Part VI. TRAFFIC CONTROLS FOR STREET AND HIGHWAY CONSTRUCTION AND MAINTENANCE OPERATIONS

A. INTRODUCTION AND GENERAL SPECIFICATIONS

6A–1 Need for Standards

Problems of traffic control occur when traffic must be moved through or around road or street construction, maintenance operations, and utility work. No one standard sequence of signs or other control devices can be set up as an inflexible arrangement for all situations due to the variety of conditions encountered.

The following treatment of signs, signals, and markings for street and highway construction and maintenance work provides a comprehensive guide to be applied as a national standard. This Part of the Manual establishes principles to be observed in the design, installation, and maintenance of traffic control devices, and prescribes standards where possible, and is designed so that it can be used independently. To that end some material concerning specifications and devices having more general application is repeated here from preceding parts of this Manual.

These principles and standards are directed to the safe and expeditious movement of traffic through construction and maintenance zones and to the safety of the work force performing these operations.

6A–2 Scope

This Part sets forth basic principles and prescribes standards for the design, application, installation, and maintenance of the various types of traffic control devices required for road or street construction, maintenance operations and utility work. These include signs, signals, lighting devices, markings, barricades, channelizing, and hand signaling devices. Minimum standards of application are prescribed for typical situations, and for methods of controlling traffic through work areas. As part of these standards a number of typical situations are illustrated, showing the proper application of standard protective devices.

6A–3 Application of Standards

The general principles outlined in this Manual are applicable to both rural and urban areas. Since it is not practical to prescribe

detailed standards of application for all the situations that may conceivably arise, minimum standards are presented here for the most common situations. It is emphasized that these are minimum desirable standards for normal situations and that additional protection must be provided when special complexities and hazards prevail. The protection prescribed for each situation shall be based on the speed and volume of traffic, duration of operation, and exposure to hazards. As used in this Part the term street refers to all the streets in any municipality, including cities, towns, villages, or other local jurisdictions.

Traffic conditions on streets are characterized by relatively low speeds, wide ranges of volumes, limited maneuvering space, frequent turns and cross movements, a significant pedestrian movement and other obstructions. Construction and maintenance operations are more numerous and varied, including such diverse activities as pavement cuts for utility work, pavement patching and surfacing, pavement marking renewal and encroachments by adjacent building construction. Work on arterial streets should be restricted to off-peak hours to minimize conflicts with traffic.

Rural highways are characterized by lower volumes, higher speeds, and less interference from pedestrians, turns, and encroachments.

Limited access highways present problems requiring a special effort by administrators, supervisors, and work forces. Both high speeds and high volumes may be anticipated, with peak flows restricting work to relatively short periods during daylight hours.

The difficulties associated with the completion of work on lanes carrying high volumes of traffic have made it necessary in some instances to schedule construction and/or maintenance operations at night. While night scheduling avoids peak flows, the problems associated with work site delineation and warning device placement are increased.

Although each situation must be dealt with individually, conformity with the provisions established herein is required. In particular situations not adequately covered by the provisions of this Manual, the protection of the traveling public and of the workmen on the scene will dictate the measures to be taken, consistent with the general principles set forth herein.

6A–4 Responsibility

The provisions for public protection established herein are for application by (1) State highway department, county, and municipal forces performing construction or maintenance operations on roads and streets, (2) contractors employed in road or street construction or maintenance under contract to any governmental author-

ity, and (3) all others, including employees of public utility companies, performing any work on highways or so closely adjacent as to create hazards for the public or for themselves.

These standards, as a part of the Manual on Uniform Traffic Control Devices, should be adopted by all public authorities concerned with highways, and should be given effect by official instructions to employees and by incorporation into the specifications for all contracts.

It is important that the authorities having jurisdiction be able to require proper protection, that responsibility be clearly assigned, adequate training of personnel be provided, and that there be adherence to the standards and provisions of this Manual.

6A–5 General Requirements

All traffic control devices used on road or street construction or maintenance work shall conform to the applicable specifications of this Manual.

Traffic control devices shall be installed at the inception of construction or maintenance operations, and shall be properly maintained and/or operated during the time such special conditions exist. They shall remain in place only as long as they are needed and shall be immediately removed thereafter. Where operations are performed in stages, there shall be in place only those devices that apply to the conditions present. Signs that do not apply to existing conditions shall be removed, covered, or turned so as not to be readable by oncoming traffic. Barricades and sign supports shall be constructed and erected in a workmanlike manner.

Weeds, shrubbery, construction materials or equipment, spoil, etc., shall not be allowed to obscure any traffic control device.

B. SIGNS

General

6B–1 Design of Signs

Street or highway construction and maintenance signs fall into the same three major categories as do other traffic signs; namely, Regulatory signs, Warning signs, and Guide signs. Many signs normally used elsewhere will also find application for signing construction and maintenance operations. Special construction and maintenance signs follow the basic standards for all highway signs as to shape. Warning signs in construction areas shall have a black legend on an orange background. Existing yellow warning signs already in place within these areas may remain in use. Color for other signs shall follow the standard for all highway signs.

The use of stripes (other than the standard border) or other geometric patterns or contrasting colors on or around any sign in an attempt to make it more conspicuous, distracts attention from the message, and defeats the purpose of maintaining uniformity and simplicity of design. Such practice is contrary to standards and is accordingly disapproved. However, the use of standard orange flags or yellow flashing warning lights in conjunction with signs is permitted, so long as they do not interfere with a clear view of the sign face.

The dimensions of signs shown herein are for standard sizes, which may be increased wherever necessary for greater legibility or emphasis. On secondary highways and city streets smaller signs may be used if authorized by lawful authority. Deviations from standard sizes as prescribed herein shall be in six-inch increments.

Standard sign sizes and colors are shown in the illustrations of the individual signs rather than in detailed specifications in the text. Where the orange background is specified and reflectorization is not required, a fluorescent material may be used for increased daytime visibility.

6B–2 Illumination and Reflectorization

All signs intended to be used during hours of darkness shall be reflectorized or illuminated. Where there is serious interference from extraneous light sources and a reflectorized installation is not likely to give effective performance, an illuminated sign should be used. Sign illumination may be either internal or external. When the full face of the sign is outlined by internal illumination, thereby indicating the shape of the sign, background reflectorization is not required. Where external illumination is provided, the light source should be properly shielded to protect drivers from glare. Torches or lanterns are for warning or guidance, and shall not be used for sign illumination. Street or highway lighting is not regarded as meeting the requirements for sign illumination.

6B–3 Position of Signs

Signs shall be placed in positions where they will convey their messages most effectively and placement must therefore be accommodated to highway design and alignment. Signs shall be so placed that the driver will have adequate time for response.

As a general rule signs shall be located on the right-hand side of the street or roadway. Where special emphasis is deemed necessary, dual installations may be made which consist of duplicate signs opposite each other on the left and right sides of the roadway, respectively. Within a construction or maintenance zone, however, it is often necessary and/or desirable to erect signs on portable sup-

ports placed within the roadway itself. It is also permissible to mount appropriate signs on barricades.

Standards for height and lateral clearance of roadside signs are shown in figure 6–1. Signs mounted on barricades, or temporary supports, may be at lower heights but the bottom of the sign shall be not less than one foot above the pavement elevation. Higher mounting heights are, however, desirable.

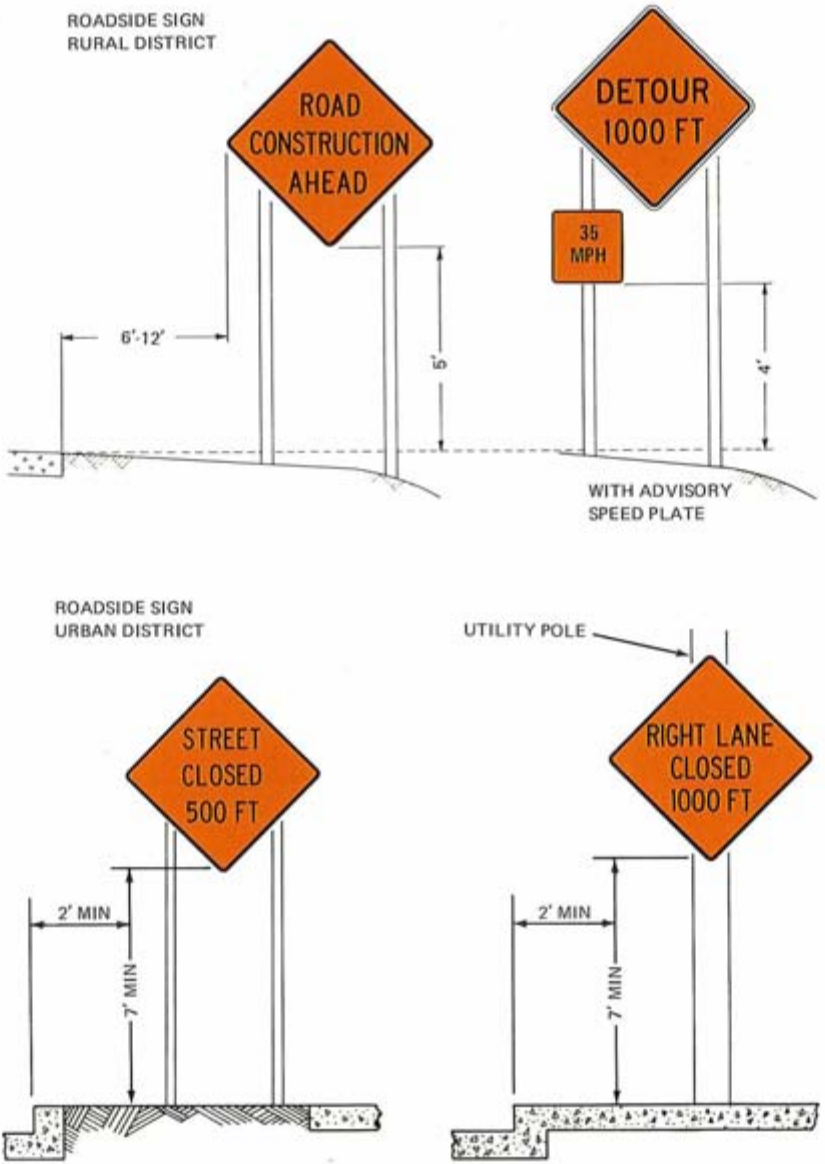


Figure 6–1. Height and lateral location of signs—typical installations.

Where open highway conditions prevail on the approach to the work site, advance warning signs should be placed approximately 1,500 feet in advance of the condition to which they are calling attention. Where a series of advance warning signs are used, the

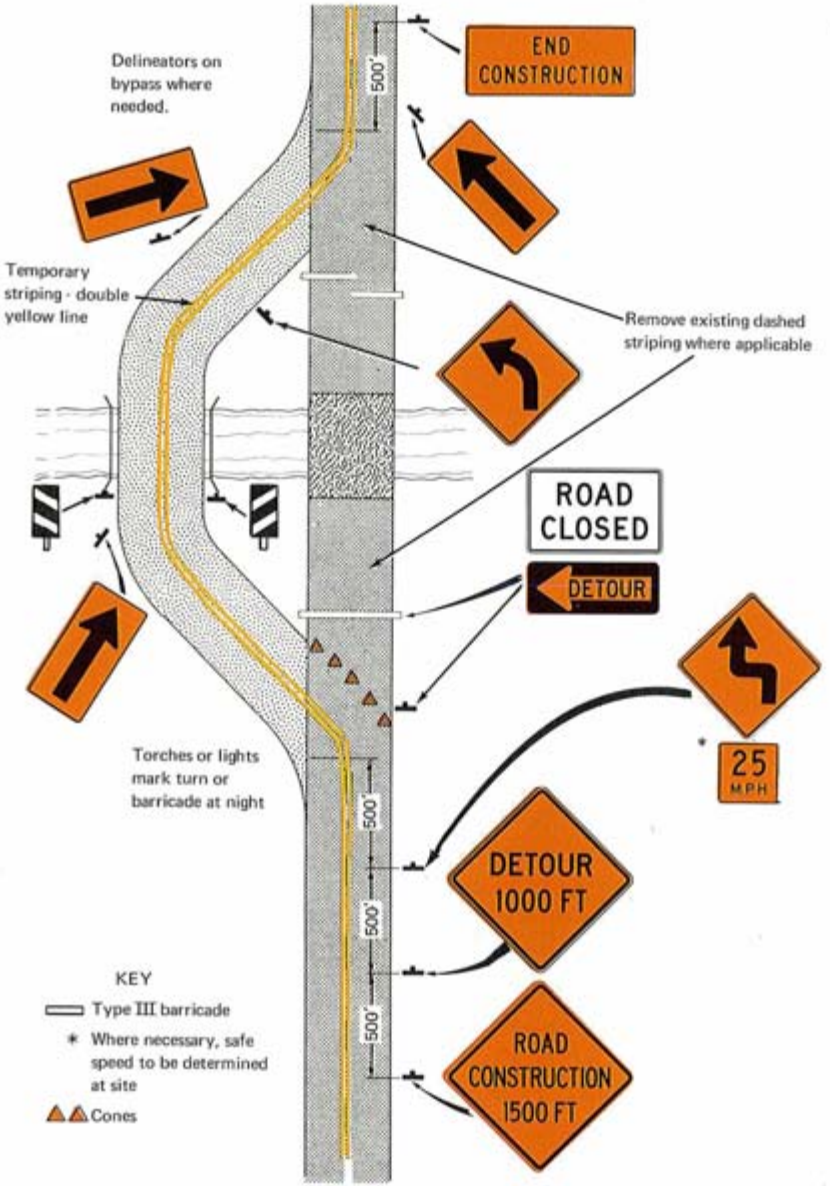


Figure 6–2. Typical applications of traffic control devices on 2-lane highway where the entire roadway is closed and a bypass detour is provided (signs shown for one direction of travel only).

