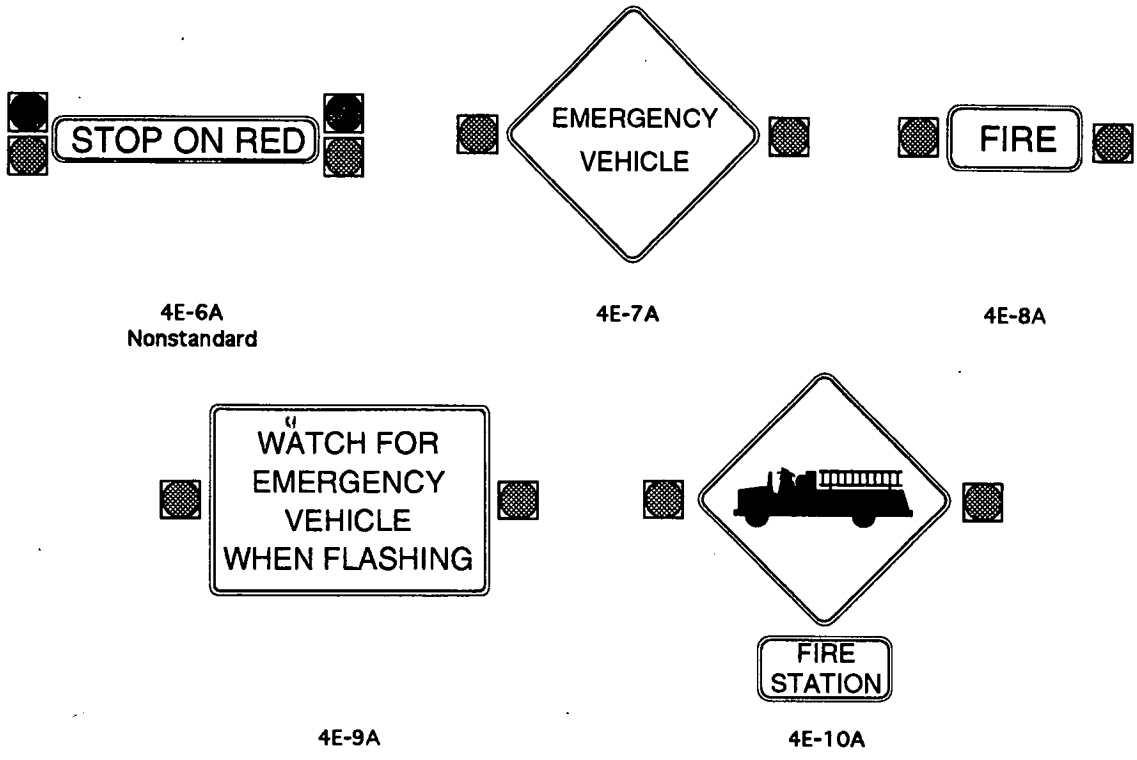


FIGURE 52 Emergency vehicles, active devices.

SUBCATEGORY 4F: OTHER ZONES

Slow-Moving Vehicles
Device ID Numbers: 4F-1 to 4F-4

Purpose

To warn motorists of the possible presence of slow-moving vehicles on the roadway.

Comments

Device 4F-4 is a black-on-white sign with the text CAUTION/ SENIOR CITIZENS ENTERING HIGHWAY. It is used in locations with a relatively large number of elderly motorists who may be driving slowly. All of these existing signs are the result of extremely old installations. This device is a nonstandard warning device due to the black and white color and an ambiguous message.

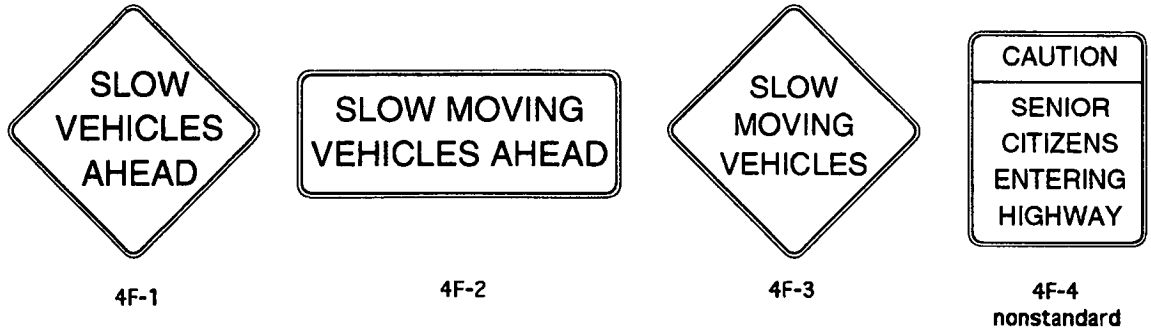


FIGURE 53 Slow-moving vehicles.

SUBCATEGORY 5A: APPROACHING TRAINS

Railroad Crossings
Device ID Numbers: 5A-1 to 5A-11

Purpose

Installed at or in advance of railroad crossings to warn motorists of stop control at the crossing, of rough or skewed crossing surfaces or of unusual crossing geometrics.

Comments

Device 5A-1 is installed in advance of a railroad crossing located at the bottom of a grade and around a curve. Railroad Advance Warning signs (W10-1) and pavement markings were tried as prior countermeasures before this device was installed.

Device 5A-2 is a symbolic sign depicting a flatbed truck crossing an elevated railroad section and scraping the pavement. It is installed in advance of crossings with a difference in elevation between the approach roadway and the railroad tracks to warn of the potential of getting hung-up at the crossing. It has been effective at two locations for two years, but is nonstandard due to the use of a symbol not contained in the MUTCD.

Device 5A-4 consists of a representation of a motorcycle rider at the top and a roadway that is crossed by a rail line at a 45° angle beneath. It is used in advance of a grade crossing that is skewed 30° or less from the roadway centerline. The device is mounted about midway between the crossing and a standard Railroad Advance Warning sign (W10-1). It is also nonstandard due to the symbol used.

Devices 5A-5 through 5A-8 depict various geometric configurations with railroad grade crossings. Device 5A-5 is installed where the crossing is at an angle of 30° or less from the centerline of the roadway. Device 5A-6 is installed where the railroad crossing obstructs the view of a T-intersection. Device 5A-7 is used at locations where the roadway narrows at a skewed railroad crossing. This device is nonstandard due to the combination of symbols.

Devices 5A-9 and 5A-10 consist of a sign warning of a rough crossing surface and are used in conjunction with an advisory speed plate (W13-1). They are used at railroad crossings that are so uneven or rough that a reduction in speed is required. Both devices are erected midway between the standard Railroad Advance Warning sign (W10-1) and the tracks.

Device 5A-11 is located where a railroad crosses a roadway that is on an upgrade. The tracks are superelevated in a direction opposite that of the roadway grade, resulting in an extremely rough crossing.

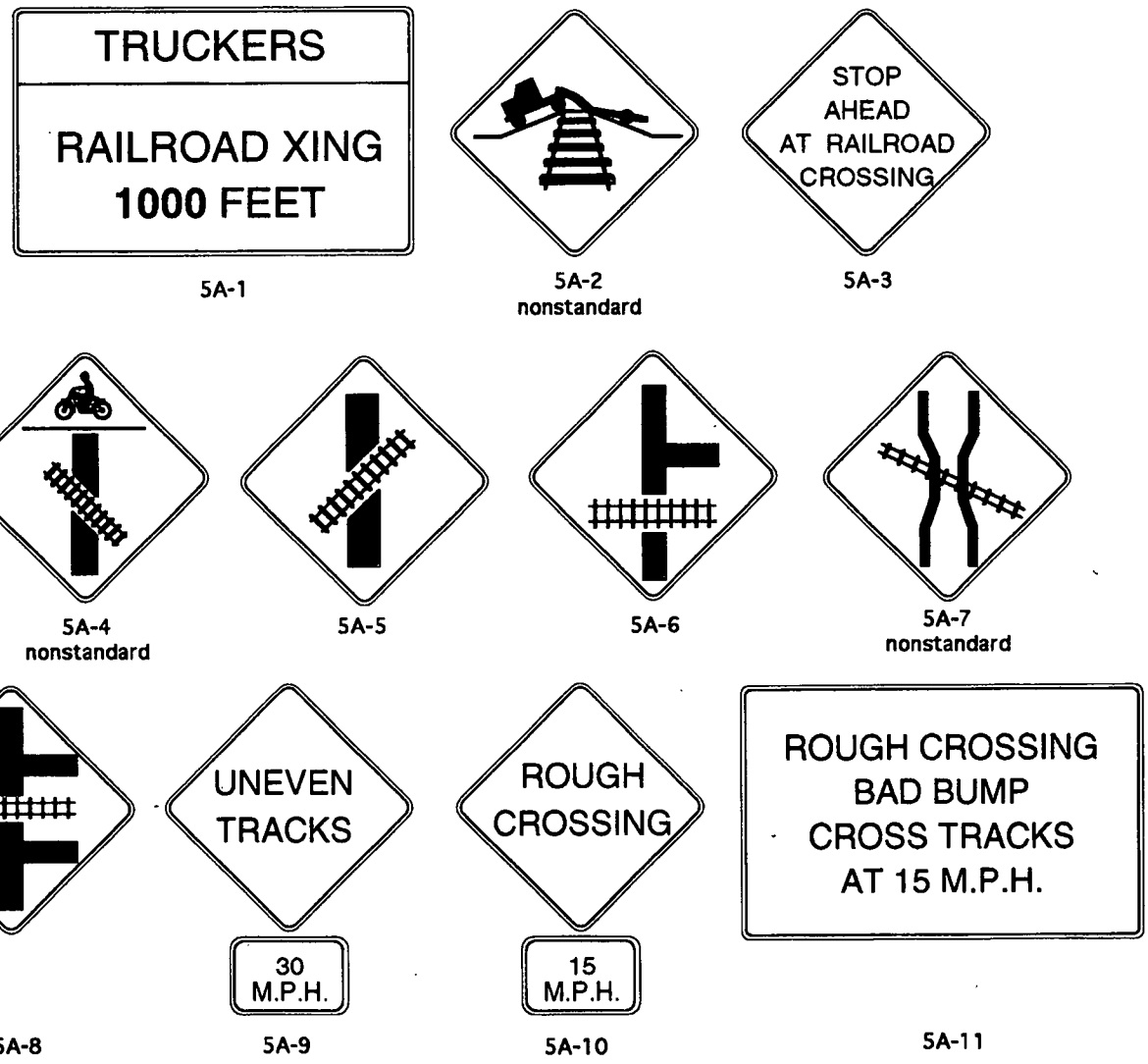


FIGURE 54 Railroad crossings.

Approaching Trains
Device ID Numbers: 5A-12A to 5A-15A

Purpose

To warn motorists of approaching trains at railroad grade crossings.

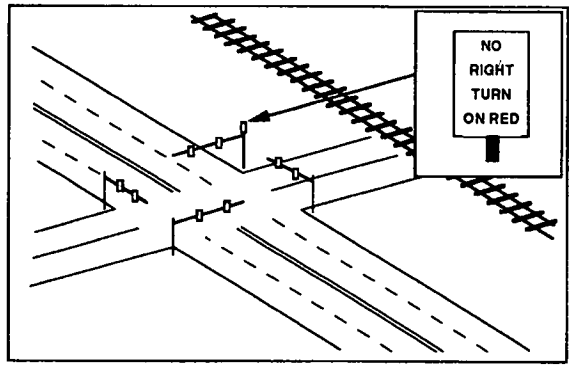
Comments

Device 5A-12A is a changeable message sign mounted on a signal mast arm where a railroad crossing is adjacent to an intersection at which a right turn on red is normally permitted. The changeable message sign prohibits this movement during train presence. This device is activated by a railroad track circuit when a train is approaching, and it displays the message NO RIGHT TURN ON RED until the train clears the crossing. It is operated in conjunction with an all-red phase at the intersection.

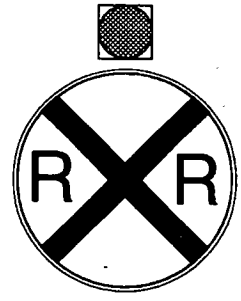
Device 5A-13A consists of a flashing yellow beacon installed above a standard Railroad Advance Warning sign (W10-1). The flashers are activated by a railroad track circuit approximately 30 seconds prior to when the train will cross the roadway. It is used at approaches to railroad crossings with insufficient sight distance. The agency reports that there have been no reported accidents since this device was installed. The reported installation cost of the device is $3,000, with an annual operation and maintenance cost of $400.

Device 5A-14A has train-activated illuminated flashers and the text TRAIN APPROACHING WHEN FLASHING. This device is activated by a train approach circuit. It is located on roadway approaches to at-grade crossings where insufficient sight distance to the crossing exists. The device is located at a distance equal to the safe stopping distance plus 50 ft from the tracks. The agency using this device reports an installation cost of $11,200.