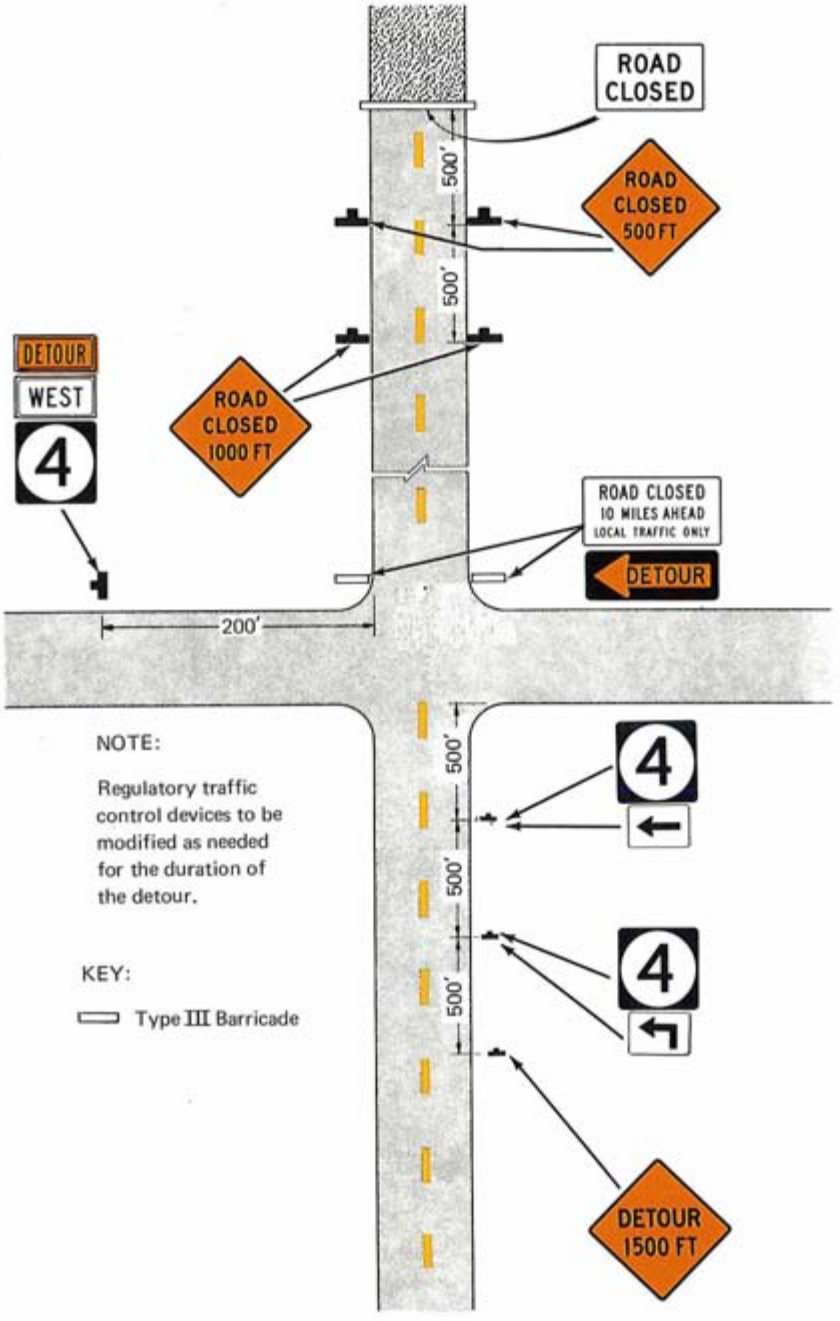


Figure 6–3. Typical application—roadway closed beyond detour point.

warning sign nearest the work site should be placed approximately 500 feet from the point of restriction with the additional signs at 500–1000 foot intervals. On expressway and limited access facilities, the advance warning distance should be increased to one-half mile or more. On city streets, where more restrictive conditions generally prevail on the approach to the work area, signs in the

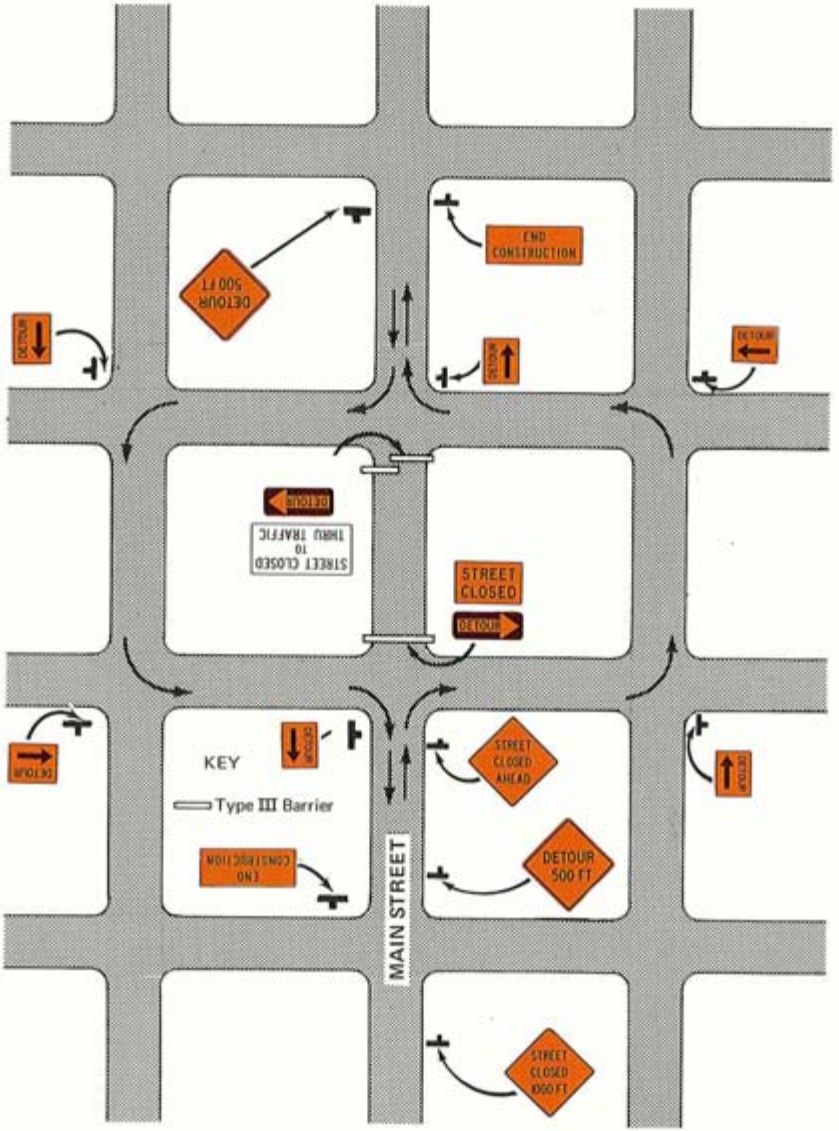


Figure 6–4. Typical application—detour signing for street construction project in a street grid.

immediate vicinity of the work may be placed at closer spacings. Typical sequences and spacings of advance warning signs are shown in figures 6–2 to 6–10.

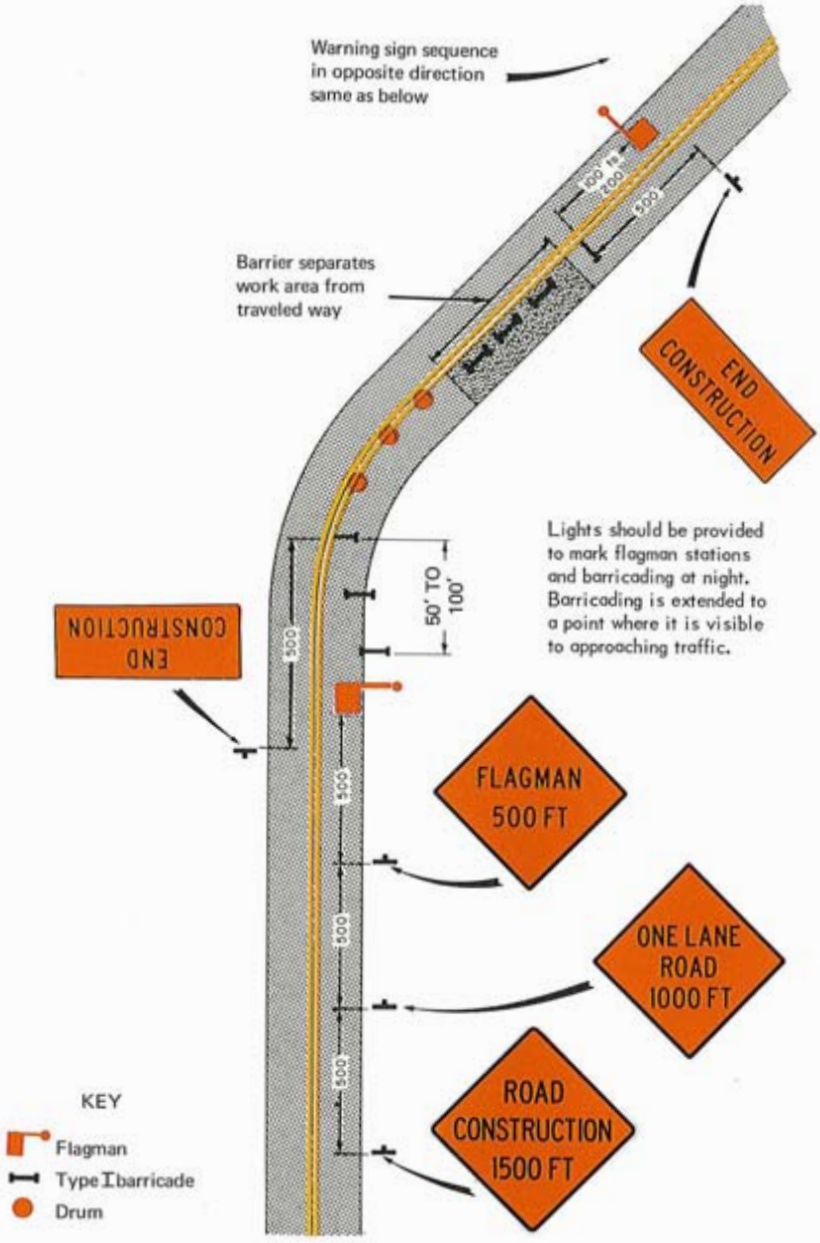


Figure 6–5. Typical applications of traffic control devices on 2-lane highway where one lane is closed.

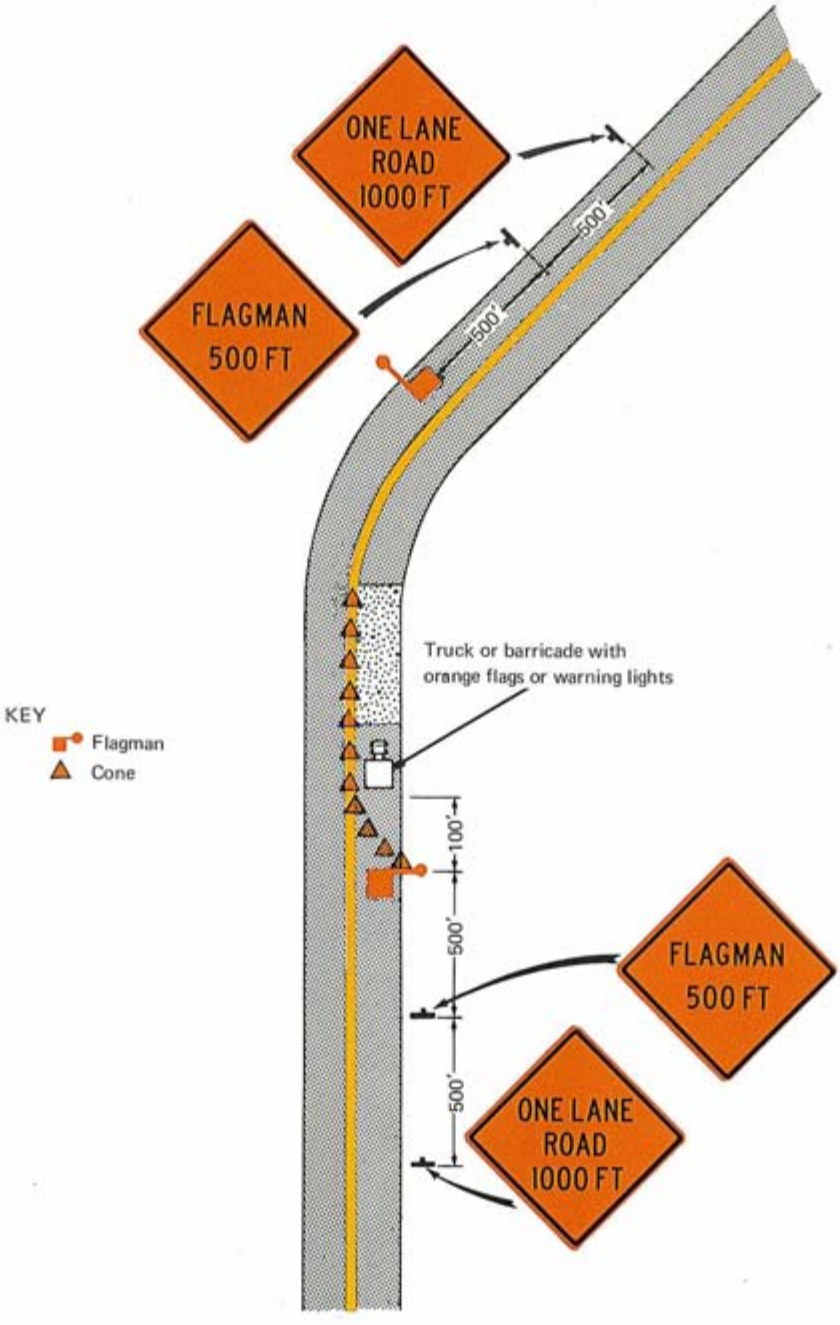


Figure 6–6. Typical application—maintenance operations of short duration on a 2-lane roadway.

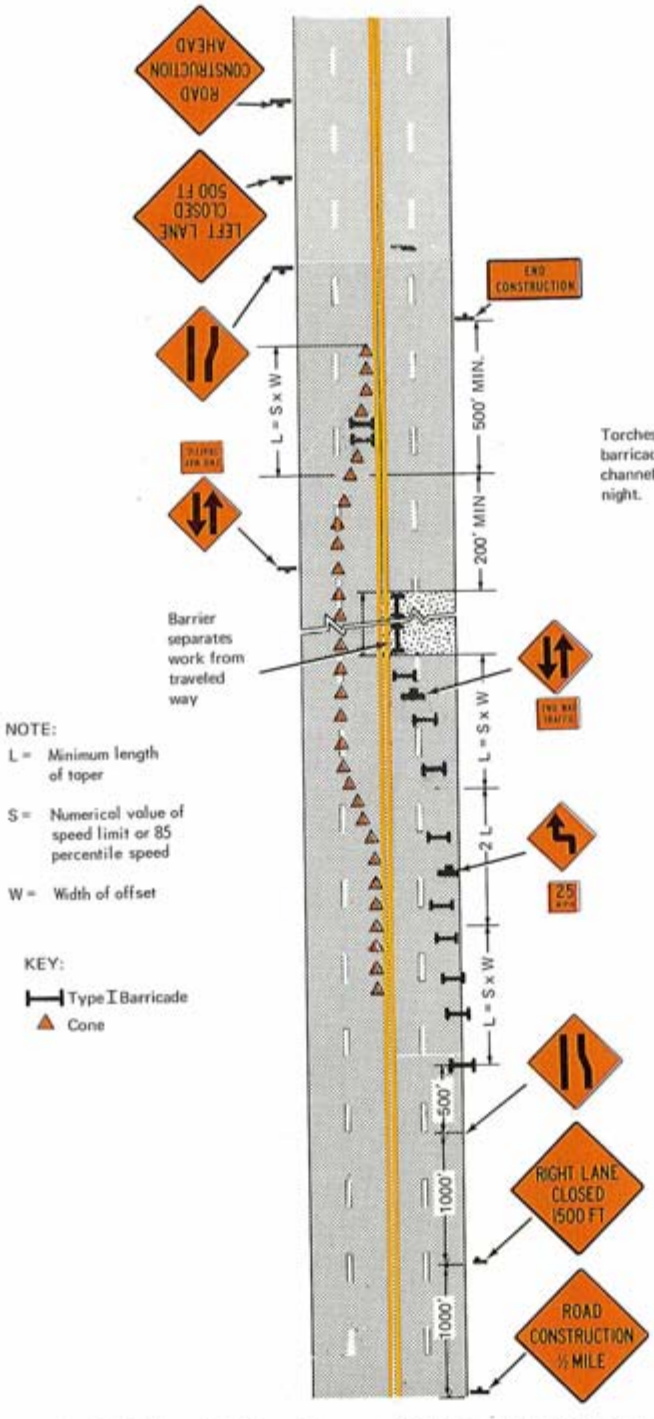


Figure 6–7. Typical application—4-lane undivided roadway where half the roadway is closed.

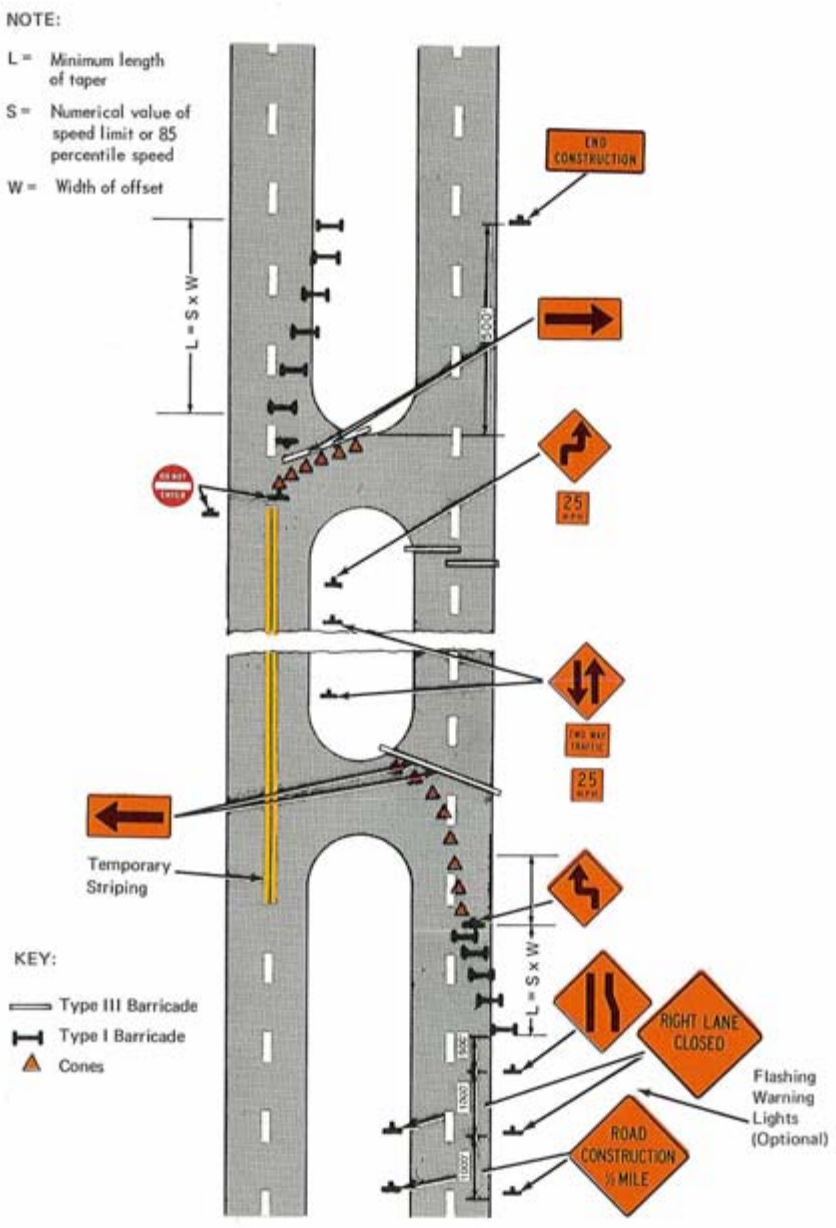


Figure 6–8. Typical application—4-lane divided roadway where one roadway is closed (signs show one direction of travel only).

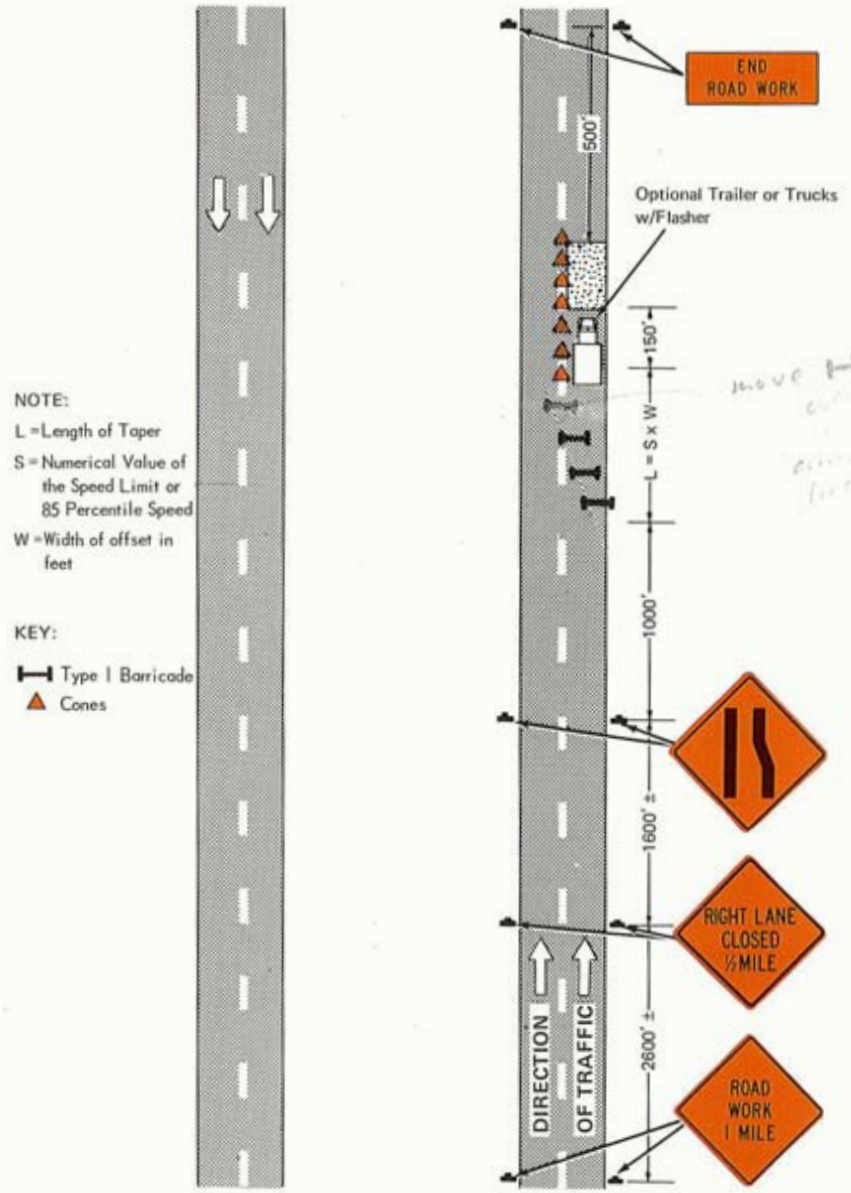


Figure 6–9. Typical application—4-lane divided roadway where half of roadway is closed.

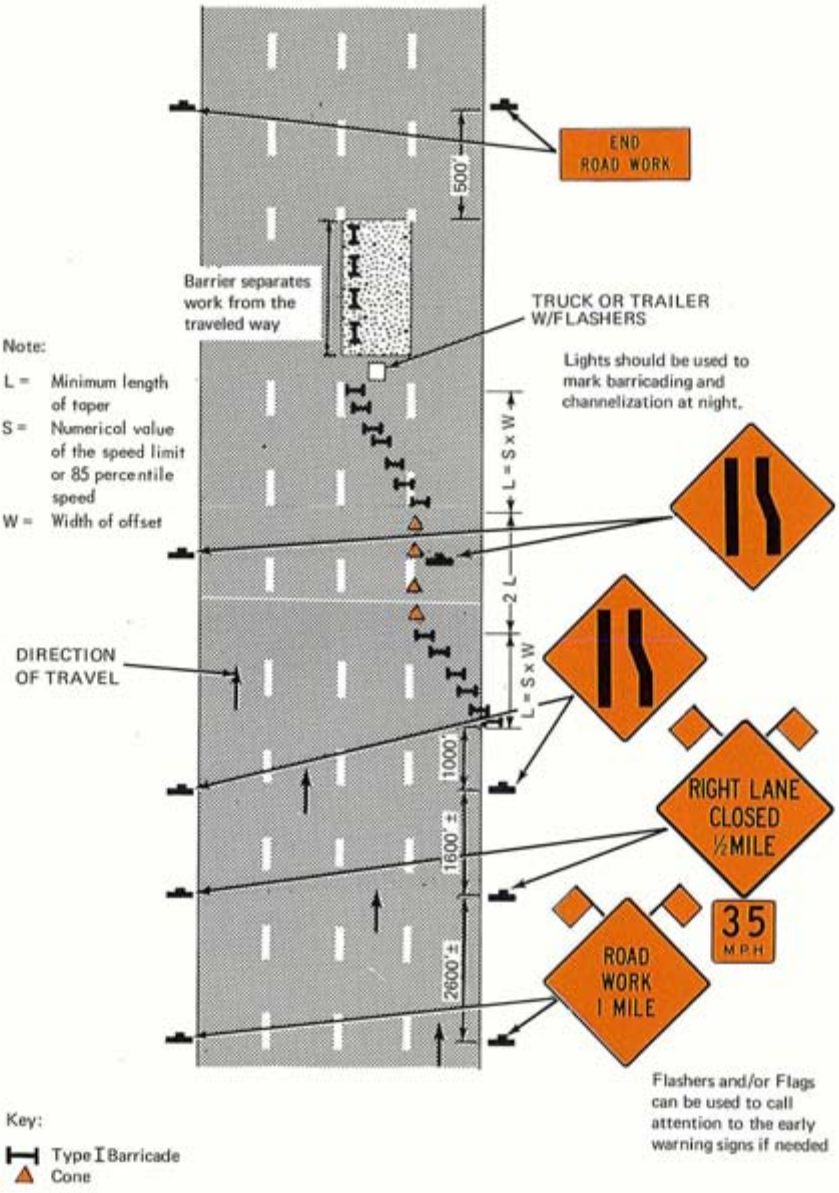


Figure 6–10. Typical application—closing multiple lanes of a multilane highway.