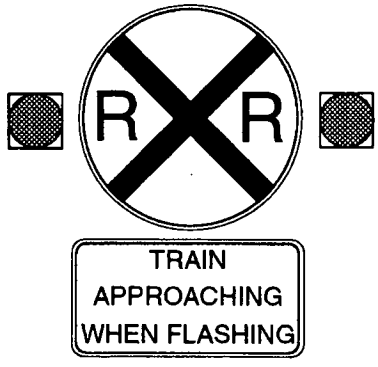
Device 5A-15A consists of a standard Railroad Advance Warning sign (W10-1) mounted in conjunction with a supplementary WATCH FOR TRAINS message plate and two alternately flashing amber beacons. The flashers are activated when a train passes over the train detection circuitry approximately 10 seconds prior to activation of the at-crossing warning system. It is used at locations where sight restrictions render it difficult for motorists to see approaching trains, as well as trains that are already crossing the roadway ahead. An effectiveness study was conducted and the results indicated that device 5A-15A is effective in reducing the mean speed of vehicles passing the railroad grade crossing (*20*).



5A-12A



5A-13A



5A-14A

5A-15A
[Source 19]

FIGURE 55 Approaching trains.

SUBCATEGORY 5B: LIGHT RAIL TRANSIT CROSSINGS

Light Rail Transit Crossings
Device ID Numbers: 5B-1 to 5B-3

Purpose

To warn motorists of light rail transit (LRT) grade crossings.

Comments

Device 5B-1 is a passive black-on-yellow sign with a graphic of a trolley. A supplemental plate with the text TROLLEY CROSSING may be mounted below. It is placed in advance of LRT crossings controlled by traffic signals or stop signs. Device 5B-3 is similar, but it features a symbol of a streetcar. These devices are nonstandard due to the symbols used.

Device 5B-2 consists of a supplemental plate with a front view of an LRT vehicle and a double-headed arrow. Between the word TRAINS and the double-headed arrow, the text LOOK BOTH WAYS is printed. This sign is placed below a standard Railroad Advance Warning sign (R10-1) or a STOP sign (R1-1). It is installed where there is insufficient sight distance for motorists emerging from alleys onto a roadway on which the trains run. The major street is one way, but the trains run both directions. This device is also nonstandard because the symbol used is not contained in the MUTCD.

SUBCATEGORY 6A: PAVEMENT CONDITIONS

Pavement Conditions
Device ID Numbers: 6A-1 to 6A-14

Purpose

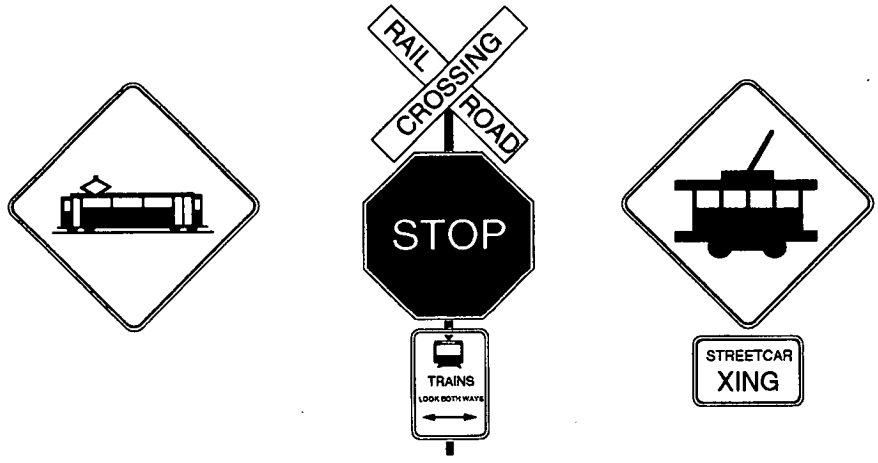
To warn motorists of unusual pavement conditions such as rough roadway surfaces, bridge deck surfaces, traffic islands, and grooved pavements.

Comments

Device 6A-1 consists of a sign with the text ROUGH ROAD and is often supplemented by an advisory speed plate. It is installed in advance of pavement irregularities that warrant a reduction in speed.

Device 6A-3 consists of the text message GRAVEL PAVEMENT AHEAD. It is installed in advance of locations where there is a change in the roadway surface. MUTCD devices W8-3a and W8-3 convey the same message. Devices identified with similar messages include ROAD DAMAGE, BROKEN PAVEMENT, SUNKEN GRADE, and SUBSTANDARD ROADWAY.

Device 6A-4 is installed in advance of structures with all-steel grid decks, which are treacherous for narrow-tired two-wheeled vehicles. This device is nonstandard due to the use of a symbol not contained in the MUTCD.



5B-1 nonstandard **5B-2 nonstandard** **5B-3 nonstandard**

FIGURE 56 Light rail transit crossings.

Device 6A-5 is a sign with the text GRATED BRIDGE DECK. The sign is often supplemented with a distance plate. It is installed in advance of grated bridge decks, which may cause vehicle control problems for motorcycles and small cars due to the low amount of traction afforded by this type of bridge deck. Devices identified with similar messages include STEEL GRID DECK ___ MILES, STEEL GRID DECK, and BRIDGE HAS STEEL GRID DECK.

Device 6A-6 is a sign with a thick arrow pointing down to the left or right at a 45° angle. It is installed to mark obstructions in the roadway where traffic is permitted to pass on one side only.

Device 6A-7 is installed on undivided highways where curbed islands begin dividing directions of traffic. This device is not as descriptive as device 6A-8, which is a sign with the text TRAFFIC ISLANDS AHEAD, or the text KEEP RIGHT OF ISLAND. Device 6A-8 is installed in advance of an island surrounding a bridge support that falls between the lanes of one direction of an undivided highway.

Device 6A-9 is a sign with the text DIPS. It is installed in advance of depressions in the roadway that are abrupt enough to cause shifting of cargo or deflection of a vehicle from its course at normal speeds. The MUTCD has a sign with the text DIP (W8-2), which is intended for the same purpose.

Device 6A-10 consists of a sign with a symbolic representation of rumble strips over the text UNDULATIONS AHEAD. The sign is supplemented with an advisory speed plate. It is installed in advance of road humps or before pedestrian crossings that have a surface elevated above that of the adjacent roadway pavement. This device is nonstandard due to the use of a symbol not contained in the MUTCD. Device 6A-11 provides a more readily understood message without the nonstandard symbol.

Devices 6A-13 and 6A-14 are installed in advance of roadway surfaces that have been grooved longitudinally to improve wet-weather traction. These longitudinal grooves have a tendency to steer motorcycles, resulting in lateral control problems. These problems are especially prevalent on longitudinally grooved horizontal curves.

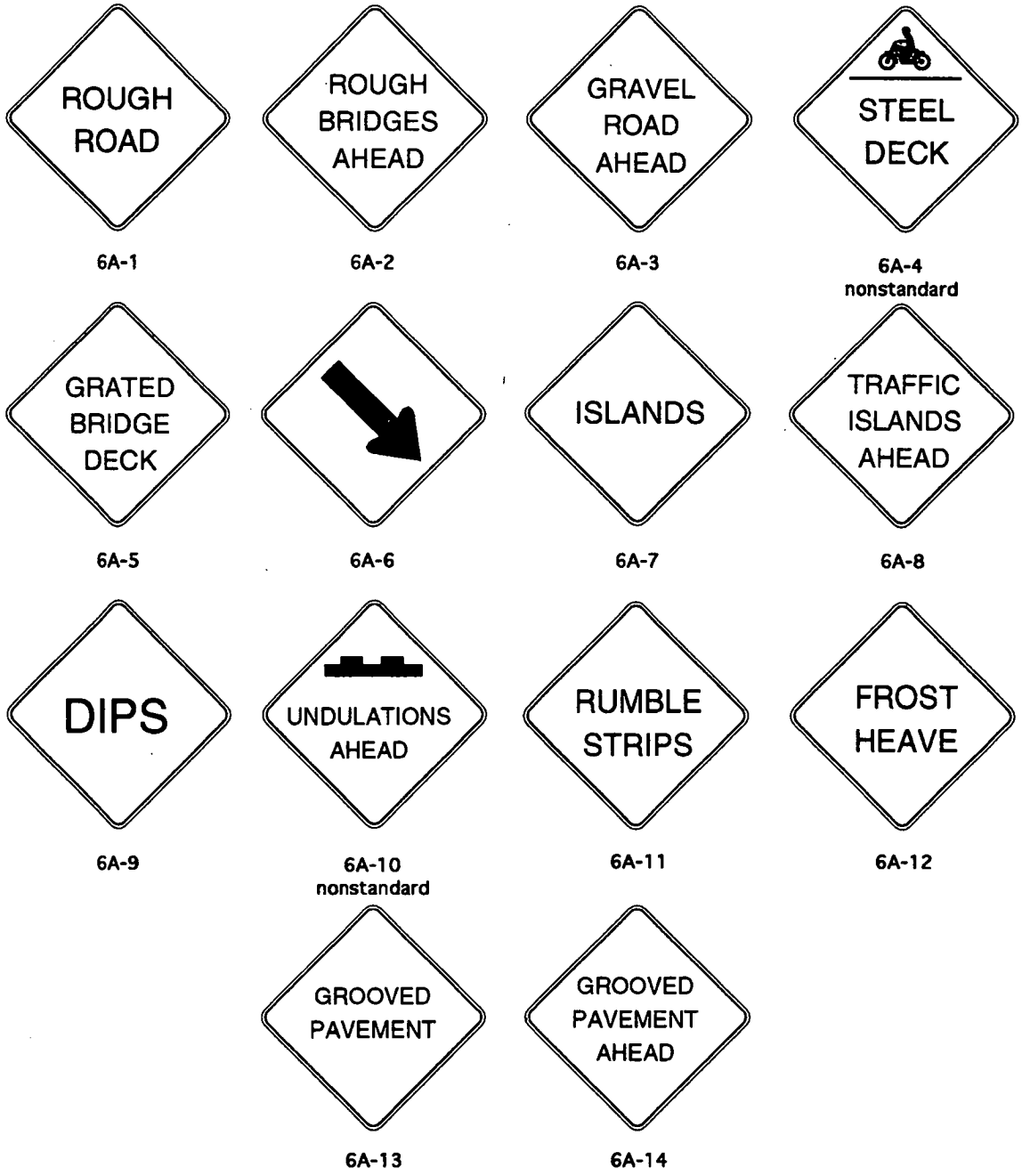


FIGURE 57 Pavement conditions.

SUBCATEGORY 6B: SHOULDER CONDITIONS

Shoulder Conditions
Device ID Numbers: 6B-1 to 6B-7

Purpose

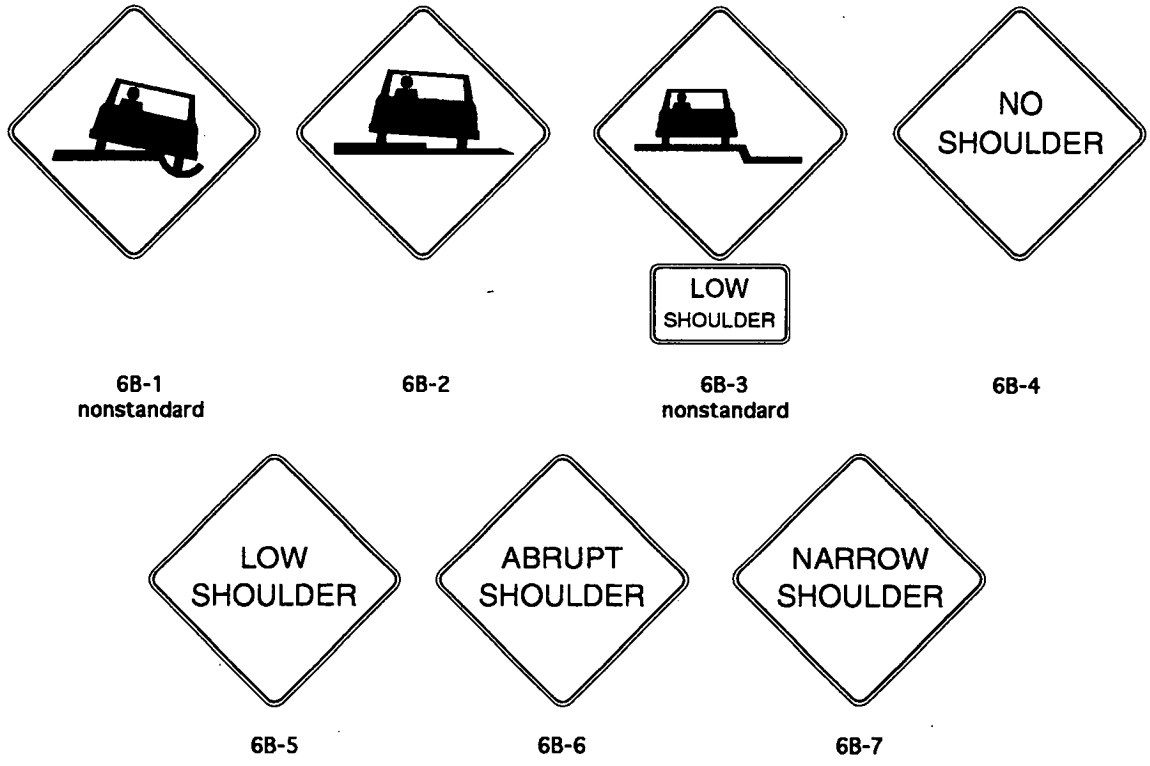
To warn motorists of deficient shoulder widths and shoulder dropoffs.

Comments

Devices 6B-1 through 6B-3 consist of a vehicle and a representation of a shoulder dropoff. The vehicle symbol is the same as that used by the MUTCD for the SLIPPERY WHEN WET symbol sign (W8-5), although it is rotated slightly on 6B-1 and 6B-2. Device 6B-3 is supplemented with a LOW SHOULDER plate. Devices 6B-1 and 6B-3 are nonstandard due to the use of road profile symbols that are not contained in the MUTCD. Device 6B-2 is designated as W8-9a in *Standard Highway Signs* (*8*).

Device 6B-6 is installed where there is a definite drop-off, such as on narrow roads, in construction zones, and in places where the guardrail is close to the roadway.

Device 6B-7 consists of the text NARROW SHOULDER. Devices identified with similar messages include SHARP DROP-OFF AT PAVEMENT EDGE and ABRUPT EDGE.



6B-1 nonstandard | 6B-2 | 6B-3 nonstandard | 6B-4

6B-5 | 6B-6 | 6B-7

FIGURE 58 Shoulder conditions.

SUBCATEGORY 6C: RUMBLE STRIPS

Rumble Strips
Device ID Number: 6C

Purpose

Rumble strips are used to provide physical sensation and noise so as to gain motorist attention to a stop condition ahead or the need to redirect the vehicle path.

Comments

Rumble strips are surface irregularities intentionally placed on the roadway or roadside surface to cause tactile sensation and noise. A wide diversity of rumble strip designs and methods of making the surface irregularities are being used by roadway agencies. These include asphalt overlay, textured asphalt rollers, layered thermoplastic strips, saw grooves, saw cuts, raised pavement markers, and mushroom buttons installed perpendicular to the vehicle path. Typical motorist warning applications for which rumble strips are being used include the following:

- On residential streets with a high volume of through traffic in an effort to reduce speeds and to encourage motorists to choose alternate routes. Previous countermeasures used by agencies include regulatory signs. One effectiveness study determined that such use of rumble strips was not effective because of a negative response to the noise generated by the strips, little or no reduction in vehicle speeds, and the subsequent execution of dangerous maneuvers by motorists to avoid the strips. The use of rumble strips on residential streets often results in complaints of noise from nearby residents.

- In advance of stop-controlled intersections to alert drivers of unusual stop conditions, recent changes to traffic control conditions, or roadway geometrics that restrict sight to the intersection.
- On the shoulders of expressways to alert straying motorists.
- In advance of an intersection where vehicles failed to stop due to excessive speeds on the approach.
- In advance of pedestrian crosswalks to increase driver awareness. This usage is especially prevalent near schools, senior citizen centers, and at crosswalks near vertical and horizontal curves. A study conducted by one state DOT indicates that rumble strip use in this manner was only partially effective in changing driver behavior at the crosswalks. In general, the motorists exhibited little change in speed or reactions.
- To alert motorists of stop control at an upcoming intersection in a rural area where such a maneuver is not frequent or may be unexpected. Larger standard signs were cited as one previous attempted countermeasure in such situations.
- In advance of toll booths on high-speed roadways.

Further information on the design and use of rumble strips can be obtained from *NCHRP Synthesis 191: Use of Rumble Strips to Enhance Safety*.

CATEGORY 7: CONGESTION AND STOPPED VEHICLES

Congestion and Stopped Vehicles
Device ID Numbers: 7-1 to 7-6

Purpose

To provide warnings of possible congestion and of vehicles that may be temporarily stopped on the roadway ahead.

Comments

Device 7-1 is installed in areas of restricted sight distance. This sign is also used when special events may cause unexpected backups.

Device 7-2 is a set of two signs dual-mounted on a divided multilane highway. One sign has the text MULTIPLE TRAFFIC SIGNALS AHEAD and is supplemented with flags. The other has the text CONGESTED AREA AHEAD and is supplemented by continuously operating flashers. Both signs have a supplemental

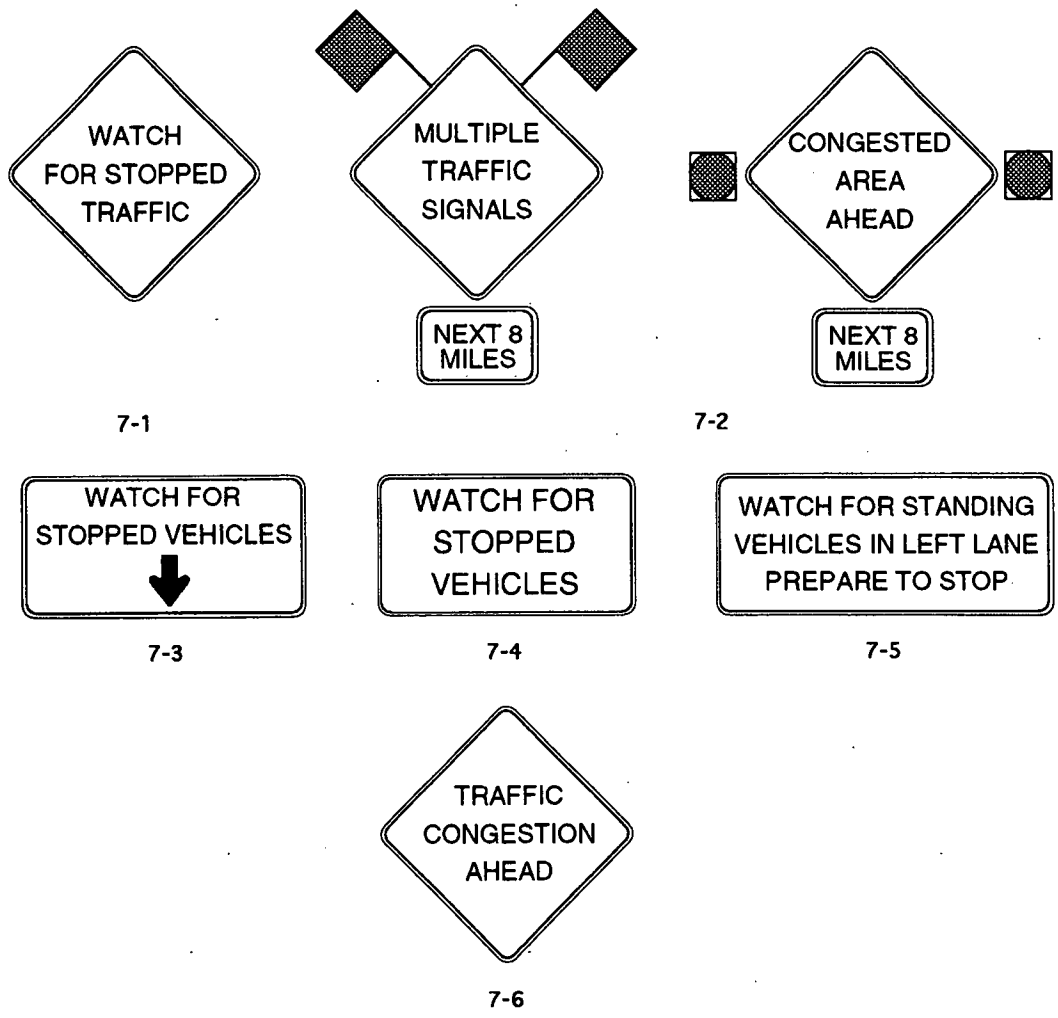


FIGURE 59 Congestion and stopped vehicles.

plate with a mileage distance mounted below. Reducing the speed limit by 5 mph was tried as a prior countermeasure before these signs were installed. The MULTIPLE TRAFFIC SIGNALS sign is mounted in the roadway median at the same location as the CONGESTED AREA AHEAD sign, which is roadside mounted. Device 7-2 has an estimated installation cost of $5,000 and an annual operating and maintenance cost of $300.

Device 7-3 is a sign with the text WATCH FOR STOPPED VEHICLES and an arrow pointing down to the roadway lane. The device is installed where there is a high potential for stopped vehicles. It is overhead mounted at a location ahead of the typical maximum queue.

Device 7-4 was installed on freeway connectors with horizontal and vertical curves in an effort to reduce rear-end accidents. Installation of CURVE warning signs (W1-2) with an advisory speed plate was a prior countermeasure.

Congestion and Stopped Vehicles
Device ID Numbers: 7-7A to 7-12A

Purpose

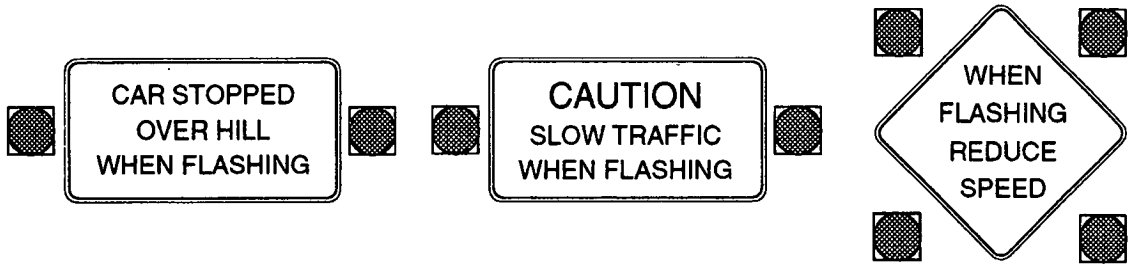
To provide warnings of possible congestion and of vehicles that may be temporarily stopped on the roadway ahead.

Comments

Device 7-7A consists of a sign with the text CAR STOPPED OVER HILL WHEN FLASHING, supplemented with two flashing beacons. The beacons are activated by lane presence loop detectors. The device is installed in a location of frequent congestion beyond a vertical curve and is mounted on a mast arm over the roadway.

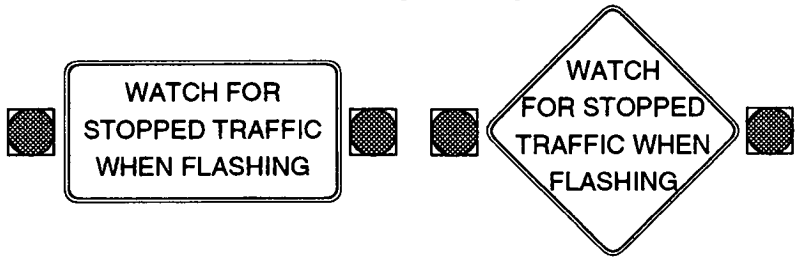
Device 7-8A consists of a sign with the text CAUTION/SLOW TRAFFIC WHEN FLASHING supplemented with flashing beacons. It is installed on the approach to a crest vertical curve with frequent traffic stoppages resulting from accidents, stalled vehicles, or congestion generated during peak period flows. It is roadside mounted at a height where it can be seen from a long distance and is activated by loop detectors. Before and after studies were conducted by the agency to measure speed changes, in addition to primary and secondary accidents (*21*). A questionnaire survey was also administered to obtain motorist reactions. The study results indicated that the warning system is cost effective. Both primary and secondary accidents were reduced and the system did not create any adverse traffic operational conditions. The survey indicated that motorists believed the system to be useful, with the sign being readily noticeable and the message generally understood.

Device 7-9A consists of a sign with the text WHEN FLASHING REDUCE SPEED supplemented with four bouncing flashers ar-

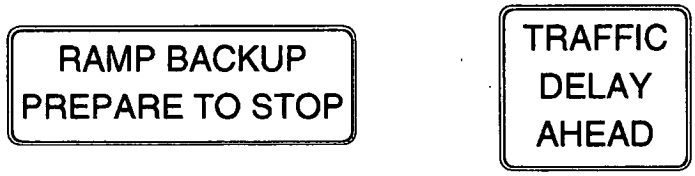


7-7A 7-8A 7-9A

[Source 20]



7-10A



7-11A 7-12A

FIGURE 60 Congestion and stopped vehicle warnings.

ranged in a square around the sign. It is activated by loop detectors designed to measure vehicle speed.

Device 7-10A consists of a sign with the text WATCH FOR STOPPED TRAFFIC WHEN FLASHING supplemented by flashing beacons mounted on either side. The beacons are activated by loop detectors that cover the area where a lead vehicle would be required to stop. When activated, the beacons operate for 10 seconds after the call drops. A similar device used by another agency has the same text displayed on a traditional diamond-shaped sign. This device is installed where traffic accumulates at the transition of a freeway to an arterial roadway. It is also used where there is restricted sight distance. An informal study was conducted and the results indicated a significant reduction in rear-end accidents. The agency uses this device at two locations, with an installation cost of $1,500.