6B–4 Erection of Signs

Signs on fixed supports are usually mounted on a single post, although those wider than 36 inches or larger than 10 square feet in area should generally be mounted on two posts. Signs mounted on portable supports are suitable for temporary conditions. All

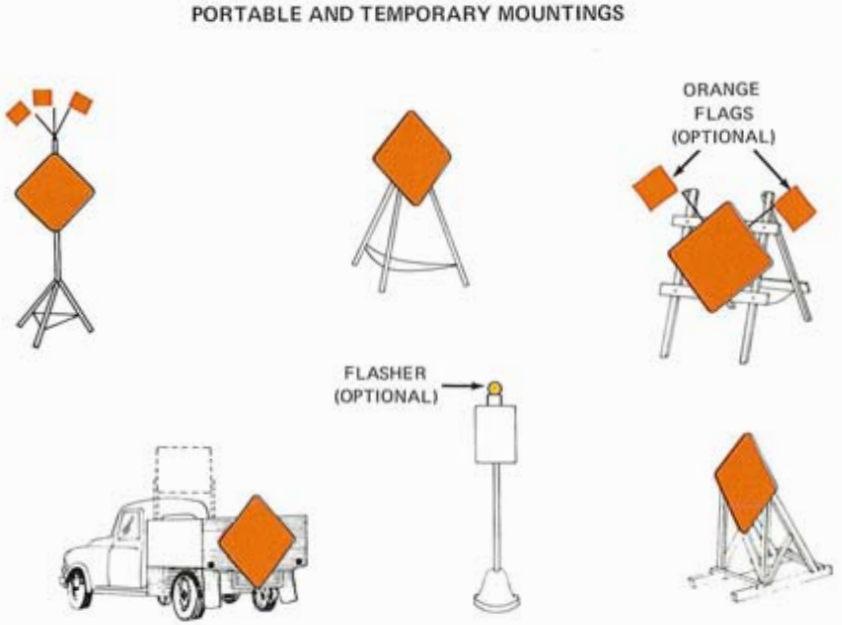


Figure 6–11. Methods of mounting signs other than on posts.

such installations should be so constructed to yield upon impact to minimize hazards to motorists.

For maximum mobility on certain types of maintenance operations, a large sign may be effectively mounted on a vehicle stationed in advance of the work or moving along with it. This may be the working vehicle itself, as in the case of shoulder-mowing or pavement marking equipment, or a vehicle provided expressly for this purpose. These mobile sign displays may be mounted on a trailer, may be provided with self-contained electric power units for flashers and lights, or may be mounted on a regular maintenance vehicle.

Guide signs, although ordinarily erected on separate posts, may also be mounted on or above barricades, but should not be permitted to interfere with the effectiveness of necessary regulatory and warning signs.

Typical methods of mounting signs other than on posts are shown in figure 6–11.

Regulatory Signs

6B–5 Authority

Regulatory signs impose legal obligations and/or restrictions on all traffic. It is essential, therefore, that their use be authorized by the public body or official having jurisdiction and that signs conform with this Manual.

6B–6 Design

Regulatory signs are generally rectangular with their longer dimension vertical, and carry a black legend and border on a white background. The STOP sign is octagonal, and has a white legend and border on a red background. The YIELD sign is a white inverted triangle with red legend and border band. The DO NOT ENTER sign consists of a white square on which is inscribed a red circle with a white band horizontally across the center of the circle and the words DO NOT and ENTER in white letters on the upper and lower parts of the circle. The ONE-WAY sign may be either a horizontal or vertical rectangular plate, the latter being used more commonly in cities where space is limited. Commonly used regulatory signs are illustrated in figure 6–12. Design details for all regulatory signs are given in Part II.

6B–7 Application

Construction and maintenance operations represent unusual roadway conditions and warrant special attention. If construction or

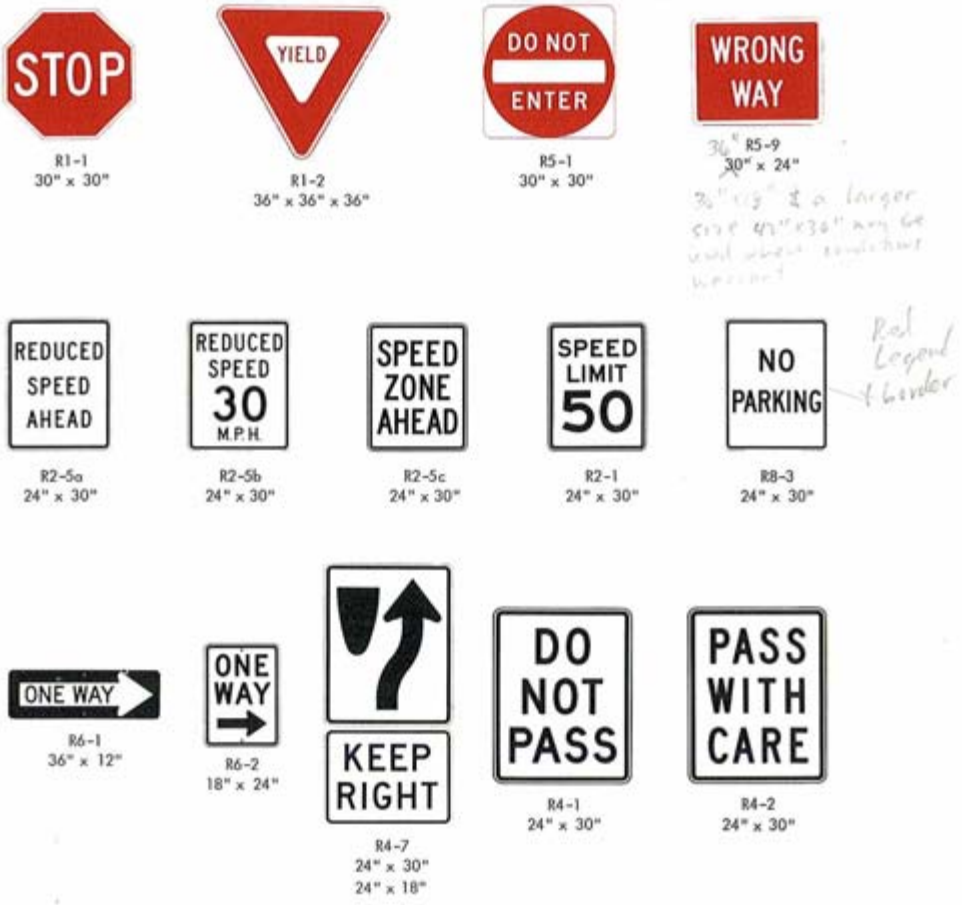


Figure 6–12. Commonly used regulatory signs.

maintenance operations require regulatory measures different from those normally in effect, the existing permanent regulatory devices shall be removed or covered and superseded by the appropriate temporary regulatory sign, taking into account applicable ordinances or statutes of the jurisdiction involved.

6B–8 Road (Street) Closed Sign (R11–2)

The ROAD (STREET) CLOSED sign shall be used where the roadway is closed to all traffic except contractors' equipment and officially authorized vehicles and shall be accompanied by appropriate detour signing. The sign should be erected at or near the center of the roadway on or above a Type III barricade (sec. 6C–2). Because it is the last sign the driver will see before he must stop or

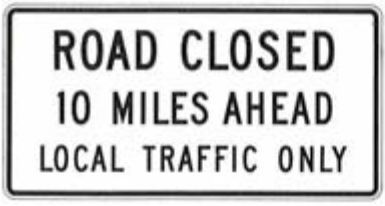
turn, it is essential that it be large and legible. It shall have a standard, and minimum, size of 48 inches by 30 inches.

The ROAD (STREET) CLOSED sign shall not be used where traffic is maintained or where the actual closure is some distance beyond the sign and local traffic is permitted access to nearer points. In the latter case the Local Traffic Only sign (sec. 6B–9) should be used.

R11–2
48" x 30"

6B–9 Local Traffic Only Signs (R11–3, R11–4)

The Local Traffic Only sign should be used where through traffic must detour to avoid a closing of the road or street some distance beyond, but where the road or street is open for traffic up to the point of closure. It shall carry the legend ROAD CLOSED (10) MILES AHEAD—LOCAL TRAFFIC ONLY or, optionally for urban use, STREET CLOSED TO THRU TRAFFIC and shall be accompanied by appropriate detour signing (fig. 6–4). The words BRIDGE OUT may be substituted for ROAD CLOSED where applicable.



R11–3
60" x 30"

R11–4
60" x 30"

6B–10 Weight Limit Signs (R12–1, R12–2)

For traffic safety in areas of road or street construction and maintenance, a Weight Limit sign shows the gross weight or axle weight

that can be permitted on a roadway surface or bridge. Weight restrictions must be consistent with State or local regulations and shall not be imposed without the approval of the authority having jurisdiction over the highway. When weight restrictions are imposed, a marked detour should be provided for vehicles whose legal weight exceeds the limit posted.

R12–1
24" x 30"

R12–2
24" x 30"

6B–11 Special Regulatory Signs

Various other regulatory signs may be called for by special operations located in or around the roadway. Although it is not practicable to standardize many such signs in detail, they should conform to the general requirements pertaining to color and shape. Their messages should be brief, legible, and clearly understandable.

Warning Signs

6B–12 Function

Warning signs for construction and maintenance projects are used to notify drivers of specific hazards which may be encountered, when those operations are underway. Within the construction zone there may be a variety of temporary roadway facilities. Pavement width may be reduced. Open excavations may be present in or near the roadway, or travel across an unpaved section may be required. Drivers should be properly alerted to possible dangers ahead in sufficient time to adjust their speed for the hazard.

6B–13 Design and Application

Warning signs for construction and maintenance shall be diamond shaped (square with one diagonal vertical), having a black symbol or message on an orange background except as provided for herein.

Construction or maintenance operations on freeway or expressway facilities, may also require large movable warning signs. Mounting considerations for some of these signs may justify a change from the standard diamond shape to a rectangular shape, but such variances should have prior approval of the appropriate highway authority.

The square Advisory Speed plate (sec. 6B–34) shall have a black message and border, and shall have an orange background when used in conjunction with an orange background sign and shall have a yellow background when used with a yellow background sign. It shall have a minimum 24″ x 24″ size.

Detailed specifications are given only for signs prescribed for construction and maintenance work and for some of the standard signs that are commonly required for these work areas.

On secondary roads or city streets where speeds are low, the use of plates 6 inches smaller on a side than the standard size, but not less than 24 inches, may be used for warning signs having short word messages or clear symbols.

Where distances are to be shown on warning signs as part of the legend, a separate panel with the distance shown thereon may be erected immediately below the sign on the same support.

Where any part of the roadway is obstructed or closed, construction approach warning signs are required to alert traffic well in advance of these obstructions or restrictions to normal traffic flow (sec. 6B–14). These signs may be used singly or in combination. Because of their importance, these signs shall have a standard size of 48 inches by 48 inches and shall be the standard diamond shape for warning signs, except as provided for above.

Where speeds and volumes are relatively low, a minimum size of 36 inches by 36 inches may be used for Construction Approach Warning Signs, provided that a minimum letter size of 5 inches can be accommodated on this size with the appropriate legend.

6B–14 Application of Construction Approach Warning Signs

Various circumstances will occur which will require extra advance warning because of limited sight distance or the nature of the obstruction may require a motorist to bring his vehicle to a stop. Therefore, specified standards or a set sequence of signs are not noted. The determination of the sign or signs to be used shall be on the basis of an engineering study using the following sections as guidelines (secs. 6B–15 to 6B–20). As an alternate to the specific distances on these advance construction signs, the word AHEAD may be used.

6B–15 Advance Road (Street) Construction Sign (W20–1)

The Advance Road (Street) Construction sign shall be located in advance of the initial activity or detour a driver may encounter,

and is intended for use as a general warning of obstructions or restrictions. It carries the legend ROAD (STREET) CONSTRUCTION (1500) FT or ROAD (STREET) CONSTRUCTION (½) MILE. It may be used in repetition with appropriate legends, or in conjunction with other construction signs.

W20–1
48" x 48"

6B–16 Advance Detour Sign (W20–2)

The Advance Detour sign is intended for use in advance of a point at which traffic is diverted over a temporary roadway or route. It carries the legend DETOUR (1500) FT or DETOUR (½) MILE. It may be used with repetition with appropriate legends or in conjunction with other construction signs.

W20–2
48" x 48"

W20–3
48" x 48"

6B–17 Advance Road (Street) Closed Sign (W20–3)

The Advance Road (Street) Closed sign is intended for use in advance of a point at which a roadway is closed to all traffic or to

all but local traffic. It carries the legend ROAD (STREET) CLOSED (1000) FT or ROAD (STREET) CLOSED (¼) MILE. It may be used in repetition with appropriate legends or in conjunction with other construction signs.

6B–18 Advance One Lane Road Sign (W20–4)

The Advance One Lane Road sign is intended for use only in advance of a point where traffic in both directions must use a single lane (secs. 6E–6 and 7). It carries the legend ONE LANE ROAD (1000) FT or ONE LANE ROAD (¼) MILE. It may be used in repetition with appropriate legends or in conjunction with other construction signs.

If the one-lane stretch is of such length as not to be visible throughout from either end, or if the traffic is of such volume that simultaneous arrivals at both ends occur frequently, provision must be made to permit traffic to move alternately under control (secs. 6E–6 to 6E–10).

W20–4
48" x 48"

W20–5
48" x 48"

W20–7
48" x 48"

6B–19 Advance Lane Closed Sign (W20–5)

The Advance Lane Closed sign is intended for use where applicable in advance of a point where one lane of a multiple-lane roadway is closed (sec. 6F–3). It carries the legend RIGHT (LEFT) LANE CLOSED (1000) FT or RIGHT (LEFT) LANE CLOSED (¼) MILE. It may be used in repetition with appropriate legends or in conjunction with other construction signs.

6B–20 Advance Flagman Sign (W20–7)

The Advance Flagman sign is intended for use in advance of any point at which a flagman has been stationed to control traffic through a construction or maintenance project. It carries the legend FLAG-

MAN (500) FT or FLAGMAN (¼) MILE. It may be used in repetition with appropriate legends or in conjunction with other construction signs.

The sign shall be promptly removed, covered, or turned to face away from the roadway whenever the flagman is not at his station.

6B–21 Two-Way Traffic Sign(W6–3)

The Two-Way Traffic sign should be used as needed at intervals to periodically remind drivers that they are on a two-way highway which contains opposing traffic.