Device 7-11A is a fiber optic sign with the text RAMP BACKUP/PREPARE TO STOP. Loop detectors, two on the ramp and two on the freeway, measure vehicle speeds and activate a timer when three vehicles are detected traveling under 20 mph during a 10 second interval. The sign is activated for a 90 second duration. The reporting agency considers this device to be effective and uses this sign at one location, with an estimated installation cost of $15,000 and an annual operating and maintenance cost of $2,300.

Device 7-12A is an electronic message sign displaying the illuminated message TRAFFIC DELAY AHEAD. Loop detectors measure vehicle speeds at a downstream point. When a predetermined low threshold of speed and time has been met, the sign is activated. When another higher detectable threshold of speed and time has been met, the message is removed. It is installed on a section of roadway with recurring traffic backups and is mounted overhead. The reporting agency uses this device at two locations with an estimated installation cost of $150,000 and an annual maintenance and operation cost of $1,400 per device.

CATEGORY 8 - MISCELLANEOUS HAZARDS

Miscellaneous
Device ID Numbers: 8-1 to 8-17

Purpose

To warn motorists of tunnels, roadway endings, speed changes, drawbridges, and other unusual roadway features and operational characteristics.

Comments

Devices 8-4 to 8-6 are examples of signs used to convey that a high-speed roadway is ending. The exact wording and location of the text has many variations among these devices, but the message conveyed is the same. Such signs are installed where a change from a freeway to a highway of lower design standards occurs.

Device 8-8 is installed where there is a high incidence of U-turn maneuvers in the roadway ahead.

Device 8-10 is a sign with the text SPEED LIMIT AHEAD/___ M.P.H. The MUTCD provides notice of reduced speed ahead by the R2-5a regulatory sign. Some agencies also use the SPEED LIMIT sign (R2-1) with the text AHEAD added beneath the numeric speed designation.

Devices 8-11 and 8-12 are installed at bridges that are frequently closed to highway traffic in order to permit the passage of boats. The reporting agencies also use flagmen at those bridges that are opened infrequently.

Device 8-13 consists of a sign with the text RESIDENTIAL STREET and a supplemental speed plate. It was installed in response to public complaints regarding excessive vehicle speeds in residential areas. Previous countermeasures included speed limit enforcement to a limited degree.

Device 8-14 consists of a standard Type 3 object marker supplemented by two flashing yellow beacons operating continuously. It is installed at locations where bridge supports divide two lanes of traffic moving in the same direction. The beacons increase the target value of the standard device.

Device 8-15 consists of a 36-in. diameter mirror installed at a low-volume driveway or alley intersection. It is used to rectify problems of poor visibility that may occur due to retaining walls, buildings erected close to the curb, landscaping, and non-aligned intersections. The agency responding to the survey uses the device to give motorists at least five seconds reaction time to compensate for insufficient sight distance due to a bridge abutment prior to the intersection. The device can be either roadside mounted or suspended over the roadway. The surveyed agency reports that the mirror is mounted from the railroad bridge approximately 10 ft above the pavement. This device has been widely used in Europe. At both reported locations where used in the United States, it is considered effective, with an estimated installation cost of $200. Metal and plastic mirrors may be used, but do not offer the visibility obtained from glass mirrors (22).

Device 8-16 consists of raised reflective pavement markers installed on a small concrete refuge island for delineation purposes. The raised reflective pavement markers (RPMs) are used to increase the visibility and recognition of traffic islands. Increasing the size of existing signing and additional hazard markers on the islands were tried as prior countermeasures before the RPMs were installed.

Device 8-17 consists of spring-loaded posts for object marker signs mounted at bridge abutments. These spring-loaded posts are used at narrow bridge locations. When wide trucks, farm equipment, and snow plows hit them, they bend out of the way, then back into place. The object marker is mounted immediately before the bridge abutment. The reporting agency uses this device at three locations, with an estimated installation cost of $124 and an annual maintenance cost of $10.

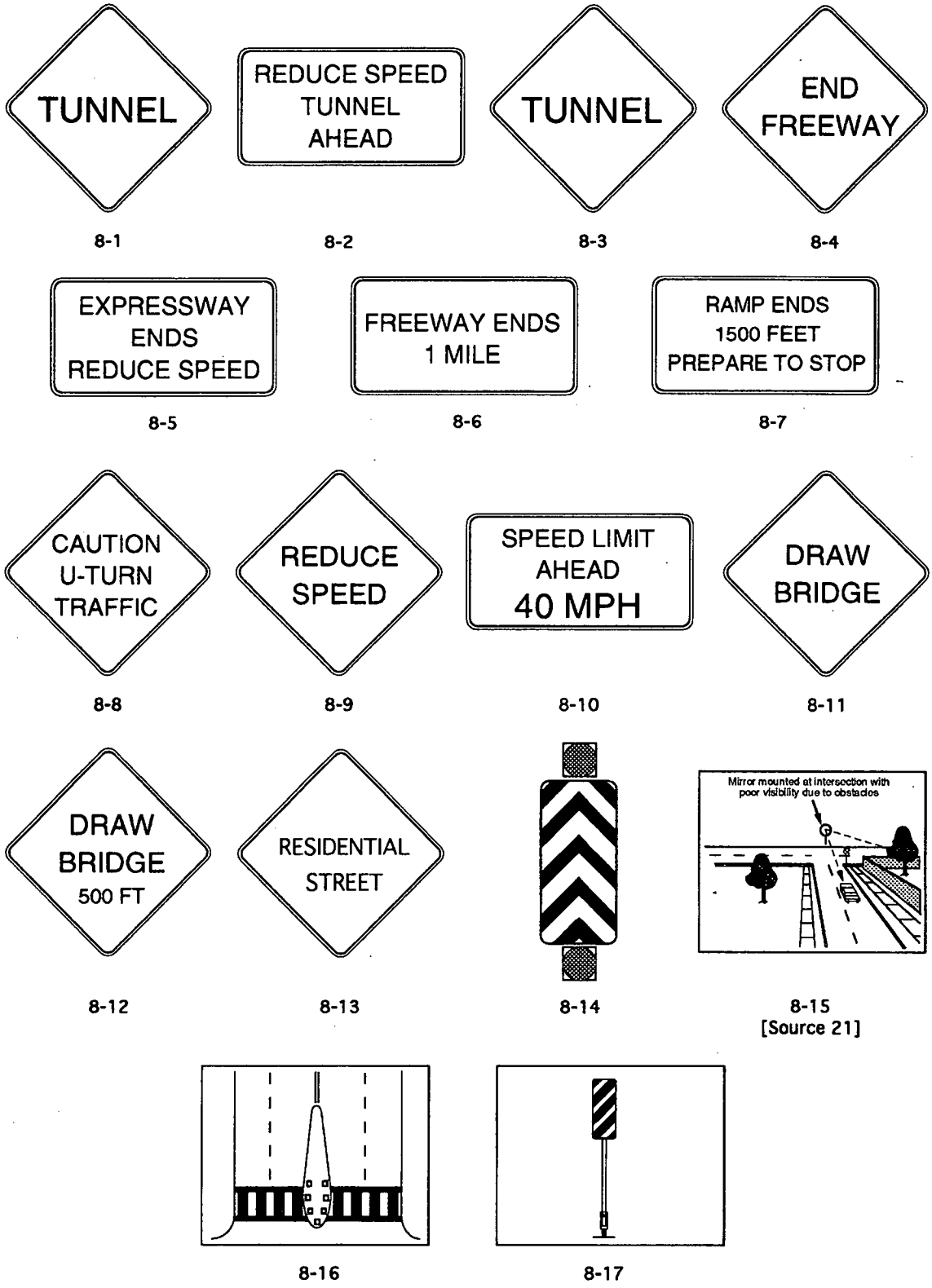


FIGURE 61 Miscellaneous passive devices.

Miscellaneous
Device ID Numbers: 8-18A to 8-22A

Purpose

To advise motorists of certain operational characteristics or to draw their attention to traffic control devices.

Comments

Device 8-18A consists of a sign with the text BUSWAY CLOSED supplemented with two flashing amber beacons mounted on top of the sign. The device is activated manually by traffic operations personnel when necessary. It is used to inform bus drivers that a lane or set of lanes reserved exclusively for their use is closed. Prior countermeasures included manual placement of barriers and traffic cones.

Device 8-19A consists of an internally illuminated sign with the text METER ON, supplemented by a flashing amber beacon mounted on top. The beacon is activated by a time clock when the meter is in operation. It is used to inform motorists that an upstream expressway ramp metering signal is in operation and to warn that a stop may be required before entering the roadway.

Device 8-20A consists of a standard WRONG WAY sign (W5-1a) supplemented by two flashing beacons mounted above. The beacons are activated by two loops that detect a vehicle traveling the wrong way on an expressway ramp. It is used to alert a motorist who is traveling in the wrong direction. Adding flashers increases the target value of the passive standard sign. Device 8-19A is reported to have an estimated installation cost of $1,500.

Device 8-21A is a traffic signal with strobe lights installed near the red and amber lenses. The strobes are activated during the yellow and red intervals and are used to attract driver attention to the changing signal indications. Typical installation locations for this device are at traffic signals located in the low point of a sag vertical curve and at isolated intersections. A standard SIGNAL AHEAD sign (W3-3) was tried as a prior countermeasure. Other agencies report using a strobe around only the red signal head at locations with a high accident rate, at high-speed intersections, and on approaches to the first traffic signal encountered when entering an urban area. According to one reporting agency, the strobe ring is used more for public appeasement than for its effectiveness. Agencies using the ring around only the red signal head consider it an effective device, with a reported installation cost of $500.

Device 8-22A is a halo strobe light that surrounds the red indication of a standard traffic signal face. The strobe emphasizes the red indication by increasing its conspicuity. This device is used on high-speed roadways at the first signalized intersection when entering an urbanized area and at locations where accident analysis indicates signal noncompliance.

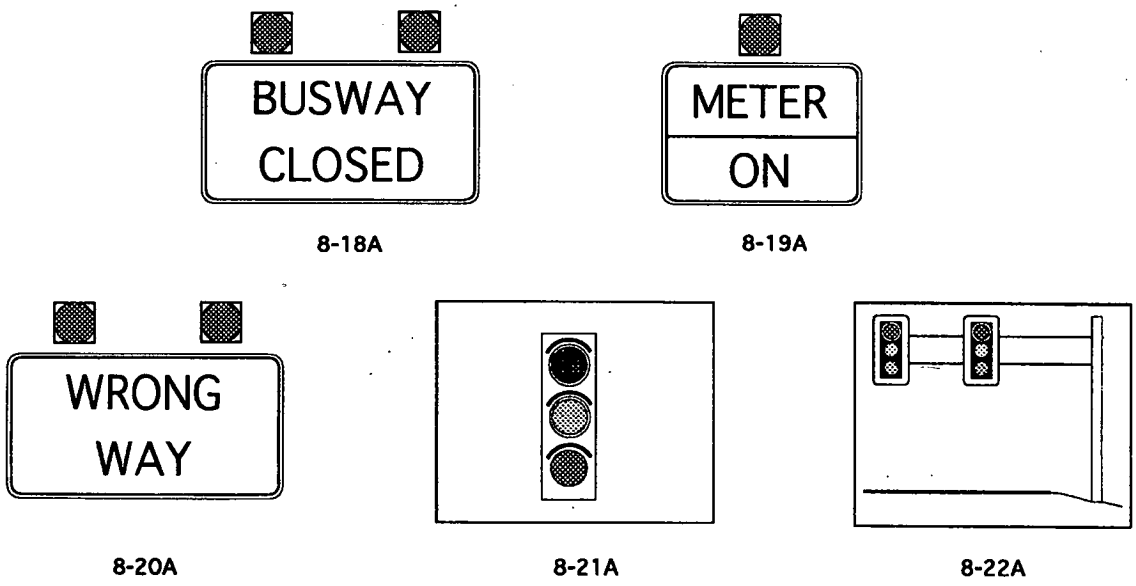


FIGURE 62 Miscellaneous active devices.

CHAPTER FOUR

SUMMARY OF SUPPLEMENTAL WARNING DEVICES

The sampling of supplemental warning devices described in this synthesis indicates the diversity of devices currently in use. While information was requested from each of the 50 states and a large number of local and county governments, not every agency responded. In addition, due to time constraints and personnel turnover, agencies that did respond forwarded information only on those devices with which the respondent had personal knowledge. Undoubtedly, readers of this synthesis can remember warning devices that they have experienced on the roadways that are not contained in the MUTCD or in this synthesis.

In Chapter Three, verbal and graphic descriptions of some 340 supplemental devices are provided. The information contained in that chapter is a result of the state-of-the-practice survey and a review of available literature. For several of the categories and subcategories used, additional devices were revealed during the research conducted for this synthesis that were not included because of insufficient background information. For example, a number of devices to warn of icy bridges were not included in Chapter Three. Redundant devices or devices with little available information are included in the summaries of this chapter rather than in Chapter Three.

On the following pages are tables that summarize the different purposes for which supplemental devices are developed and installed, the characteristics of each device contained in a subcategory, and the number and type of identified agencies that use each device. Accompanying each table is a discussion of conclusions resulting from synthesis activities. Those devices not included in Chapter Three are noted, along with the source.

CATEGORY 1 ENVIRONMENTAL CONDITIONS

This category is divided into five separate tables, rather than the four that might be expected from an examination of the list of subcategories presented in Table 2. This was necessary since subcategory 1A may be further divided into devices that are used to warn specifically of ice on a bridge deck and devices that warn of ice and snow on the roadway itself. The large number of icy bridge devices identified necessitated that this subcategory be separated and so it is presented as Tables 3 and 4.

Of the 31 state agencies responding to the questionnaire, six indicated that they used at least one device to warn of an icy bridge and six different messages were identified. The NCUTCD study, however, revealed that 11 additional states are currently using such devices, with the most common message being WATCH FOR ICE ON BRIDGE. Together, these 17 agencies use a total of 12 different messages, with four agencies using more than one device. Two devices, 1A-7A and 1A-8A, as well as 10 additional text messages being used around the nation, were identified from the literature (*10*). No information was available on which agencies are currently using these 12 devices. A total of 24 different text messages to warn of icy bridges were identified.

Table 4 presents a summary of the devices used to warn motorists of ice or snow on the roadway surface. Survey responses revealed only one state using 1A-10 WATCH FOR ICE, but three additional states were revealed by the literature as using this device (*10*). The same agency using 1A-10 also uses 1A-11. Devices 1A-12 and 1A-13 are both used by another state agency. In addition to these four messages, six other states are currently using one or more of six other text messages (*23*). Three more signs were identified from the literature, but no information was found on the characteristics of these devices (*10*). A total of 13 different text messages were identified to warn motorists of slippery roads due to ice or snow.

In addition to the devices presented above, three variations of the standard SLIPPERY WHEN WET sign (W8-5) were identified from the literature (1A,14A, and 16A) (*14*). All use flashers that are activated by moisture detection devices and two use supplemental plates to reinforce the need for motorists to reduce their speed.

Table 5 presents a summary of devices that are used to warn of the potential of water on the roadway. The questionnaire identified 10 messages used by six different states and the literature revealed 12 additional messages (*23*). A total of 22 text messages are used by 18 state agencies, 10 of which use more than one device for this purpose. Only one of the devices is active, consisting of a sign with the text ROAD FLOODED AHEAD and a beacon, which is activated by a moisture detector.

Table 6 is a summary of the devices used to warn motorists of limited visibility due to fog or smoke. Five different devices used by six agencies were identified; one agency uses more than one of the devices. The changeable message sign was identified from the literature, as well as the survey (*15*).

Table 7 summarizes subcategory 1D, which consists of devices to warn motorists of transient atmospheric and roadway hazards such as high winds and land slides. Ten different text messages are used by eight state agencies to warn of high winds. Seventeen agencies were identified as using one or more of ten text warning signs to advise motorists of sand or rock falling onto the roadway. Thirteen of these messages were identified by the states responding to the questionnaire.

CATEGORY 2 HEAVY VEHICLES

The devices summarized in Table 8 warn drivers of large vehicles of restricted vertical clearance. All but the last three in the table warn of permanent obstructions such as a bridge overpass and were identified by the survey. Fourteen devices used by nine states and one county were identified. Two states use more than one device to warn of permanent vertical clearance obstructions, with 2A-11, 2A-12, 2A-13A and 2A-14 being used in sequence by another state agency. The three signs used to warn of low-

TABLE 3
ICE ON BRIDGE (SUBCATEGORY 1A)

ID Number	Description	Type[1]	No. Agencies[2]
1A-1	Watch for Ice on Bridge	P,D	7S
1A-2	Caution/Bridge Freezes Before Pavement	P,D	1S
1A-3	Ice on Bridge	P,D[3]	2S
1A-4	Bridge Ices Before Road	P,D	1S
1A-5	Ice Forms on Bridge Before Pavement	P,D[3]	1S
1A-6	Bridge May Ice in Cold Weather	P,D	2S
1A-7A	Watch for Ice	A,D	n/a
1A-8A	Bridge Icy Ahead	A,D,S[4]	n/a
1A-9A	Ice on Bridge/When Flashing	P,D[7]	3S
	Bridge May Be Icy	P,D[9]	1S
	Bridge Freezes First	P or A[5,9]	1S
	Icy Bridge	P,D[9]	1S
	Watch for Frost on Bridge	P,D[9]	1S
	Bridge Freezes Before Road Surface	P,R[6,9]	1S
	Bridges Ice Before Highways	A,D[7,9]	n/a
	Bridge Icy When Flashing	P,D[9]	n/a
	Bridge Freezes Before Roadway	P,D[9]	n/a
	Bridge Freezes Before Pavement	P,D[9]	n/a
	Bridge freezes Before Road	P,D[9]	n/a
	Bridge May Be Slippery	P or A,D[9]	n/a
	Bridges May Be Icy	A,D[9]	n/a
	Icy Bridge Ahead	A,D[8,9]	n/a
	Icy Bridge Ahead - 55 M.P.H.	A,D[7,9]	n/a
	Reduce Speed/Ice on Bridge	P[3,9]	n/a
	Watch for Ice on Bridges	P[9]	

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device. S = state, C = county, L = local (city)
[3] Responding agency noted that the device can be folded to hide the message during warm weather.
[4] Icy activated by detector.
[5] Passive version is diamond-shaped. Active version is rectangular, with fluorescent flashing letters.
[6] Blue-on-white color scheme.
[7] Amber flashers activated by detector.
[8] Amber flashers activated manually.
[9] Additional devices with similar messages that were not assigned a device number.

flying aircraft are used near runways where planes taking off and landing may startle unsuspecting motorists (*23*).

Table 9 presents a summary of devices used to warn heavy-vehicle operators of severe curves and steep downgrades. Two of the devices were identified from the literature (*16,17*), and the remaining 16 devices were used by one city agency and three state agencies. All of the states use more than one device. Devices 2B-4 and 2B-5 are used in conjunction with each other by one agency.

The devices summarized in Table 10 represent a range of roadway and operational conditions concerned with large trucks and other similar vehicles. Devices 2C-7 through 2C-11 are targeted at other motorists operating near such vehicles, while the remaining

TABLE 4
ICE ON ROAD (SUBCATEGORY 1A)

ID Number	Description	Type[1]	No. Agencies[2]
1A-10	Watch for Ice	P,D[3]	4S
1A-11	Freezing Spraying Water	P,D	1S
1A-12	Watch for Snow/Slippery	P,D	1S
1A-13	Snow Slide Area	P,D	1S
	Icy Road	P or A[4,8]	1S
	Icy	P,D[8]	1S
	Icy Spots Ahead	P,D[8]	1S
	Ice	P or A[5,8]	2S
	Warning/Icy Spots Next __ Mile	P,R[8]	1S
	Ice at Intervals	P,D[8]	1S
	Safe Speed __ /Ice Ahead	A,D[6,8]	n/a
	Slippery When Frosty	P,D[8]	n/a
	Slippery When Wet or Frosty	P,D[8]	n/a
1A-14A	W8-5 with two flashers	A,D[7]	n/a
1A-15A	W8-5 with two flashers and plate Slow When Flashing	A,D[7]	n/a
1A-16A	W8-5 with two flashers and plate Max __ MPH	A,D[7]	n/a

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device. S = state, C = county, L = local (city)
[3] Responding agency noted that the device can be folded to hide the message during warm weather.
[4] Passive version is diamond-shaped. Active version is also diamond-shaped, but has neon letters and is supplemented with amber flashers which are activated manually or by an ice detector.
[5] Passive version is diamond-shaped. Active version is rectangular, with red neon letters on a black background. No information on activation was available.
[6] Overhead illuminated sign, activated either manually or by ice detector.
[7] Flashers activated by moisture detection devices.
[8] Additional devices with similar messages that were not assigned a device number.

nine devices are directed at heavy-vehicle operators. Five of these nine pertain to restricted lateral clearance and are used by two states, one county and one city. Devices 2C-3 and 2C-4 are used by the same state agency. One device warns of a bridge with reduced load capacity and the remaining three signs, which are used by three different states, use the same symbol in different configurations to warn truck drivers of the potential for rollovers on horizontal curves.

CATEGORY 3 GEOMETRICS

The devices in Table 11 warn motorists of unusual geometrics. Of the 39 devices in subcategory 3A, information on three was provided by one state agency, depicting variations of standard advance intersection warning signs. Such variations are permitted by the MUTCD and the devices contained in this synthesis probably represent only a small sample of those currently in use. Two of the devices, 3A-38 and 3A-39, are included in this subcategory since they feature text messages necessitated by unusual intersection geometrics.

Table 12 provides information on devices used to warn motorists of restrictive geometrics such as vertical and horizontal curves. Information on the first five was obtained from the literature, while the remaining six devices are used by four state agencies and two county agencies, with one state using more than one device. The use of device 3B-6 is probably more common than the results of the survey indicate, but the vagueness of the message and lack of motorist comprehension has resulted in many agencies discouraging its use.

The devices in Table 13 warn motorists of downstream traffic signals that have changed to a red indication or will have changed

TABLE 5
WATER ON ROAD (SUBCATEGORY 1B)

ID Number	Description	Type[1]	No. Agencies[2]
1B-1	Water Crossing	P,D	1S
1B-2	Water On Road	P,D	1S
1B-3	Water Over Road	P,D	3S
1B-4	Watch for Water on Road	P,D	2S
1B-5	High Water Area	P,D	1S
1B-6	High Water	P,D	5S
1B-7	Flash Flood Area	P,D	1S
1B-8	Flooded During Storm	P,D	1S
1B-9	Do Not Enter If Under Water	P,D	1S
1B-10A	Road Flooded Ahead	A,D[3]	1S
	Water Over Roadway	P,D[4]	2S
	Low Water Crossing	P,D[4]	2S
	Road Subject to Flooding/Next __ Miles	P,D[4]	1S
	Impassable During High Water	P,D[4]	1S
	Road Subject to Flooding	P,D[4]	1S
	Watch for High Water	P,D[4]	1S
	Caution/High Water Ahead	P,D[4]	1S
	Flooded	P,D[4]	1S
	Road Flooded	P,D[4]	1S
	Do Not Enter When Flooded	P,D[4]	1S
	Road May Be Flooded	P,D[4]	1S
	Flood Area	P,D[4]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device. S = state, C = county, L = local (city)
[3] Changeable message sign with roadside detector-activated beacon and message
[4] Additional devices with similar messages that were not assigned a device number

by the time the motorist reaches the intersection. Such warning is necessary when sight distance is restricted or when high speeds create a large dilemma zone. The survey identified 10 different text messages that are currently used by 10 states and five cities. A total of 18 different devices are listed because of the frequent use of the same text message in different configurations. By far, the most widely used message is PREPARE TO STOP WHEN FLASHING, which is used in six different configurations by five states and one city. Of the 15 agencies that use the devices contained in this subcategory, three states and one city use more than one device to warn of signal changes. Some 23 percent of the agencies responding to the questionnaire indicated that they use a device of this nature.

The devices in Table 14 are used to warn of merging conditions ahead. Six different text messages were identified to serve as replacements for the standard merge signs contained in the MUTCD. These devices are used by four state agencies and three cities, with devices 3D-2 and 3D-3 being used by the same agency.

Table 15 contains information on devices used to inform and instruct motorists of the proper movements at intersections that are offset or feature a traffic circle. In addition, since motorists in many areas are unfamiliar with traffic circles, one agency uses a warning sign to inform and warn of a circle at an intersection ahead.

The devices summarized in Table 16 warn motorists of traffic entering, leaving, or approaching the roadway at an intersection downstream. A total of 20 different devices were identified as being used by 13 states, four counties, and four cities. Devices 3F-16A and 3F-17A are used together by one county agency. Several variations of device 3F-6 are currently in use, probably more widely than the table indicates. Only two states indicated use of such a device in the survey, but six more were identified

TABLE 6
LIMITED VISIBILITY DUE TO FOG OR SMOKE (SUBCATEGORY 1C)

ID Number	Description	Type[1]	No. Agencies[2]
1C-1	Fog Area/Next __ Miles	P,D	3S
1C-2A	Fog Area	A,D[3]	3S
1C-3A	Fog	A,D[3]	1S
1C-4A	Smoke	A,D[3]	2S
1C-5A	Changeable message sign	A,R[4]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device. S = state, C = county, L = local (city)
[3] Flashers activated by fog/smoke detection device
[4] Changeable message sign activated manually.

by the literature (*21*). It is possible that such signs are so prevalent that many people do not realize that these devices are not detailed in the MUTCD.

Table 17 presents information on devices that warn of traffic control devices downstream, such as stop signs, yield signs, and signals. These 10 devices are used by three states, three counties, and one city, with one county using three of the devices.