W6–3
48" x 48"
24" x 18"

6B–22 Application of Maintenance and Minor Construction Warning Signs

At many maintenance and minor construction operations, particularly on lightly traveled roads, there may be no need for the sequence of Construction Approach Warning signs prescribed for major operations. The signs described in the following sections and on figures 6–13a and 6–13b, will ordinarily provide sufficient advance warning in such situations, either by themselves or in combination with appropriate Construction Approach Warning signs, as dictated by conditions. In addition, some of them may be needed inside the limits of a major work area where traffic is maintained through the job.

Figure 6–13a. Warning signs used in construction areas.

Figure 6–13b. Warning signs used in construction areas.

6B–23 Men Working Sign (W21–1)

The MEN WORKING sign is intended for use in conjunction with minor maintenance and public utility operations for the protection of men working in or near the roadway. On low-speed urban areas the MEN WORKING sign is intended for use at limited obstruction sites which are adequately marked and clearly visible, such as an open manhole with a fence around it.

W21–1
30" x 30"

W21–2
30" x 30"

6B–24 Fresh Oil Sign (W21–2)

The FRESH OIL (TAR) sign is intended for use to warn motorists that resurfacing operations have rendered the surface of the pavement temporarily hazardous, and that objectionable splashing on vehicles may occur.

6B–25 Road Machinery Sign (W21–3)

The ROAD MACHINERY sign is intended for use in areas where heavy equipment is operating in or adjacent to the roadway.

W21–3
36" x 36"

W21–4
36" x 36"

6B–26 Road Work Sign (W21–4)

The ROAD WORK sign is intended for use in advance of maintenance or minor reconstruction operations in the roadway (fig. 6–9).

6B–27 Shoulder Work Sign (W21–5)

The SHOULDER WORK sign is intended for use in advance of maintenance or minor reconstruction operations involving the shoulder, where the traveled way remains unobstructed.

W21–5
30" x 30"

W21–6
30" x 30"

6B–28 Survey Crew Sign (W21–6)

The SURVEY CREW sign is intended for use in advance of a point where a surveying crew is working in or adjacent to the roadway.

6B–29 Signs for Blasting Areas

As sources of radio-frequency (RF) energy can cause the premature firing of electric blasting caps used in construction operations, the public must be warned of such conditions and, as a part of the overall safety precautions, be advised to turn off mobile radio transmitters. From a practical standpoint, however, the possibility of a premature explosion is extremely remote due to the necessary combination of circumstances that is very unlikely to occur in actual practice. There does not appear to be a radio-frequency (RF) initiation hazard in the normal storage and transportation of electric blasting caps as long as they are in their original cartons.

The Institute of Makers of Explosives Publication No. 20, "Radio Frequency Energy, A Potential Hazard in the Use of Electric Blasting Caps," should be consulted for information on this hazard and guidelines for safe operations.[1] This publication provides tables of recommended safe distances which will give the blaster a high degree of assurance that his blasting layout should be safe against radio frequency (RF) initiation.

As a precautionary measure a sequence of signs is recommended for use to remind operators of mobile radio equipment to turn off

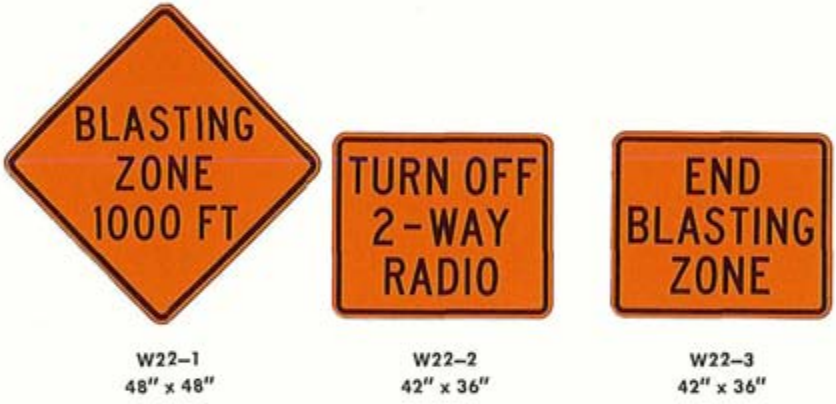
[1] Radio Frequency Energy, A Potential Hazard in the Use of Electric Blasting Caps, Publication No. 20, Institute of Makers of Explosives, 420 Lexington Avenue, New York, New York 10017.

transmitters when in a blasting area. The maximum power for amateur radio mobile units being 1000 watts, a minimum safe distance of 1,000 feet is recommended for warning sign placement to satisfy the worst condition. Occasionally, situations may develop where adherence to the 1,000 foot distance or to the tables in Publication No. 20 will create an operational handicap. In these instances it is recommended that competent experts be consulted to evaluate the particular situation.

Recommended practices for warning sign application follow.

6B–30 Blasting Zone Sign (W22–1)

The BLASTING ZONE (1000) FT sign is intended for use in advance of any point or work site where there are explosives being used. The TURN OFF 2-WAY RADIO and END BLASTING ZONE signs must be used in sequence with this sign. Provision shall be made for covering or removing the sign sequence when there are no explosives in the area or the area is otherwise secured.



W22–1
48" x 48"

W22–2
42" x 36"

W22–3
42" x 36"

6B–31 Turn Off 2-Way Radios Sign (W22–2)

The TURN OFF 2-WAY RADIOS sign is to be used in sequence with the BLASTING ZONE (1000) FT and END BLASTING ZONE sign and placed at least 1,000 feet from the beginning of the blasting zone. These signs shall be prominently displayed and covered or removed when there are no explosives in the area or the area is otherwise secured.

6B–32 End Blasting Zone Sign (W22–3)

The END BLASTING ZONE sign is to be used to denote the end of the danger zone and shall be placed a minimum of 1,000 feet from the blasting zone, either with or preceding the END CONSTRUCTION sign.

6B–33 Other Warning Signs

In addition to the warning signs specifically related to construction and maintenance operations there are numerous other warning signs, standardized for general use and treated in Part II of this Manual, that may find application in work areas. These include the following:

1. Large Arrow (W1–6)
2. ROAD NARROWS (W5–1)
3. Divided Highway Ends (W6–2)
4. BUMP (W8–1)
5. DIP (W8–2)
6. PAVEMENT ENDS (W8–3)
7. SOFT SHOULDER (W8–4)
8. TRUCK CROSSING
9. LOOSE GRAVEL
10. ROUGH ROAD
11. LOW SHOULDER

The application of most of these signs is prescribed in detail in Part II of this Manual, although their application is generally apparent from their legends. When used in construction operations, these signs shall have an orange background and when used in highway maintenance operations, they should have an orange background.

6B–34 Advisory Speed Plate (W13–1)

In conjunction with a warning sign, an Advisory Speed plate may be used to indicate a maximum recommended speed through the hazardous area. For use with orange construction and maintenance signs this plate shall have a black legend on an orange background and when used with yellow background warning signs shall have a yellow background.

W13–1
24" x 24"

Except in emergencies, an Advisory Speed plate shall not be erected until the recommended speed has been determined by the authority in charge of the highway.

Guide Signs

6B–35 Function and Design of Information and Guide Signs

The following informational signs are required at construction and maintenance sites:

1. Standard directional signs and route markings, to the extent that temporary route changes are necessary.

2. Special information signs (secs. 6B–36 to 39) relating to the work being done. These signs shall have a black message on an orange background.

6B–36 Length of Construction Sign (G20–1)

The Length of Construction sign shall be erected at the limits of any road construction or maintenance job of more than 2 miles in extent, where traffic is maintained through the job. It carries the legend ROAD CONSTRUCTION (5) MILES. It can be effectively mounted on a wing barricade. This sign may be used where required, for jobs of lesser length or on urban streets with appropriate distances shown.

G20–1
60" x 36"

G20–2
60" x 24"

6B–37 End Construction (Road Work) Sign (G20–2)

The END CONSTRUCTION (ROAD WORK) sign should be erected approximately 500 feet beyond the end of a construction or maintenance job. It may be erected on the back of a warning sign set up facing the opposite direction of traffic or on the back of a wing barricade. Where appropriate, the legend END ROAD WORK may be used.

6B–38 Detour and Detour Arrow Signs (M4–9 and 10)

The Detour Arrow sign (M4–10) is used at a point where a detour roadway or route has been established due to the closure of a street or highway to through traffic. It should normally be mounted just below the ROAD CLOSED sign (sec. 6B–8) or the Local Traffic Only sign (sec. 6B–9).

M4–9R
30" x 24"

M4–10R
48" x 18"

The Detour Arrow sign uses a horizontal arrow pointed to the right or left as required at each location.

Each detour shall be adequately marked with standard temporary route markers and destination signs, as a responsibility of the highway department. If an unmarked street or highway is detoured, the DETOUR sign (M4–9) may be used to indicate the points at which the detour changes direction.

6B–39 Pilot Car Sign (G20–4)

The Pilot Car sign shall be mounted in a conspicuous position on the rear of a vehicle used for guiding one-way traffic through or around a road construction or maintenance project (sec. 6E–9). It carries the legend PILOT CAR—FOLLOW ME. A flagman must be stationed on every approach to a project on which a pilot car is used, to hold traffic as necessary until the pilot car is available to lead.

G20–4
36" x 18"

C. BARRICADES AND CHANNELIZING DEVICES

6C–1 Function

The functions of barricades and channelizing devices are to warn and alert drivers of hazards created by construction or maintenance activities in or near the traveled way, and to guide and direct drivers safely past the hazards.

In fulfilling these two functions, barricades and channelizing devices are often required to satisfy two opposing requirements. For example, a channelization installation should be constructed in a substantial manner to provide protection for men working in the roadway. At the same time, however, the channelization devices should provide a smooth and gradual transition which reduces the width of the traveled way, and in this case the channelizing devices should not inflict any severe damage to a vehicle that inadvertently strikes them. The objective should be the development of a traffic control plan which uses a variety of traffic control measures in whatever combination necessary to assure smooth, safe vehicular movement past the work area and at the same time provides maximum safety for the equipment and the workmen on the job.

Barricades and channelizing devices are elements in a total system of traffic control devices for use in highway construction and maintenance operations, and these elements shall be preceded by a subsystem of warning devices that are adequate in size, number and placement for the type of highway on which the work is to take place.

6C–2 Barricade Design

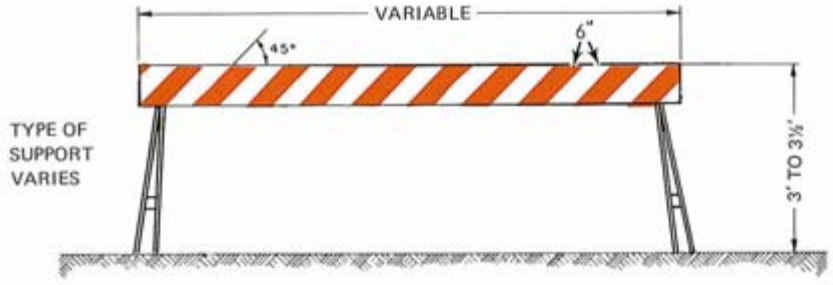
Barricades shall be one of three types: Type I, Type II and Type III. The characteristics of these types are shown in table VI–1 and figure 6–14.

Markings for barricade rails shall be either alternate orange and white or black and white stripes (sloping downward at an angle of 45 degrees in the direction traffic is to pass). The orange and white and white and black markings shall not be intermixed in the same installation or area.

Where a barricade extends entirely across a roadway, it is desirable that the stripes slope downward in the direction toward which traffic must turn in detouring. Where both right and left turns are provided for, the chevron striping may slope downward in both directions from the center of the barricade.

The entire area of white and orange stripes shall be reflectorized so as to be visible under normal atmospheric conditions from a minimum distance of 1,000 feet when illuminated by the low beams of standard automobile headlights. The predominant color for other barricade components shall be white.

TYPE I BARRICADE



TYPE II BARRICADE

NOTE:
For dimensions not shown, see Table VI-1.

TYPE III BARRICADE

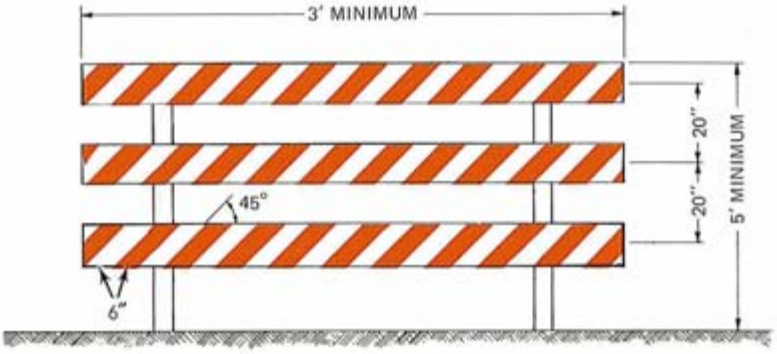


Figure 6–14. Standard barricades.

TABLE VI-1 Barricades—Characteristics

	Type I	Type II	Type III
Width of Rail	8″ min—12″ max	8″ min—12″ max	8″ min—12″ max
Length of Rail	6′—8′	3′ min—4′ max	3′ min—variable max
Width of Stripes	6 in.	6 in.	6 in.
Height	3 ft. min	3 ft. min	5 ft. min
Type of Frame	Demountable or Heavy "A" Frame	Light "A" Frame	Post or Skids
Flexibility	Essentially movable	Portable	Essentially permanent

6C–3 Cone Design

Traffic cones and tubular markers of various configurations are available. These shall be a minimum of 18 inches in height with a broadened base and may be made of various materials to withstand impact without damage to themselves or to vehicles. Larger size cones should be used where speeds are relatively high or wherever more conspicuous guidance is needed. Orange shall be the predominant color on cones. They should be kept clean and bright for maximum target value. For nighttime use they shall be reflectorized or equipped with lighting devices for maximum visibility.