Information on devices from two subcategories is presented in Table 18. Devices 3H-1 and 3H-2 are used to inform the motorist that the lane in which they are traveling does not merge or that no stop is necessary ahead. They are black-on-white and used by different city agencies. The remaining seven devices in subcategory 3H warn that opposing or crossing traffic at an intersection is not required to stop, as might be expected from the geometrics. Four states, three counties, and three cities indicated usage of such a device, which translates into 16 percent of those agencies responding to the questionnaire. Subcategory 3I consists of devices that indicate the names of crossroads and side roads at downstream intersections. Only two county agencies and one city agency reported the use of these information signs, which is probably not representative of the extent of such usage.

CATEGORY 4 ZONES

Table 19 summarizes information on devices that are being used by agencies to warn motorists of pedestrians. Many are modifications of standard signs and all are used to reinforce the hazard potential to the motorists. The devices in subcategory 4A are currently in use by five states and five cities, representing 16 percent of the agencies responding to the survey. Two of the states and three of the cities use more than one of these devices. The devices in subcategory 4B warn of handicapped pedestrians and are used by three state agencies and two cities, or 8 percent of the survey respondents.

Ten agencies responding to the survey included information on devices that warn of miscellaneous crossings, such as all-terrain vehicles, horses, bicycles, golfers, and animals. These responses represent 16 percent of the agencies participating in the survey. Two of the agencies use more than one of the devices presented in Table 20. In addition to those identified from the questionnaire, three additional states using the symbolic sign with a horse-drawn carriage, as well as one state using a text version of the same sign, were identified from the literature.

Seven different agencies, or 11 percent of those responding to the survey, were identified as using one or more of 12 different devices to warn of school areas or the maneuvers of school buses. Information on these devices is summarized in Table 21, along with information on devices warning of emergency vehicles and slow-moving vehicles. Eleven agencies, or 17 percent of those responding to the survey, use one or more of 10 identified devices to warn of fire engines or other emergency vehicles entering the roadway. Two agencies have developed signs to warn of slow-moving vehicles. Devices 4F-1, 4F-2, and 4F-3 are all used by the same agency, while device 4F-4 is an extremely old installation.

CATEGORY 5 RAIL/HIGHWAY CROSSINGS

Table 22 contains information on devices that warn of approaching trains and light rail transit crossings. Of the agencies responding to the survey, 12 indicated that they used supplemental devices for this purpose, representing 19 percent of all the responses. A total of 18 different devices were identified for this purpose.

CATEGORY 6 ROADWAY CROSS SECTION

Table 23 presents information on devices that deal with the pavement surface or shoulder conditions. The pavement surface devices cover a variety of potential hazards, such as potholes, steel bridge decks, islands, rumble strips, and grooves. Only nine of the agencies responding to the survey indicated the use of one or more devices for this purpose, but an additional eight agencies were identifed from the literature (*23*). Likewise, the survey results did

TABLE 7
OTHER TRANSIENT ATMOSPHERIC AND ROADWAY COND. (SUBCATEGORY 1D)

ID Number	Description	Type[1]	No. Agencies[2]
1D-1	Trailers-Campers/Gusty Wind Area Next __ Miles	P,R	1S
1D-2	Strong Wind Possible	P,D	1S
1D-3	Strong Cross Wind	P,D	1S
1D-4	Heavy Cross Wind Possible	P,D	1S
	Severe Side Wind Ahead	P,D[3]	1S
	Dangerous Cross Winds/Next __ Miles	P,D[3]	1S
	Caution/Wind Currents	P,D[3]	1S
	Strong Wind Area	P,D[3]	1S
	Wind Area	P,D[3]	1S
	Watch for Cross Wind	P,D[3]	1S
1D-5	Drifting Sand	P,D	1S
1D-6	Blowing Dust	P,D	1S
1D-7	Watch for Fallen Rocks	P,D	2S
1D-8	Rock Slides	P,D	3S
1D-9	Falling Rock	P,D	8S
1D-10	Land Slides	P,D	1S
	Earth Slides	P,D[3]	1S
	Watch for Fallen Rock	P,D[3]	1S
	Watch for Rock	P,D[3]	2S
	Rock	P,D[3]	3S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device. S = state, C = county, L = local (city)
[3] Additional devices with similar messages that were not assigned a device number.

not adequately reveal the usage extent of devices to warn of depressed or nonexistent shoulders. Only six agencies were identified from the survey, but an additional four were noted in the literature (*23*).

CATEGORY 7 CONGESTION/QUEUES

Seven agencies, or 11 percent of those responding to the survey, indicated the use of one or more devices to warn of stopped vehicles or congestion downstream. A total of 13 different text messages were identified. Information on these devices is summarized in Table 24.

CATEGORY 8 MISCELLANEOUS HAZARDS

Seventeen agencies, or 27 percent of the responding agencies, included information on a variety of devices that could not be placed into any of the primary categories. Devices included in Category 8 deal with tunnels, the end of expressways, speed limits, and the use of special innovative devices. Information obtained regarding these devices is summarized in Table 25.

TABLE 8
VERTICAL CLEARANCE (SUBCATEGORY 2A)

ID Number	Description	Type[1]	No. Agencies[2]
2A-1	Vertical Clearance __ Ft __ In	P,R	2S
2A-2	Side and center clearance signs	P,R	1S
2A-3	Low Clearance	P,R,S[3]	1S
2A-4	Low Clearance/ __ Miles Ahead with alternate route listed	P,R	1S
2A-5	__'__ Will Not Clear	P,D	1C
2A-6A	Aluminum pipes suspended below sign reading Trucks That Hit This Will Hit Bridge	A,R	1S
2A-7A	Vehicle Too High/Stop	A,R[4]	1S
2A-8A	Vehicle Overheight When Flashing	A,D[5]	1S
2A-9A	Overheight/Stop	A,D[6]	1S
2A-10A	Stop with arrow to turnaround	A,R[5]	1S
2A-11A	High Load Sensor/ __ Miles Ahead	P,D,S	1S
2A-12	High Load Sensor All Lanes	P,R	1S
2A-13A	When Flashing/High Load Exit	A,R[5]	1S
2A-14	High Load/Do Not Proceed	P,R	1S
2A-15	Low Flying Aircraft	P,R	3S
2A-16	Low Flying Planes	P,R	1S
2A-17	Aircraft	P,R	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Supplemental plate used when clearance is less than 14 ft 6 in.
[4] Neon lettering on black background. Activated by height detector beam.
[5] Flashers activated by height detector beam.
[6] Illuminated with flashing arrows. Activated by height detector beam.

TABLE 9
DOWNGRADES (SUBCATEGORY 2B)

ID Number	Description	Type[1]	No. Agencies[2]
2B-1	All Buses Keep in Lowest Gear	P,R	1L
2B-2	Stay in Low Gear	P,D	1L
2B-3	Pump Brakes/Steady Braking Causes Fade	P,R	1L
2B-4	Brake Check Area/ __ Mile	P,R[3]	1S
2B-5	Trucks/ __ Mile of __% Downgrade Ahead/Check Your Brakes	P,R[3]	1S
2B-6	Steep Grade __ Miles Ahead/Conserve Brakes	P,R	1S
2B-7	Trucks/Steep Grade/Use Lower Gear	P,R[4]	1S
2B-8	Trucks/ __% Grade Next __ Miles	P,R	1S
2B-9	Steep Grade __ Miles Ahead/ Trucks Must Use Right Lane Only	P,R	1S
2B-10	Steep Hill Next __ Miles/Use Low Gear	P,R	1S
2B-11	Steep Grades __ Miles Ahead	P,R[4]	n/a
2B-12	Jct __ / __ Miles/Stop Required	P,R	1S
2B-13	Trucks/Check Brakes Before Using Exit __	P,R	1S
2B-14	Crooked and Steep Next __ Miles/Trucks __ M.P.H.	P,R	1S
2B-15	Trucks/ __ M.P.H. Curves __ Miles Ahead	P,R	1S
2B-16	Combination of Hill graphic and Winding Road graphic with text Next __ Miles and two flashers	P,R[4]	1S
2B-17	Detailed roadway geometric information	P,R	1S
2B-18	Weight specific speeds	P,R	n/a

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] 2B-4 and 2B-5 are mounted together.
[4] Flashers operate continuously.

TABLE 10
OTHER HEAVY VEHICLE WARNINGS (SUBCATEGORY 2C)

ID Number	Description	Type[1]	No. Agencies[2]
2C-1	Narrow Subway	P,D	1S
2C-2	Wide Vehicles/Narrow Bridge Ahead/Cross With Caution	P,R	1L
2C-3	Narrow Structures Ahead	P,D	1S
2C-4	Narrow Underpass	P,D	1S
2C-5	Width with two horizontal arrows	P,D	1C
2C-6	__ Ton Restricted Bridge Ahead	P,D	1S
2C-7	Trucks Turning with supplemental plate Watch for Long Logs	P,D,S	1S
2C-8	Graphic of large truck	P,D[3]	1S
2C-9	Trucks Entering Highway	P,D[3]	1S
2C-10	Truck Crossing with flasher	P,D	1S,1L
2C-11	Trucks Crossing to Scales	P,D	1S
2C-12	Graphic of truck tipping onto NJ barrier	P,D	1S
2C-13	Graphic of truck tipping	P,D	1S
2C-14	Graphic of truck tipping with arrow	P,R	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Widely used across the country, but only mentioned by one respondent.

TABLE 11
UNUSUAL GEOMETRICS (SUBCATEGORY 3A)

ID Number	Description	Type[1]	No. Agencies[2]
3A-1	Severe curve sign with four bouncing flashers on black background	P,R[3]	1S
3A-2	Severe curve sign with four bouncing flashers on yellow background	P,R[3]	1S
3A-3 to 6	Severe curve signs	P,D[4]	1S,1L
3A-7 to 8	Severe curve signs with speeds	P,R[4]	1S
3A-9 to 17	Unusual intersection geometrics with main road continuing straight	P,D[4]	3S, 1C, 1L
3A-18 to 37	Unusual intersection geometrics in vicinity of main road curve	P,D[4]	3S, 1C, 1L
3A-38	Signal for Left Turn	P,D	1S
3A-39	Turn Signal	P,D	1L

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Bouncing flashers operate continuously.
[4] Devices of this nature are much more widely used across the country than the survey indicates.

TABLE 12
RESTRICTIVE GEOMETRICS (SUBCATEGORY 3B)

ID Number	Description	Type[1]	No. Agencies[2]
3B-1	Caution/Hill Blocks View	P,D	n/a
3B-2	Slow/Hill Blocks View	P,D	n/a
3B-3	Graphic of car ascending hill with line of sight restricted	P,D	n/a
3B-4	Graphic of car ascending hill with line of sight to obstacle restricted	P,D	n/a
3B-5	Graphic of two cars approaching each other from opposite sides of hill	P,D	n/a
3B-6	Limited Sight Distance	P,D	2S
3B-7	Over Hill	P,R,S[3]	1S
3B-8	Large arrow sign with object marker signs to either side	P,R	1S
3B-9	Flashers within chevron	P,R[4]	1C
3B-10A	Bridge railing mounted beacons that flash in sequence	A[5]	1S
3B-11A	Curve sign with flashers and plate __ M.P.H.	A,D[5]	1C

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Supplemental plate mounted below intersection or curve advance warning sign.
[4] Flashers operate continuously.
[5] Flashers activated by loop detectors when a speeding vehicle is detected.

TABLE 13
SIGNAL CHANGES (SUBCATEGORY 3C)

ID Number	Description	Type[1]	No. Agencies[2]
3C-1A	Stop Ahead	A,R[3]	1S
3C-2A	Red Signal Ahead	A,R[3]	1S
3C-3A	Prepare to Stop When Flashing	A,R[4]	1S
3C-4A	Prepare to Stop When Flashing	A,R[4]	1L
3C-5A	Prepare to Stop When Flashing	A,R[4]	1L
3C-6A	Signal Ahead sign supplemented with flashers	A,D[4]	1S,1L
3C-7A	Prepare to Stop When Flashing mounted on black background	A,R[4]	1S
3C-8A	Prepare to Stop When Flashing	A,D[4]	1S
3C-9A	Prepare to Stop When Flashing	A,R[4]	1S,1L
3C-10A	Be Prepared to Stop with plate When Flashing	A,D,S[4]	1S
3C-11A	Be Prepared to Stop When Flashing	A,D[4]	1L
3C-12A	Stop Ahead When Flashing	A,R[4]	1S
3C-13A	Signal Ahead/Prepare to Stop When Flashing	A,R[4]	1S
3C-14A	Red Signal Ahead When Flashing	A,R[4]	1S
3C-15A	When Flashing Stop Ahead	A,D[4]	1S
3C-16A	Prepare to Stop	A,R[5]	1S
3C-17A	Prepare to Stop mounted next to Signal Ahead sign	A,R[6]	1L
3C-18A	Modified Signal Ahead sign mounted next to sign with text When flashing and both with internal flashers	A,D[4]	1L

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Fiber optic sign which is activated by tie-in to signal controller.
[4] Black-on-yellow sign with flashers which are activated by tie-in to signal controller.
[5] Internally illuminated sign which is activated by tie-in to signal controller.
[6] Internally illuminated sign supplemented with flashers. All activated by tie-in to signal controller.

TABLE 14
MERGING (SUBCATEGORY 3D)

ID Number	Description	Type[1]	No. Agencies[2]
3D-1	Thru Traffic Merge Right	P,D[3]	1S,2L
3D-2	Merging Traffic Ahead	P,D	1S
3D-3	Left (Right) Lane Ends, Merge Right (Left)	P,R	1S
3D-4	Give Gap/Take Gap	P,R,S[4]	1S
3D-5	This Lane Merges with arrow	P,D	1L
3D-6	Merging Traffic with flashers	P,R[5]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] This device is much more widely used than the survey results indicate.
[4] Supplemental plaque mounted below standard Merge sign.
[5] Flashers operate continuously.

TABLE 15
MOVEMENTS (SUBCATEGORY 3E)

ID Number	Description	Type[1]	No. Agencies[2]
3E-1	Graphic of movements at offset intersection	P,R	1L
3E-2	Graphic of movements around a four-approach intersection with traffic circle	P,R[3]	2L
3E-3	Graphic of movements around a three-approach intersection with traffic circle	P,R[3]	2L
3E-4	Traffic Circle	P,D	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Black on white.

TABLE 16
SIDEROAD AND CROSSROAD TRAFFIC (SUBCATEGORY 3F)

ID Number	Description	Type[1]	No. Agencies[2]
3F-1	Watch for Side Road Traffic	P,D	1C
3F-2	Turning Traffic Ahead	P,D	1S,1C
3F-3	Watch for Turning Vehicles	P,D	2S
3F-4	Caution/Traffic Entering	P,D	1L
3F-5	Cross Traffic Ahead	P,D	1S
3F-6	Plant Entrance	P,D[3]	8S
3F-7	Hidden Driveways Ahead with arrow	P,D	1L
3F-8	Military Entrance	P,D	1S
3F-9	Caution/Cars with Boats Entering Highways __ Feet	P,R	1S
3F-10A	Traffic Entering Intersection When Flashing	A,D[4]	1L
3F-11A	Traffic Approaching Intersection When Flashing	A,D[4]	1L
3F-12A	Flashing beacons mounted over main road to warn of vehicles on minor road	A[5]	1L
3F-13A	Traffic Coming From Left (Right) When Flashing and supplemental plate If Lights Out/No Power/Signal Not Working	A,R[6]	1L
3F-14A	Traffic Coming From Left (Right) When Flashing	A,R[7]	1L
3F-15A	Vehicles Entering When Flashing	A,R[8]	1S
3F-16A	Look Left Last with flasher	A,R[9]	1C
3F-17A	When Flashing/ __ Road Vehicle	A,D[10]	1C
3F-18A	Car Coming Over Hill When Flashing	A,R[11]	1L
3F-19A	Vehicles Approaching From Right (Left) When Flashing	A,D[4]	1C

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Variations included Factory Entrance, Industrial Area and others.
[4] Black-on-yellow signs with flashers activated by loop detectors.
[5] Amber beacons activated by vehicle presence on side road.
[6] Black-on-white sign with amber beacons activated by vehicles on main roadway. Supplemental plate is yellow-on-black and has two continuously lit white lights to inform motorists whether the device is working.
[7] Black-on-white sign with flashers activated by detectors. Span-wire mounted.
[8] Black-on-yellow sign with flashers activated by detectors. Span-wire mounted.
[9] Used on minor roadway on conjunction with 3A-17A mounted on main roadway. Flasher activated by detector on main roadway.
[10] Used on main roadway in conjunction with 3A-16A mounted on minor roadway. Flasher activated by detector on minor roadway.
[11] Span-wire mounted at crest of hill. Double-sided with flashers activated by detectors.

TABLE 17
STOP SIGN AND SIGNAL WARNING (SUBCATEGORY 3G)

ID Number	Description	Type[1]	No. Agencies[2]
3G-1	Yield Ahead sign on black background with flashers	P,R[3]	1L
3G-2	Illuminated overhead mounted Stop sign	P,R[3]	1C
3G-3	Illuminated Signal Ahead with flasher	P,R[3]	1S
3G-4	Signal Ahead/Prepare to Stop	P,R	1S
3G-5	Stop Ahead with curved arrow	P,R	1S
3G-6	Be Prepared to Stop/New Stop Sign (Signal) with flags	P,D,S	1C
3G-7	Signal Operation Changed	P,D or R[4]	1S
3G-8	Be Prepared to Stop/New Stop Sign (Signal) Ahead with flags or flashers	P,D,S[3]	1C
3G-9	New Signal/ __ Feet	P,R	1C
3G-10	Traffic Change	P,D	1C

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Continuous operation.
[4] Rectangular used on low-speed roadways. Diamond used in advance of rectangular sign on high-speed roadways.

TABLE 18
INTERSECTION APPROACH FLOW & MOTORIST INFORMATION (SUBCATEGORIES 3H AND 3I)

ID Number	Description	Type[1]	No. Agencies[2]
3H-1	This Lane/No Stop Required with green arrow to left	P,R[3]	1L
3H-2	Continuous Lane with arrow	P,R[3]	1L
3H-3	Watch for Cross Traffic	P,R	1L
3H-4	Two horizontal opposing arrows	P,D	1L
3H-5	Cross Traffic Does Not Stop	P,R,S[4]	1S,1C
3H-6	Cross Traffic Does Not Stop with double-ended arrow	P,R,S[4]	1S,1C
3H-7	Caution/Cross Traffic Does Not Stop	P,R,S[4]	2S
3H-8	Traffic From Right (Left) Not Required to Stop	P,R,S[5]	1L
3H-9	Warning/Traffic From Left (Right) Does Not Stop	P,R,S[4]	1C
3I-1	Black-on-yellow name blades	P,R,S[6]	2C
3I-2	Street name next to signal logo	P,R	1L

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Black on white.
[4] Supplemental plate mounted below stop sign at an intersection.
[5] Black-on-white supplemental plate mounted below stop sign at an intersection.
[6] Black-on-yellow name blade mounted above or below intersection, Stop Ahead or Signal Ahead signs.

TABLE 19
PEDESTRIAN CROSSINGS AND HANDICAPPED AREAS (SUBCATEGORIES 4A AND 4B)

ID Number	Description	Type[1]	No. Agencies[2]
4A-1	Pedestrian Crossing sign with cane	P,D	1L
4A-2	Pedestrian Crossing sign with advisory speed plate 5 mph below posted limit	P,D,S	1L
4A-3	Stop for Pedestrians	P,R	1L
4A-4	Watch for Pedestrians	P,D	1L
4A-5	Pedestrians/Use Caution	P,R	1L
4A-6	State Law/Yield to Pedestrians in Crosswalk	P,R	1S
4A-7	Yield to Pedestrians	P,R	1L
4A-8	Pedestrians Using Roadway	P,D	1S
4A-9	Pedestrians in Roadway	P,D	1S
4A-10	Safety Zone	P,D	1S
4A-11	University Campus Ahead	P,D	1S
4A-12	Hospital	P,D	1S
4A-13	Church	P,D	1S
4A-14	Children at Play with graphic of young child	P,D[3]	1L
4A-15	Pedestrian signal explanatory signs	P,R	n/a
4A-16A	Yield to Pedestrians supplemented with flashers	A,R[4]	1L
4A-17/18A	Pedestrian Crossing signs with flashers	A,D[4]	1L
4B-1	Pedestrian Crossing sign with white cane and text plate Blind and Deaf Area	P,D,S	1L
4B-2	Handicapped symbol	P,D	1S,1L
4B-3	White cane on black inverted triangle with text plate Blind Area	P,D	1L
4B-4	Deaf Children Near	P,D	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Number of variations used by communities is large, but use is discouraged.
[4] Flashers activated by pedestrian push button.

TABLE 20
MISCELLANEOUS CROSSINGS (SUBCATEGORY 4C)

ID Number	Description	Type[1]	No. Agencies[2]
4C-1	Watch for Bikes	P,D	1S
4C-2	ATV Crossing	P,D	1S
4C-3	Graphic of horse-drawn carriage	P,D	4S
4C-4	Duck Crossing Ahead with ducks graphic	P,D	1L
4C-5	Golf Cart Area	P,D	1L
4C-6	Graphic of pedestrian pulling golf cart	P,D	1C
4C-7	Golf Cart Crossing	P,D	1S
4C-8	Slippery with horseback rider graphic	P,D	1L
4C-9	Horse Crossing Not Paved	P,D	1S
4C-10	Graphic of horseback rider	P,D	2S
4C-11	Graphic of farmer on tractor pulling trailer	P,D	1S
4C-12	Cattle Guard	P,D	1S
4C-13	Grazing Area with supplemental text plate Liability for Damage Limited by Law	P,D,S	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)

TABLE 21
SCHOOLS, EMERGENCY VEHICLES, OTHER (SUBCATEGORIES 4D, 4E AND 4F)

ID Number	Description	Type[1]	No. Agencies[2]
4D-1	School sign with School	P[3]	1S
4D-2	School Crossing sign with School Xing	P[3]	1S
4D-3	School Bus Xing	P,D	1S
4D-4	School Bus Route/Stop On Signal	P,R	1S
4D-5	School Bus Turn Ahead	P,D	1S
4D-6	School Signal Ahead	P,D	1S
4D-7A	Variable speed School Speed Limit signs	A,R[4]	2S
4D-8A	Intersection warning sign with flashers and text plate __ M.P.H. When Flashing	P,R,S[5]	1S
4D-9A	School sign (S1-1) with flasher	A[6]	1L
4D-10A	School with flasher	A,D[7]	1L
4D-11A	School Crossing with flashers	A,R[8]	1L
4D-12A	School Bus Stop Ahead When Flashing	A,D[5]	1S
4E-1	Emergency Vehicles Entering	P,D	1S
4E-2	Fire Station	P,D	1S
4E-3	Fire Station/Watch for Trucks	P,D	1S
4E-4	Watch for Emergency Vehicles	P,D	1L
4E-5	Fire Signal Ahead	P,D	1S
4E-6A	Stop on Red with amber and red flashers	A,R[9]	1C
4E-7A	Emergency Vehicle with flashers	A,D[10]	1S
4E-8A	Fire with flashers	A,R[9]	1S
4E-9A	Watch for Emergency Vehicles When Flashing	A,R[9]	1L
4E-10A	Graphic of fire engine with flashers and text plate Fire Station	A,D[10]	4S
4F-1	Slow Vehicles Ahead	P,D	1S
4F-2	Slow Moving Vehicles Ahead	P,R	1S
4F-3	Slow Moving Vehicles	P,D	1S
4F-4	Caution/Senior Citizens Entering Highway	P,R[11]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Pentagonal signs.
[4] Black-on-white signs with illuminated speeds activated by a time clock.
[5] Flashers activated by time clock.
[6] Pentagonal standard sign with flashers activated by time clock.
[7] Overhead mounted with flashers activated by time clock.
[8] Illuminated sign with flashers. All activated by push button in school or by pedestrian push button.
[9] Overhead illuminated sign with flashers activated by emergency department personnel.
[10] Black-on-yellow signs with flashers activated by emergency department personnel.
[11] Black-on-white color scheme.

TABLE 22
APPROACHING TRAINS AND LIGHT RAIL TRANSIT CROSSINGS
(SUBCATEGORIES 5A AND 5B)

ID Number	Description	Type[1]	No. Agencies[2]
5A-1	Truckers/Railroad Xing __ Feet	P,R	1S
5A-2	Graphic of flatbed getting hung-up at railroad crossing	P,D	1S,1L
5A-3	Stop Ahead at Railroad Crossing	P,D	1S
5A-4	Graphic of motorcyclist above skewed railroad crossing	P,D	1S
5A-5	Graphic of skewed railroad crossing	P,D	2S
5A-6	Graphic of railroad crossing before an intersection	P,D	1S
5A-7	Graphic of narrow roadway over railroad	P,D	1L
5A-8	Graphic of railroad crossing between two intersections	P,D	1S
5A-9	Uneven Tracks with speed plate	P,D,S	2S
5A-10	Rough Crossing with speed plate	P,D,S	1S
5A-11	Rough Crossing/Bad Bump/Cross Tracks at __ M.P.H.	P,R	1L
5A-12A	Changeable message No Right Turn on Red sign	A,R[3]	1S
5A-13A	Railroad Crossing sign (W10-1) with flasher	A[4]	1S,1L
5A-14A	Railroad Crossing sign (W10-1) with flashers and text plate Train Approaching When Flashing	A,S[4]	1S
5A-15A	Railroad Crossing sign (W10-1) with flashers and text plate Watch for Trains	A,S[4]	n/a
5B-1	Graphic of trolley	P,D	1S
5B-2	Graphic of front view of LRT vehicle with Trains/Look Both Ways and double-ended arrow	P,R,S[5]	1L
5B-3	Graphic of streetcar with text plate Streetcar Xing	P,D,S	1L

[1] P = passive, A = active, C = circular, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Text illuminated when train passes a track detection circuit.
[4] Circular with flashers activated by train detector.
[5] Supplemental plate mounted below Railroad Advance Warning sign or Stop sign.