6C–4 Drum Design

Drums are normally metal drums, of 30 to 55 gallon capacity, set on end and used as an expedient method for traffic channelization. The color and marking of drums shall be consistent with marking standards for barricades, orange and white or black and white. These colors shall not be intermixed in the same area. The predominant color on drums shall be black or orange with at least two horizontal, circumferential white stripes 4 to 6 inches wide (fig. 6–15). Drums shall be reflectorized for use at night and should never be placed in the roadway without advance warning signs. In addition, a flashing warning light should be added when drums are used singly, and steady warning lights when they are used in a series for channelization (sec. 6D–3).

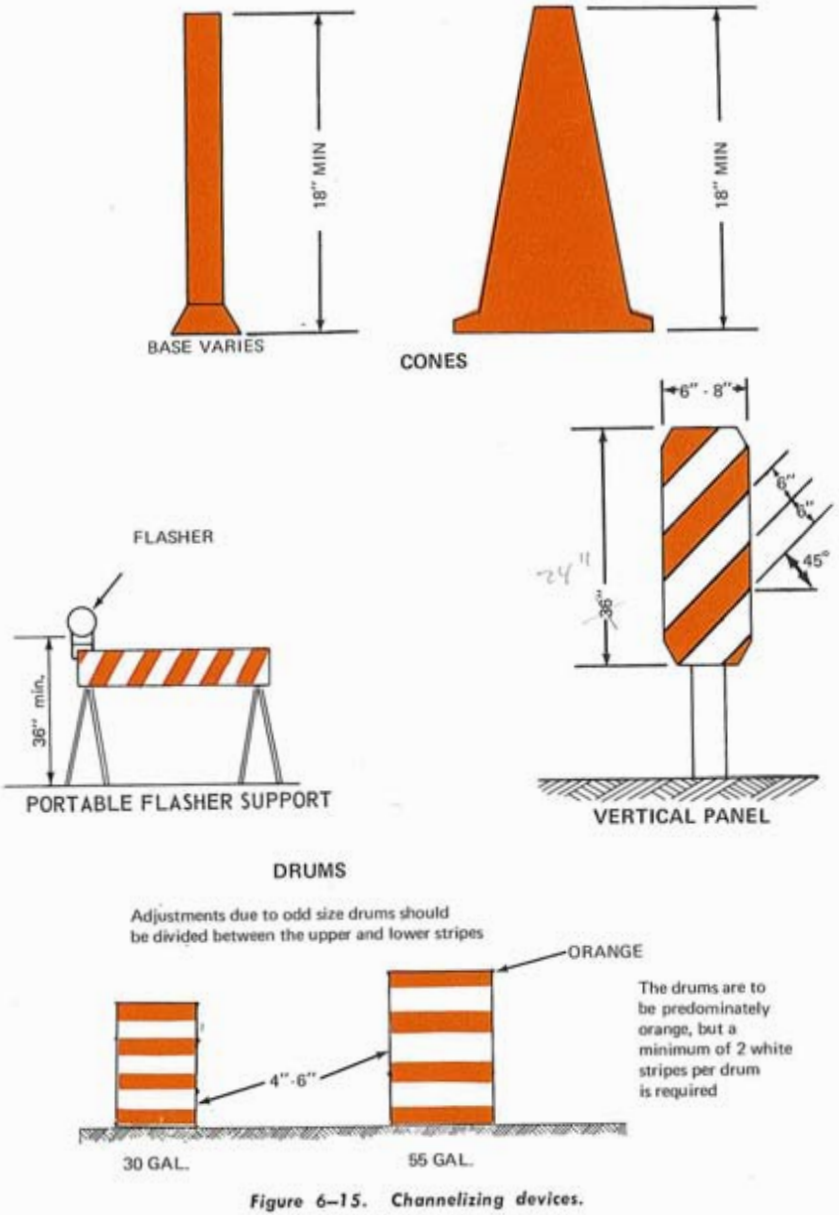


Figure 6–15. Channelizing devices.

6C–5 Vertical Panel Design

Vertical panels used as channelizing devices shall consist of at least one panel 6 to 8 inches in width and 24 inches in height. They shall be striped and reflectorized in the same manner as barricades and mounted with the top a minimum of 36 inches above the road-

way on a single lightweight post. The optional orange and white or black and white design shall not be intermixed in the same area. These devices may be used for traffic separation or shoulder barricading where space is at a minimum.

6C–6 Barricade Construction

Typical examples of barricade construction are shown in figures 6–11 and 14.

The horizontal members of Type I barricades shall be 8 to 12 inches wide. The supports for the rail may be fabricated of lumber, metal or other suitable material, properly shaped. In either case the support should contain, at the prescribed height, a notch or loop into which the horizontal members may be inserted. The essential element of this feature is to permit rapid assembly and disassembly of the barricade for movable situations. This barricade is normally used in 6 to 8 foot lengths.

Type II barricades may be constructed of wooden, metal or other components, or combinations thereof. The supports should be of an "A" frame configuration or hinged or otherwise fastened at the top to permit convenient folding and stacking for transporting from one work site to another. Since portability is a prime consideration, the materials chosen for the barricades should be as light weight as possible commensurate with structural soundness. Irrespective of the materials used for constructing Type II barricades, they have a relatively high center of gravity and are, therefore, susceptible to overturning in the wind. Sandbags should be used for ballasting when required.

Since Type III barricades are somewhat permanent in nature and are required to function in one location for a relatively long time, they should be substantially constructed. When the barricades are constructed on bases instead of posts set into the ground, it may be desirable to ballast the bases with sand bags to provide added resistance to overturning during periods of high winds.

6C–7 Barricade Application

On construction projects, when a road section is closed to traffic, Type III barricades shall be erected at the points of closure. They may extend completely across a roadway and its shoulders (as a fence) or from curb to curb. Where provision must be made for access of equipment and authorized vehicles, the Type III barricades should be provided with gates or movable sections that can be closed when work is not in progress, or with indirect openings that will discourage public entry. Where access is provided through the Type III barricades, responsibility should be assigned to a person to assure proper closure at the end of each working day.

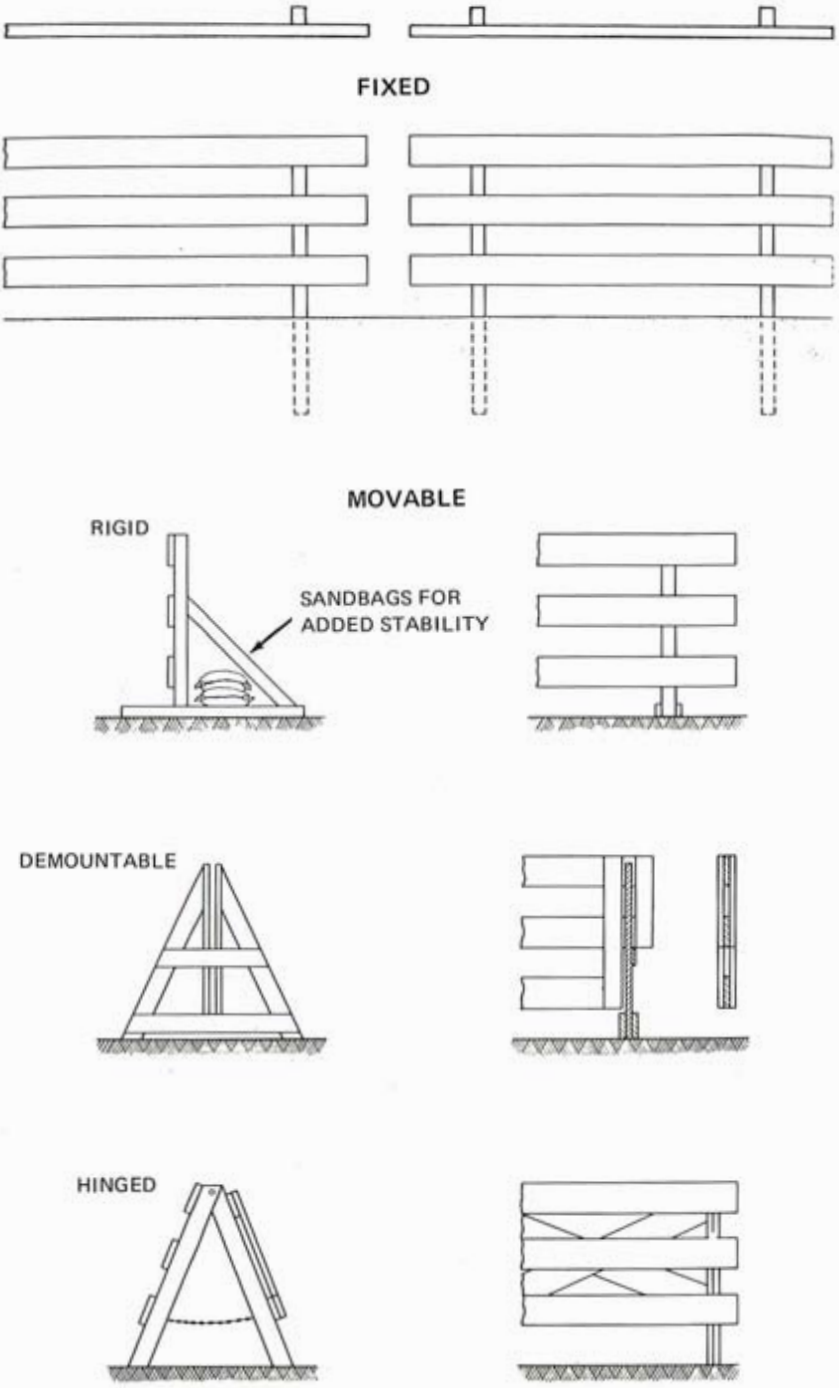


Figure 6–16. Type III barricade construction—typical examples.

When a road or street is legally closed, but access must still be allowed for local traffic, the Type III barricade cannot be erected completely across a roadway. Instead, an arrangement should be devised that will permit local use but effectively discourage use by through traffic. A sign with the appropriate legend concerning permissible use by local traffic should be installed.

Applications of this principle are illustrated in figures 6–3 and 6–4.

Type I or Type II barricades shall be used when traffic is maintained through the area being constructed and/or reconstructed. The important characteristic of these barricades is that each is movable, and they may be used interchangeably. In general, Type I barricades are the heavier and more bulky of the two, but these factors are dependent in large part, on the materials from which each type is constructed.

The ultimate choice in a given situation would probably be dependent upon the degree of mobility required in the particular project. It should be kept in mind, however, that Type I and Type II barricades, although movable, are somewhat clumsy and are not as adaptable to changeable situations as traffic cones.

Where maintenance activities are being performed, a street or highway condition is seldom of a character that will require a complete closing of the facility. When such a condition does occur, it is almost always an emergency situation, as would result from a broken water main or a washed-out culvert, for example. Repair work is generally initiated on an emergency basis and the street or road closing generally is of a kind wherein Type I or Type II is utilized.

Wing barricades are a special application of Type III barricades, erected on the roadway shoulder (on one or both sides of the pavement) to give the illusion of a narrowed or restricted roadway. In advance of a construction or maintenance area, even where no part of the roadway is actually closed, wing barricades serve a useful purpose in alerting the driver. If used in a series, they should start at the outer edge of the shoulder and be brought progressively closer to the pavement. Wing barricades may be used as a mounting for the advance warning or guide signs or lighting devices. During periods of inactivity, a foldaway type of design may be advantageous. Examples of wing barricades are shown in figure 6–11.

Signs may be erected on barricades, particularly those of the fixed type, and they offer a most advantageous facility for this purpose. The ROAD CLOSED and Detour Arrow signs, and the Large Arrow warning signs, for example, can effectively be mounted above the barricade that closes the roadway.

6C–8 Barrel or Drum Application

Barrels or drums are an effective traffic control device, particularly for use in construction areas.

One effective application is to delineate an unusual vehicle path made necessary by the construction activity. Another effective application occurs on road widening projects, where a row of barrels is used at night to mark the edge of pavement and channelize traffic away from an open trench alongside the pavement. During working hours, the same barrels are moved onto the pavement to provide working room for the construction activity and smoothly channelize traffic around the work area.

Barrels or drums are bulky and not readily transportable, but they are highly visible and have good target value. They give the appearance of being formidable obstacles and, therefore, command the respect of drivers, yet they do not inflict undue damage to a vehicle in the event they are struck. Finally, the barrels are portable enough to be shifted from place to place within a construction project in order to accommodate changing conditions as construction progresses. Barrels should not be weighted with sand, water or any material to the extent that would make them hazardous to motorists. As an effective channelizing method, barrels or drums may be used to support conventional guardrail sections.

For routine maintenance activities, barrels or drums are seldom used because of their bulk and relative lack of portability. Where maintenance forces undertake work such as pavement replacement, however, barrels or drums may be included among the traffic control devices used. Their application should be as described above for construction projects.

6C–9 Traffic Cone Application

Included under this heading are a group of devices whose primary function is the channelization of traffic. They may be conical in shape, but there are also tubular shaped devices available capable of performing the same function. They may be set on the surface of the roadway or rigidly attached for continued use.

Traffic cones may be easily stacked on a truck and one workman can carry and distribute several cones with ease. This mobility and flexibility (which cannot be equalled by Type I barricades) increases the usefulness of these devices.

When cones are used, precautions are necessary to assure they will not be blown over or displaced. This may be particularly critical adjacent to lanes of moving traffic where there may be a wind created by passing vehicles. Some cones are constructed with bases that

may be filled with ballast. With others, it may be necessary to double the cones in order to provide added weight, or to construct weights such as a square of reinforcing rod, that can be dropped over the cone and onto the base to provide increased stability. These added weights should not be sufficient to present a hazard if the devices are inadvertently struck.