TABLE 23
PAVEMENT AND SHOULDER CONDITIONS (SUBCATEGORIES 6A AND 6B)

ID Number	Description	Type[1]	No. Agencies[2]
6A-1	Rough Road	P,D	3S
6A-2	Rough Bridges Ahead	P,D	1S
6A-3	Gravel Road Ahead	P,D	1S
	Road Damage	P,D[3]	1S
	Broken Pavement	P,D[3]	1S
	Sunken Grade	P,D[3]	1S
	Substandard Roadway	P,D[3]	1S
6A-4	Graphic of motorcycle rider with text Steel Deck	P,D	1S
6A-5	Grated Bridge Deck	P,D	2S
	Steel Grid Deck/ __ Miles	P,D[3]	1S
	Steel Grid Deck	P,D[3]	1S
	Bridge Has Steel Grid Deck	P,D[3]	1S
6A-6	Arrow pointing down to road surface	P,D	1S
6A-7	Islands	P,D	2S
6A-8	Traffic Islands Ahead	P,D	3S,1L
	Keep Right of Island	P,D[3]	1S
6A-9	Dips	P,D	1S
6A-10	Undulation ahead with graphic	P,D	1L
6A-11	Rumble Strips	P,D	1S
6A-12	Frost Heave	P,D	1S
	Frost Heaves	P,D[3]	1S
6A-13	Grooved Pavement	P,D	7S
6A-14	Grooved Pavement Ahead	P,D	3S
6B-1	Graphic of car with right wheels in ditch	P,D	1L
6B-2	Graphic of car with right wheels on depressed shoulder	P,D	2S
6B-3	Graphic of car on roadway with depressed shoulder to right with text plate Low Shoulder	P,D	1S
6B-4	No Shoulder	P,D	1L
6B-5	Low Shoulder	P,D	1S
6B-6	Abrupt Shoulder	P,D	1S
6B-7	Narrow Shoulder	P,D	1S
	Sharp Drop-Off at Pavement Edge	P,D[3]	1S
	Abrupt Edge	P,D[3]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Additional devices with similar messages that were not assigned a device number.

TABLE 24
CONGESTION AND STOPPED VEHICLES (CATEGORY 7)

ID Number	Description	Type[1]	No. Agencies[2]
7-1	Watch for Stopped Traffic	P,D	1S
7-2	Multiple Traffic Signals with supplemental distance plate and flags mounted in conjunction with sign with Congested Area Ahead with supplemental distance plate and flashers	P,D,S	1S
7-3	Watch for Stopped Vehicles and arrow	P,R	1S
7-4	Watch for Stopped Vehicles	P,R	1S
7-5	Watch for Standing Vehicles in Left Lane/Prepare to Stop	P,R	1L
7-6	Traffic Congestion Ahead	P,D	1S
7-7A	Car Stopped Over Hill When Flashing	A,R[3]	1L
7-8A	Caution/Slow Traffic When Flashing	A,R[3]	1S
7-9A	When Flashing/Reduce Speed	A,D[4]	1S
7-10A	Watch for Stopped Traffic When Flashing	A,D or R[3]	1S
7-11A	Ramp Backup/Prepare to Stop	A,R[5]	1S
7-12A	Traffic Delay Ahead	A,R[6]	1S

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Flashers activated by detectors.
[4] No information on activation was provided.
[5] Fiber optic sign activated by detectors.
[6] Internally illuminated sign activated by detectors.

TABLE 25
MISCELLANEOUS HAZARDS (CATEGORY 8)

ID Number	Description	Type[1]	No. Agencies[2]
8-1	Tunnel	P,D	1S
8-2	Reduce Speed/Tunnel Ahead	P,R	1S
8-3	Tunnel Ahead	P,D	1S
8-4	End Freeway	P,D	2S
8-5	Expressway Ends/Reduce Speed	P,R	1S
8-6	Freeway Ends/__ Miles	P,R	1S
8-7	Ramp Ends/__Feet/ Prepare to Stop	P,R	1S
8-8	Caution/U-Turn Traffic	P,D	1L
8-9	Reduce Speed	P,D	1S
8-10	Speed Limit Ahead __ M.P.H.	P,R	1S
8-11	Draw Bridge	P,D	1S
8-12	Draw Bridge __ Feet	P,D	1S
8-13	Residential Street	P,D	1L
8-14	Flashers supplementing object marker	P[3]	1L
8-15	Mirror used in areas of limited sight distance	P	2L
8-16	RPM's on refuge island to increase visibility	P	1L
8-17	Spring mounted target signs	P	1S
8-18A	Busway Closed with flashers	A,R[4]	1S
8-19A	Meter On with flasher	A,R[5]	1S
8-20A	Wrong Way with flashers	A,R[6]	1S
8-21A	Strobe ring in red and amber lenses of traffic signal	A	n/a
8-22A	Strobe ring on red lens on traffic signal	A[7]	1S,1L

[1] P = passive, A = active, D = diamond-shaped, R = rectangular, S = supplemental plate, n/a = not applicable
[2] Number of agencies identified as using a particular device, S = state, C = county, L = local (city)
[3] Flashers operate continuously.
[4] Flashers activated manually.
[5] Internally illuminated with flasher. Device activated by time clock.
[6] Flashers activated by detectors.
[7] Flashes during red indication.

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APPENDIX A
SUPPLEMENTAL ADVANCE WARNING SIGNS SURVEY QUESTIONNAIRE
NCHRP Project 20-5, Topic 21-09

Respondent: Name _____

Agency _____

Telephone _____

1. Brief description of device:

2. A photograph or sketch of the figure is:

   _____ Attached

   _____ Not available

3. Why is the device needed? (For example: Insufficient sight distance due to overpass at vertical curve blocking vision of traffic signal)

4. Sketch of typical device placement and site characteristics.

5. What countermeasures (if any) were tried before the installation of the supplemental device?

6. If the device is an active device (e.g. flashing lights, changeable message sign, etc.)

   (a) How is it activated?

   _____ Continuous 24-hour operation

   _____ Time clock

_____ Ambient light sensor

_____ Manually by _____
(school personnel, fire dept., etc.)

_____ Environmental conditions of _____
(ice, water, etc.)

_____ Traffic actuated by _____
(speed, headway, lane occupancy,etc.)

_____ Other _____
(train, drawbridge, upstream traffic signal, etc.)

(b) How does it operate? (e.g. loop detectors measure vehicle speed and trigger flashing lights when speeds is over 55 mph)

(c) How is it timed? (e.g. advance flashing lights are activated 10 seconds before railroad crossing red flashers)

7. Is the device considered effective?

_____ Yes at _____ locations

_____ No, due to _____

APPENDIX B
KEY WORDS

Agriculture Used in agricultural areas to warn of farm equipment or livestock hazards
4C-11, 12, 13

ATV Used to warn of all-terrain vehicles crossing the roadway
4C-2

Bicycle Used to warn of bicyclists crossing the roadway
4C-1

Blind Used to warn of blind pedestrians crossing the roadway
4B-1, 3

Break-in period Used only temporarily to warn motorists of a change in stop control, signal phasing, new installation, or a change in traffic flow patterns
3G-6, 7, 8, 9, 10

Bridge Used to advise of load limits, pavement conditions or lateral clearance restrictions on bridges
1A-1, 2, 3, 4, 5, 6, 7
2C-2, 3, 6
6A-2
8-11, 12, 17

Bus Used to warn bus drivers of a closed busway or a steep grade ahead
2B-1
8-18A

Changeable A device with a variable message
1B-10A; 1C-5A
4D-7A
5A-12A

Chevron A device that uses a chevron or is a modification of the standard chevron alignment sign
3B-9

Circle Used to warn that a traffic circle is ahead or to inform the motorist of allowed movements at a circle
3E-2, 3, 4

Children Used to warn of children crossing the roadway near schools and in residential areas
4A-14, 17A, 18A; 4B-4
Subcategory 4D

Church Used to warn motorists of vehicles leaving the roadway or entering from a church driveway, or possibly to warn of churchgoers crossing the roadway
4A-13

Clearance Used to warn truck drivers of a vertical clearance restriction ahead
Subcategory 2A

Crossing Used to warn of a rail grade crossing due to limited sight distance or rough pavement or to warn of an approaching train at the crossing
Subcategory 5A
Subcategory 5B

Curve Used to warn of a change in horizontal alignment ahead
2B-14, 15, 16, 17; 2C-12, 13, 14
3A-1 to 8; 3A-18 to 37; 3B-6, 7, 8, 9, 10A, 11A; 3G-5

Deaf Used to warn of deaf pedestrians crossing the roadway
4B-1, 4

Delineation Used to delineate the edge of lanes or the pavement
8-16

Dilemma Used to reduce or eliminate the dilemma zone created by signals on high-speed roadways or to warn of a signal in an area of restricted sight distance
Subcategory 3C

Elderly Used to warn of slow-moving elderly pedestrians crossing the roadway or entering the roadway in a vehicle
4A-1, 2, 16A; 4F-4

Emergency Used to warn of emergency vehicles entering the roadway
Subcategory 4E

Equestrian Used to warn of horseback riders crossing the roadway, of horsedrawn carriages, or to warn horseback riders of slippery surfaces.
4C-3, 8, 9, 10

Flashers A device which uses flashing lights to increase the target value or to indicate the existence of a certain condition ahead
1A-9A, 13A, 14A, 15A; 1B-10A; 1C-2A, 3A, 4A
2A-8A, 9A, 10A, 13A; 2B-7, 11, 16
3A-1, 2; 3B-9, 10A, 11A; 3C-3A to 15A, 17A, 18A; 3D-6; 3F-10A to 19A; 3G-1, 3
4A-16A, 17A, 18A; 4D-7A to 12A; 4E-6A to 10A
5A-13A, 14A, 15A
7-2, 7A to 10A
8-14, 18A, 19A, 20A

Fog/Smoke Used to warn of poor visibility resulting from smoke or fog
Subcategory 1C
4D-12A

Freeway Used exclusively on freeways or entrance and exit ramps
2B-16
A-7, 8
3D-4, 5, 6; 3G-1, 5; 3H-2

Runaway Used to inform truck drivers of the location of a runaway truck ramp
2B-17

School Used to warn motorists of children crossing the roadway ahead in the vicinity of a school
4A-17A, 18A
Subcategory 4D

Shoulder Used to warn of hazardous shoulder conditions
Subcategory 6B

Sight distance Device that warns of an area with restricted sight distance
3B-1 to 7

Signal Used to warn of a traffic signal ahead
Subcategory 3C
3G-3, 4, 6, 7, 8, 9, 10
4E-5
7-2
8-21A, 8-22A

Speed Used to control or reduce speeds
Subcategory 2B
3A-1, 2, 7, 8; 3B-2
4A-2; 4D-7A, 8A
5A-9, 10, 11
7-5, 9A
8-2, 4, 5, 6, 7, 9, 10, 13

Speed bump Used to warn of a speed bump ahead
6A-10, 11

Spring Device that includes a spring-mounted sign
8-17

Street name Used to provide information on intersecting streets ahead
3I-1, 2

Stop Used to supplement a Stop sign or warn of a stop condition ahead
2B-12
Subcategory 3C
3G-2 to 8; 3H-5 to 9
4E-6A
5A-3
7-5, 11A
8-7

Strobe ring Device that uses a strobe light mounted onto one or more heads of a traffic signal to increase the target value
8-21A, 22A

Truck Used to warn truck drivers of potential hazards such as a steep grade, low vertical clearance, or narrow lateral clearance
Category 2
3A-1 to 8
5A-1, 2

Tunnel Used to warn of a tunnel ahead
8-1, 2, 3

Turning Used to warn of vehicles entering the roadway from a side road, crossroad, or driveway or leaving the primary roadway
2C-7 to 11
3A-38, 39
Subcategory 3F
3H-5 to 9
4D-3, 4, 5, 6
Subcategory 4F

University Used to warn of pedestrians crossing the roadway ahead in an area near a university
4A-11

U-Turn Used to warn of a high number of motorists making U-turn maneuvers ahead
8-8

Water Used to warn of water on the roadway
1A-13A to 15A
Subcategory 1B

Weather Used to warn of potentially hazardous temporary conditions ahead caused by weather such as rain, snow, fog, wind, and other phenomenon
Category 1
6A-12

Width Used to warn drivers of oversized vehicles of a lateral clearance restriction ahead
2C-1 to 5
5A-7
8-17

Wind Used to warn drivers of high-profile vehicles of potentially hazardous wind ahead
Subcategory 1D

Yield Used to warn of a yield situation ahead
3G-1

Zone Used to warn of an area where there is a high volume of pedestrian traffic or other roadway crossers that presents an unusually high level of risk to the motorist.

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