In general, traffic cones have a greater target value than do the tubular shaped devices. However, the target value of either device may be enhanced during the day time by the insertion of an orange flag in the top and at night, by the insertion of appropriate colored delineators in the tops or by use of internal lights.

6C–10 Delineator Application

As used herein, delineators mean all types of reflector units that are capable of reflecting light from either the upper or lower beam of automobile headlamps. Their usefulness in construction and maintenance zones is one of guidance rather than one of warning. Delineators properly installed will indicate the horizontal and vertical alignment of the roadway and thereby outline the required vehicle path through what otherwise might be a confusing alignment caused by construction or maintenance activities in the roadway. Delineators shall be spaced sufficiently close, to clearly outline the intended vehicle path during hours of darkness.

Delineator applications in construction or maintenance areas, would almost always be made in combination with some of the other traffic control devices discussed in the preceding paragraphs.

6C–11 Pavement Markings Application

When construction work necessitates the utilization of vehicle paths other than the lanes normally used (as indicated by existing pavement markings), daytime and nighttime drive-through checks should be made to evaluate the path (and the possibility that the pavement markings will inadvertently lead drivers into barricades and/or work sites). Where necessary these markings should be obliterated or removed.

Where stage construction requires changes in barricades or channelization, similar day-night checks and evaluations of the existing pavement marking should accompany each change.

When a temporary roadway is constructed to by-pass a closed portion of highway, appropriate reflectorized pavement markings shall be placed on the approach to, and throughout the length of, the temporary roadway. At locations where the duration of the temporary roadway is relatively short, pavement markings consist-

ing of reflectorized paint lines may not be practical due to the time required and expense involved in their removal.

Under the above conditions, adequate short term expendable pavement markings can be provided by use of pressure sensitive traffic marking tape or raised pavement markers. Either of these types of devices can be applied simply and quickly and can be removed with little or no difficulty when changing traffic patterns makes the installation obsolete.

Temporary pavement markings shall be used in combination with appropriate warning signs, channelizing devices and delineation to clearly indicate the required vehicle paths.

Where maintenance activities are being performed, the use of pavement markings generally has little application. Maintenance work performed on the roadway is usually accomplished during normal daytime working hours with the work site being protected by an adequate complement of warning signs and channelizing devices to indicate the proper vehicle path. However, on longtime maintenance jobs, such as the removal and replacement of a portion of a bridge deck, the existing pavement marking may be a significant item to be considered in the traffic control plan to be employed. The application of pavement markings should then be as discussed above for construction projects.

6C–12 Channelization

The single most important element, within the system of traffic control devices commonly used in construction or maintenance areas (where a reduction in pavement width is involved), is the taper that is provided for the channelization. An inadequate taper will almost always produce undesirable traffic operations with resulting congestion and possibly accidents through the area.

A minimum desirable taper rate expressed as length in feet per foot of offset and numerically equal to the 85 percentile speed is essential for smooth traffic operations. For example, if a lane is to be closed on a roadway with an existing 60 MPH 85 percentile speed, the channelization to accomplish the transition should be placed on a 60:1 taper.

The minimum desirable length derived from the rate indicated above applies to roadway conditions of relatively flat grades and straight alignment. Adjustments may become necessary to provide adequate sight distance on the approach to the channelization. Similarly, the proximity of interchange ramps, crossroads, etc., to the work site may dictate the need for adjustments. In general, better traffic operations will result when the adjustments consist of increasing the length of the taper rather than reducing the length (below the minimum desirable recommended above).

The real test concerning adequate length of taper is the operation of vehicles through the transition. It should be long enough so that drivers of vehicles approaching side by side have sufficient length in which to adjust their respective speeds and merge into a single lane before the end of the transition. A brief period of observing driver performance will generally provide some clear indications of the adequacy of the taper length. For example, if severe brake applications are observed, an increased taper length is indicated.

On construction projects channelization often remains in the same place for long periods of time. During such a long interval some of the elements—cones, barricades, barrels, etc.—get out of their original alignment due to being struck, moved due to construction activities, etc. It is necessary, therefore, to patrol the channelization at regular intervals to assure its proper functioning as a traffic control device. Replacement or shifting of the elements into the original alignment can best be done if the original positions of the elements had been indicated on the pavement by paint marks. This technique assures good alignment and proper vehicle performance over a long period of time with minimum expenditure of men and materials in maintaining the channelization.

Sometimes during maintenance operations, work at one site will extend over several days, thereby requiring that channelization be set up each morning and removed each evening. Under these circumstances the locations of the cones, barrels, etc., should be marked at the time of the original set-up to facilitate the rapid, orderly re-setting of the devices on each succeeding day.

D. LIGHTING DEVICES

6D–1 Function

Construction and maintenance activities often create conditions on or near the traveled way that are particularly hazardous at night when the ability of drivers to see is sharply reduced from daytime conditions. It is often desirable and necessary to supplement the reflectorized signs, barriers and channelizing devices with lighting devices that are described in the following paragraphs.

Three types of electric lights are commonly used: floodlights, steady burning lights, and flashing lights.

6D–2 Floodlights

On construction projects, floodlights have a limited, but important application. Sometimes large construction contracts are prosecuted on a double shift basis, particularly earth moving activities. Oftentimes, the earth moving involves a haul road crossing a public high-

way, at which point a flagman station is generally set up. In order to assure the safest possible conditions at this type of location, it is advisable to supplement the warning devices (used in advance of the crossing) with floodlighting of the flagman station and the crossing site. Care is required in order to adequately illuminate the desired area without creating glare in the eyes of drivers on the highway. The adequacy of the floodlight placement can best be determined by driving through and observing the floodlighted area from each direction on the highway.

Maintenance activities on urban freeways, with high volume, high density traffic conditions, are frequently required to be conducted during nighttime periods (with low traffic volumes). Good floodlighting of the work site is a necessity because the workmen need to see what they are doing and because the workmen and the work site need to be seen by passing drivers. The lighting units should be positioned so they do not cause glare to drivers on the highway.

6D–3 Hazard Identification Beacons (Flashing Electric Lights)

A Hazard Identification Beacon is a flashing yellow signal light (minimum diameter 8 inches) used at points of special hazard as a means of calling drivers' attention to these locations. When used, the flashing beacon should operate 24 hours a day.

On construction projects, because of the time and effort required to install and put these units into operation, they are used, generally, only at locations where frequent changes would not be required.

On projects where an existing dual highway is being upgraded to freeway standards (which requires the use of crossovers to permit stage construction) flashing beacons have been used effectively to call drivers' attention to the hazard created by the necessary channelizing devices. Similarly, the temporary terminus of a freeway (where all traffic is channelized into an exit) is a location where beacons have informed drivers of the speed reduction necessary in transitioning from freeway to local road operations.

Hazard Identification Beacons may be operated singly or in groups containing more than one Unit.

During normal daytime maintenance operations, the functions of flashing beacons are adequately provided for by the lighting equipment on maintenance vehicles, either the emergency flashers, the rotating dome light, or both. However, at locations where the daytime maintenance activity requires an obstruction to remain in the roadway at night, flashing beacons may be installed at the point of hazard. At locations where vandalism is no problem, the power may be provided by a portable electric generator.

6D–4 Steady Burning Electric Lamps

As used herein, steady burning electric lamps shall mean a series of low wattage yellow electric lamps. They may be used to mark obstructions or hazards, but they are generally less effective than flashing lights for these uses because of the attention getting effect of the latter. However, where lights are needed to delineate the traveled way through and around obstructions in a construction or maintenance area, the delineation shall be accomplished by use of steady burning lamps.

Steady burning lamps, placed in a line on longitudinal barricades, have been effective in delineating the proper vehicle path through stage construction areas (which require changing patterns of traffic movement).

The application of these devices during maintenance activities is infrequent due to the generally short time nature of maintenance work. A type of maintenance activity where steady burning lamps could be utilized is the removal and replacement of a portion of a bridge deck. The lamps could be mounted on barricades and effectively aid in channelizing traffic around the work area.

6D–5 Barricade Warning Lights

As used herein, Barricade Warning Lights are portable, lens directed, enclosed lights. The color of the light emitted shall be yellow. They may be used in either a steady burn or flashing mode. Barricade warning lights shall be in accordance with the requirements of ITE Standard for Flashing and Steady Burn Barricade Warning Lights (1971) (table VI–2).

Table VI–2
Barricade Warning Lights

	Type A *Low Intensity*	Type B *High Intensity*	Type C *Steady Burn*
Lens Directional Faces	1 or 2	1	1 or 2
Flash Rate per Minute	55 to 75	55 to 75	Constant
Flash Duration[1]	10%	8%	Constant
Minimum Effective Intensity[2]	4.0 Candelas	35 Candelas	
Minimum Beam Candle Power[2]			2 Candles
Hours of Operation	Dusk to Dawn	24 hrs/day	Dusk to Dawn

[1] Length of time that instantaneous intensity is equal to or greater than effective intensity.

[2] These values must be maintained within an elliptical pattern 9° on each side of the vertical axis, and 5° above and 5° below the horizontal axis.

Type A Low Intensity Flashing Warning lights are most commonly mounted on separate portable supports, on Type I or Type II barricades, or on vertical channelizing devices, and are intended to continually warn the driver that he is proceeding in a hazardous area.

Type B High Intensity Flashing Warning lights are normally mounted on the advance warning signs or on independent supports. Extremely hazardous site conditions within the construction area may require that the lights be mounted on Type I barricades, signs, or other supports. As these lights are effective in daylight as well as dark, they are designed to operate 24 hours per day.

Type C Steady Burn lights are intended to be used to delineate the edge of the traveled way on detour curves, on lane changes, on lane closures and on other similar conditions. Their application shall be as indicated in section 6D–4.

The light weight and portability of barricade warning lights are advantages that make these devices useful as supplements to the reflectorization on hazard warning devices. The flashing lights are effective in attracting a driver's attention and, therefore, provide an excellent means of identifying the hazard. Flashers shall not be used for delineation, as a series of flashers would tend to obscure the desired vehicle path.

Portable supports for barricade warning lights shall provide a minimum mounting height of 36 inches to the bottom of the lens (fig. 6–15). These stands are not intended for use as standard barricades.

6D–6 Special Lighting Units

Special lighting units, generally trailer-mounted for easy transport to a job site, have been developed to supplement conventional signs, pavement markings and lighting for maintenance activities. The flashing lights on the unit are operated from a self-contained power source mounted on the trailer, either batteries or an electric generator. A variety of light configurations are used for traffic warning and guidance. Most units are designed with racks, channels or other devices so that signs may be displayed with messages appropriate to the particular kind of work being performed.

These special lighting units are used most frequently on high density urban freeways and are placed just in advance of the work site. The flashing lights, together with appropriate signs, have proven to be very effective warning devices while also providing some physical protection to the maintenance men at work.

Although these special lighting units were developed to satisfy a need on urban freeways, they have many applications on all types

of highways. Their mobility, together with the availability of flashing lights and/or a variety of sign messages makes them useful for almost any situation where conditions require extraordinary advance warning of the maintenance activities. If the units are to be used at night, consideration should be given to providing a means whereby the intensity of the flashers may be reduced during darkness when the lower intensities are desirable.

6D–7 Lanterns or Torches

As used in this Manual, lanterns and torches are single-unit, portable, constant-burning, low-intensity types of lights with open or enclosed flame. They provide negligible illumination of other objects, and are not altogether dependable under adverse weather conditions such as high wind or heavy rain. Furthermore, the flammable fuel used in the lanterns or torches may be a hazard to life and property, and their use, therefore, is not recommended, except in the special circumstances described below.

Open flame torches may have an application in rural areas where under nighttime conditions, they might be the only device available to a maintenance man to put into immediate use, in the event of an emergency. However, even under these conditions, the torches should be replaced as quickly as possible with more effective devices that have been discussed in the previous sections.

E. CONTROL OF TRAFFIC THROUGH WORK AREAS

6E–1 Function

The primary function of traffic control procedures is to move traffic safely and expeditiously through or around work areas.

The control of traffic through work areas is an essential part of highway construction and maintenance operations. For these operations there must be adequate legislative authority for the implementation and enforcement of needed traffic regulations, parking controls and speed zoning. Such statutes must provide sufficient flexibility in the application of traffic control to meet the needs of the changing conditions in work areas.

Maintaining good public relations is necessary. The cooperation of the various news media in publicizing the existence of and reasons for work sites, therefore can be of great assistance in keeping the motoring public well informed.

6E–2 Hand Signaling Devices

A number of hand signaling devices, such as red flags, STOP/SLOW paddles and lights are used in controlling traffic through

work areas. The flag is the most common device used during the daylight hours. The sign paddle bearing the clear messages STOP or SLOW also may be used.

Flags used for signaling purposes shall be a minimum of 24 by 24 inches in size, made of a good grade of red material securely fastened to a staff approximately 3 feet in length. The free edge should be weighted to insure that the flag will hang vertically, even in heavy winds.

Sign paddles should be at least 24 inches wide, with 6 inch series C letters. A rigid handle should be provided. This combination sign may be fabricated from sheet metal or other light semirigid material. The background of the STOP face shall be red with white letters and border. The background of the SLOW shall be orange with black letters and border. When used at night the STOP face shall be reflectorized red with white reflectorized letters and border, and the SLOW face shall be reflectorized orange with black letters and border.

6E–3 Flagmen

Since flagmen are responsible for human safety and make the greatest number of public contacts of all construction personnel, it is important that qualified personnel be selected. A flagman should possess the following minimum qualifications:

1. Average intelligence.
2. Good physical condition, including sight and hearing.
3. Mental alertness.
4. Courteous but firm manner.
5. Neat appearance.
6. Sense of responsibility for safety of public and crew.

The use of an orange vest, and/or an orange cap shall be required for flagmen. For nighttime conditions similar outside garments shall be reflectorized.

Flagmen are provided at work sites to stop traffic intermittently as necessitated by work progress or to maintain continuous traffic past a work site at reduced speeds to help protect the work crew. For both of these functions the flagman must, at all times, be clearly visible to approaching traffic for a distance sufficient to permit proper response by the motorist to the flagging instructions, and to permit traffic to reduce speed before entering the work site. In positioning flagmen, consideration must be given to maintaining color contrast between the flagman's protective garments and his background.

6E–4 Flagging Procedures

The following methods of signaling with a flag should be used:

1. *To Stop Traffic.* The flagman shall face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis, the free arm may be raised with the palm toward approaching traffic.

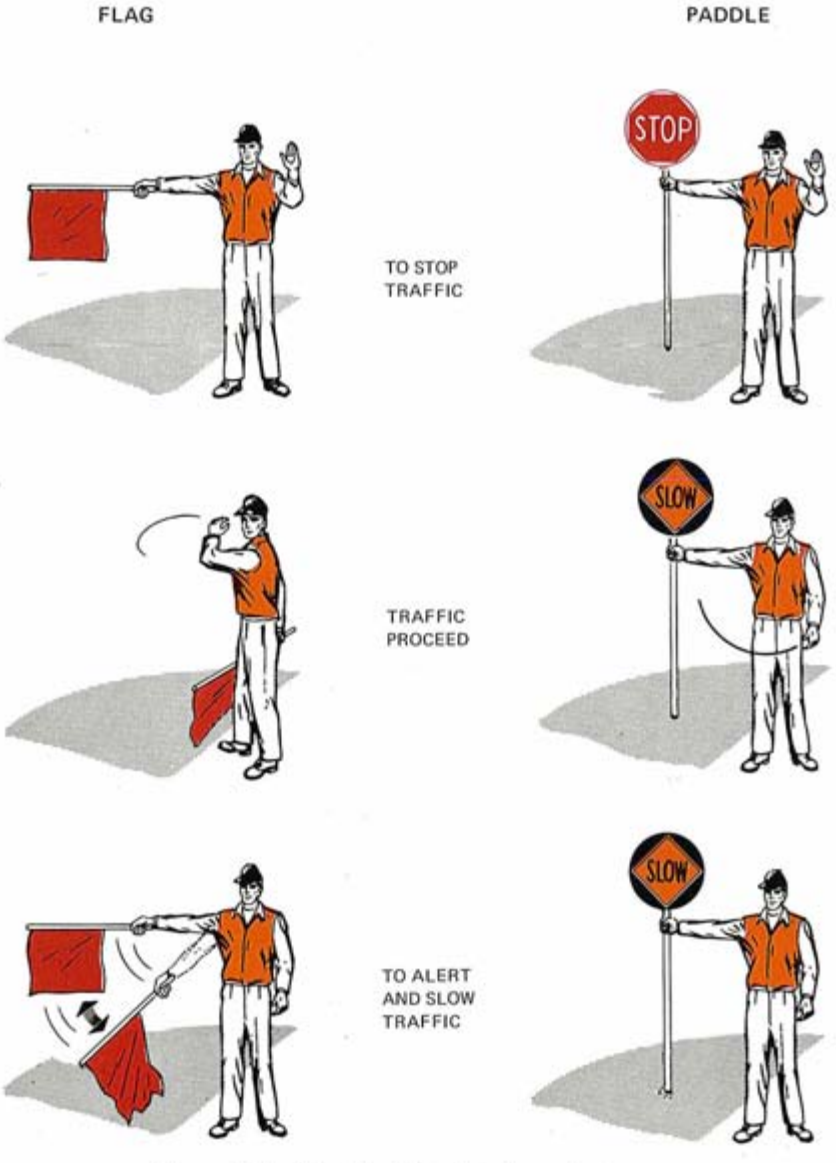


Figure 6–17. Use of hand signaling devices by flagman.

2. *When it is Safe for Traffic to Proceed.* The flagman shall stand parallel to the traffic movement, and with flag and arm lowered from view of the driver, motion traffic ahead with his free arm. Flags shall not be used to signal traffic to proceed.

3. *Where it is Desired to Alert or Slow Traffic.* By means of flagging, the flagman shall face traffic and wave the flag in a sweeping motion of the arm across the front of the body without raising the arm above a horizontal position.

If a sign paddle is used, it shall be held in a stationary position with the arm extended horizontally away from the body. The use of the flag and sign paddle are illustrated in figure 6–17.

Lights approved by the appropriate highway authority or reflectorized sign paddles or reflectorized flags shall be used to flag traffic at night. Daytime flagging procedures shall be followed whenever such lights, paddles or flags are used at night.

Whenever practicable, the flagman should advise the motorist of the reason for the delay and the approximate period that traffic will be halted. Flagmen and operators of construction machinery or trucks should be made to understand that every reasonable effort must be made to allow the driving public the right-of-way and prevent excessive delays.

6E–5 Flagman Stations

Flagman stations shall be located far enough in advance of the work site so that approaching traffic will have sufficient distance to reduce speed before entering the project. This distance is related to approach speed and physical conditions at the site; however, 200 to 300 feet is desirable. In urban areas when speeds are low and streets closely spaced, the distance necessarily must be decreased.

The flagman should stand either on the shoulder adjacent to the traffic he is controlling or in the barricaded lane. At a "spot" obstruction he may have to stand on the shoulder opposite the barricaded section to operate effectively. Under no circumstances should he stand in the lane being used by moving traffic. He should be clearly visible to approaching traffic at all times. For this reason he should stand alone, never permitting a group of workmen to congregate around him. He should be stationed sufficiently in advance of the work force to warn them of approaching danger, such as out-of-control vehicles.

Flagman stations should be adequately protected and preceded by proper advance warning signs. At night, flagman stations should be adequately illuminated.

6E–6 One-Way Traffic Control

Where traffic in both directions must, for a limited distance, use a single lane, provision should be made for alternate one-way movement to pass traffic through the constricted section. At a "spot" obstruction, such as an isolated pavement patch, the movement may be self-regulating. However, where the one-lane section is of any length, there should be some means of coordinating movements at each end so that vehicles are not simultaneously moving in opposite directions in the section and so that delays are not excessive at either end. Control points at each end of the route should be chosen so as to permit easy passing of opposing lines of vehicles.

Alternate one-way traffic control may be effected by the following means:

1. Flagman control.
2. Flag-carrying or official car.
3. Pilot car.
4. Traffic signals.

6E–7 Flagman Control

Where the one-lane section is short enough so that each end is visible from the other end, traffic may be controlled by means of a flagman at each end of the section. One of the two should be designated as the chief flagman for purposes of coordinating movement. They should be able to communicate with each other verbally or by means of signals. These signals should not be such as to be mistaken for flagging signals.

Where the end of a one-lane section is not visible from the other end, the flagmen may maintain contact by means of radio or field telephones. So that a flagman may know when to allow traffic to proceed into the section, the last vehicle from the opposite direction can be identified by description or license.

6E–8 Flag-Carrying or Official Car

Flag carrying is effective when the route is well defined and nonhazardous. It should be employed only when the one-way traffic is confined to a relatively short stretch of road, usually not more than 1 mile in length.

The driver of the last vehicle proceeding into the one-lane section is given a red flag (or other token) and instructed to deliver it to the flagman at the other end. The opposite flagman, upon receipt of the flag, then knows that it is safe to allow traffic to move in the other direction. The flag being carried should always be clean and dry.

A variation of this method is the use of an "official" car which always follows the last vehicle proceeding through the section. The use of an official car eliminates the possibility of loss of the flag.

6E–9 Pilot Car

The use of a pilot car for traffic control can be most effective where the route is particularly hazardous, or so involved or frequently altered as to preclude adequate signing. The pilot car is used to guide a train of vehicles through the job or detour. Its operation must be coordinated with flagging operations or other controls at each end of the one-lane section. Sufficient turnaround room should be provided at these points. Provision should be made for identification of the last vehicle in the column.

The vehicle selected for pilot-car study should be light weight and easy to handle and should have the name of the contractor or contracting authority prominently displayed. The Pilot Car sign (sec. 6B–39) shall be mounted on the rear of the vehicle.

Two or more pilot cars may be used to guide two-way traffic through a particularly complex or hazardous detour.

6E–10 Traffic Control Signals

Traffic control signals may be used for special applications to control vehicular traffic movements at construction or maintenance work areas.

Typical applications include:

1. A highway or street intersection with a temporary "haul road" or equipment crossing.

2. Through areas requiring one-way traffic operations..

All traffic signal and control equipment shall meet the applicable standards and specifications prescribed in Part IV of this Manual. Normally, these installations shall be operated by means of traffic actuation or manual control.

One-way traffic operation necessitates the use of an all-red interval of sufficient duration for traffic to clear the zone at the speed posted through the work area.

F. EXPRESSWAYS AND LIMITED ACCESS FACILITIES

6F–1 Application of Standards

Serious problems of traffic control occur under the special conditions encountered where traffic must be moved through or around maintenance or construction operations on high-speed, high-volume facilities. Although the general principles outlined in the previous

sections of the Manual are applicable to all types of highway facilities, special consideration must be given to the modern, high-speed and usually limited access-type of highway to accommodate traffic in a safe and efficient manner and for adequate protection of work forces. The density of traffic on these facilities requires that traffic control procedures be implemented, for example, to permit critical merging maneuvers to occur well in advance of work areas and in a manner which creates minimum turbulence in the traffic stream. These situations may require a much higher type of device than specified for normal rural or urban street use. The same important basic considerations of uniformity and standardization of general principles apply, however, for all facilities.

6F–2 Problem Areas

The conduct of maintenance and construction operations under high-speed, high-density traffic on controlled-access highways is complicated by many of the design and operational features inherent in their use.

The presence of median dividers on many facilities which establish separate roadways for directional traffic also may prohibit the closing of that roadway for maintenance operations or the diverting of traffic to other lanes.

Lack of access to and from adjacent facilities prohibits rerouting of traffic away from work areas in many cases.

A major consideration in the establishment of traffic controls is the vehicular speed differential which exists and the limited time for drivers to safely react to unusual conditions.

In many cases, the year-round night and day intensity of use of expressways and limited-access facilities means that there is no season during which maintenance work can be scheduled when traffic volumes and density are low. Instead, these activities must be performed under extremely hazardous conditions.

Other conditions exist where work must be limited to night hours necessitating increased use of warning lights and illumination for work areas and advance warning systems.

The following sections emphasize some of the special considerations which must be applied in the application of devices for control of traffic, considering the above conditions.

6F–3 Signs

The messages of most of the standard warning signs described previously are applicable; however, signs larger than 48″ x 48″ may be desirable or required for additional emphasis. For large signs,

a rectangular shape may be justified with approval of the appropriate highway authority. Movable signs mounted on trucks or trailers with specially constructed lighting units provide a means of giving additional advance warning to motorists. Requirements may exist for placing advance signs at ½, 1, or even 2 miles from the work site to inform traffic of possible delays before they reach exits that might lead to alternate routes and where traffic might be expected to back up past conventional warning signs placed at the work site. It is also desirable to place additional advance warning on adjacent facilities whenever entrances to the limited-access facility are past the usual warning signs.

A complete series of warning signs is generally required on both sides of the roadway for lane closures or other restrictions to traffic flow which may be encountered. The sign layout should provide the driver with specific information on the lane closed; for example, type of activity or event, speed controls, and special directions for passing around or through the work site. The reasonableness of all restrictions must be carefully evaluated to obtain maximum driver observance.

All supports for signing should be installed with breakaway or yielding features for motorists safety.

A variety of information and guide signs may be needed on the approach to work sites for various purposes in addition to the hazard warning signs.

6F–4 Barricades and Channelization

The direction of freeway-type traffic through or around work sites requires the use of prominently positioned barricades and delineation devices for establishing tapers for lane closures or other situations where traffic must divert from its normal path. The success or failure of a lane closure will often depend upon the ability of traffic in a closed lane to merge with the adjacent lane. In practice this merge does not usually take place until the taper barricades, cones or other devices are encountered. For this reason the taper length must be sufficiently long to give drivers every opportunity to find an acceptable gap in the adjacent lane before having to slow down or stop and impede other traffic. Under relatively normal conditions of speed and volume, and where adequate warning of a lane obstruction has been provided, the taper rate described in section 6C–12 should be sufficient. However, this length should be adjusted as required by traffic operations.

Because of space and other limitations, cones may have greater use than barricades for transition sections. For night use, illumination may be required in addition to reflectorization of all devices in the transition section.

6F–5 Lighting Devices

The general principles used for daytime freeway traffic controls are equally applicable at night. However, the need for adequate lighting devices is essential on high-speed facilities to maintain safe traffic flow. The addition of flashing lights to all advance warning signs and the complete illumination of night work areas should be considered.

6F–6 Control of Traffic

On freeway-type facilities, the objective of traffc control in maintenance and construction areas is to allow a free flow of traffic by keeping the maximum number of lanes open to traffic at all times. The use of traffic control signs should be discouraged. Additional police patrols and officers assigned to the work site to keep traffic flowing will minimize delays. During peak hour conditions or when congestion develops, it may be necessary to delay work progress until traffic is moving freely. An emergency traffic operation plan should be developed for alternate routing of traffic in the event of a complete closure of one or more segments of the highway. Predetermined routes should be employed to divert excess traffic around the obstructions by intercepting traffic at some earlier point on the roadway. A specially equipped traffic control vehicle housing a complete set of traffic control signs and devices as well as vehicle-mounted signs and lights should be available, as required.

Invaluable assistance to the traffic control on major facilities can be provided through advance use of the public information media. Radio and television announcements, newspaper notices, road condition reports and maps and ramp hand-outs can be effectively utilized to inform the public of anticipated delays or congestion resulting from necessary maintenance and construction activities.

These practices should complement the on-site traffic control procedures and the preplanning which is essential for effective operations.

Personnel used for work on controlled-access facilities should receive formal training in traffic control, in the conduct of work at these locations and in the importance of keeping traffic moving through and around maintenance and construction sites.