

Part V

TRAFFIC CONTROLS for HIGHWAY CONSTRUCTION and MAINTENANCE OPERATIONS

A—INTRODUCTION AND GENERAL SPECIFICATIONS

Section 5A-1 Need for Standards

Serious problems of traffic control occur under the special conditions encountered where traffic must be moved through or around road construction and maintenance operations. Such conditions are essentially temporary, but therefore the more dangerous and difficult to deal with because they are unexpected and not in accord with the normal pattern of highway traffic. Their record of accidents is convincing evidence of the need for the best protection possible.

Previous editions of this Manual have included a number of signs that are applicable to construction and maintenance operations—Men Working, Road Closed, and Detour, among others—but these have not always been sufficient, even in combination, nor have they been used consistently.

Obviously, no one standard sequence of signs or other control devices can be set up as an inflexible arrangement for all situations. Maintenance activities include such minor operations as shoulder mowing, tree trimming, and ditch clearing that may call only for a little extra care in driving, or some reduction in speed due to occasional encroachments on the traveled way. There may be other more tangible interferences in the form of standing or slowly moving equipment. Pavement patching or culvert repair may close parts of the roadway for extended periods, and a major job may reduce the traveled way to a single lane, over which vehicles must move alternately in one direction at a time. In the extreme case there is a complete closing of a road, with the diversion of traffic into a temporary routing.

Here is a range of requirements from the simplest sort of cautionary sign to the positive barricade. Even for the same job the necessary protection may vary from hour to hour and from day to day and particularly between day and night. Simple painted signs or barricades may be wholly sufficient by day, but at night such devices must be reflectorized and supplemented by torches, lanterns, flashers, or illumination. On the other hand,

some maintenance work is discontinued at night, leaving the highway altogether unobstructed.

Numerous State highway departments and cities have drawn up their own standards, for use by their own construction and maintenance employees and by road contractors and public utility forces. With regard to traffic control devices they are in varying degrees consistent with this Manual. On a national basis the American Association of State Highway Officials approved in 1955, a *Policy on Maintenance of Safety and Traffic Control Devices and Related Traffic Services*,³¹ which, with respect to traffic control devices, was in full accord with the then current edition of this Manual.

The following treatment of signs, signals, and markings for highway construction and maintenance work is intended to provide in effect a comprehensive handbook in its field, to be applied as a national standard. It establishes general principles to be observed in designing, installing, and maintaining traffic control devices on such work, and prescribes specific standards where possible. While it constitutes a part of this Manual, it is designed so that it can be used independently, for the convenience of those who are not concerned with the many other phases of traffic control. To that end some material concerning specifications and devices having more general application is repeated here from preceding parts of this Manual.

5A-2 Scope

This part sets forth basic principles and prescribes standards to be followed in the design, application, installation, and maintenance of all types of traffic control devices required for road construction and maintenance operations. Such devices include signs, signals, markings, barricades, and flagmen. Minimum standards of application are prescribed for typical situations, and methods of controlling traffic through work areas are described. As a part of these standards a number of typical situations are illustrated, showing the proper application of the standard protective devices.

These principles and standards are aimed at the protection of the public and workmen, the minimizing both of inconvenience to the public and of economic losses, and the maintaining of public good will.

Although these standards are basically applicable to both rural and urban situations, the specific provisions deal primarily with the problems normally found on rural highways. They are,

³¹ Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

however, equally suitable to high-speed controlled-access urban facilities, and with some modification to other urban facilities and to secondary highways. Applications to typically urban conditions are dealt with briefly in sections 5F-1 to 3.

5A-3 Application of Standards

Since it is not possible 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 open highway situations and that additional protection must be provided where special complexities and hazards prevail, particularly on high-speed, expressway-type facilities. Where speeds and volumes are relatively low, where the hazard is clearly apparent, or where a maintenance operation is short in duration, less than the "minimum" protection prescribed for normal open highway conditions may be adequate. 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.

5A-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 construction or maintenance under contract to any governmental authority, 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. Responsible officials should at all times maintain such supervision as to assure that protective devices will meet at least the minimum standards herein set forth.

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

5A-5 General Requirements

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

2. Traffic control devices shall be set up prior to the start of construction or maintenance operations, and shall be properly maintained 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 during the stage in progress. Signs such as **MEN WORKING** or **FLAGMAN AHEAD** shall be covered or set aside out of the view of traffic at times when they do not apply.

5A-6 Maintenance of Traffic Control Devices

In order to function most efficiently and retain their authority, traffic control devices must be well maintained. Deteriorated traffic control devices command little respect and lose effectiveness.

Signs shall be kept in proper position, clean, and legible at all times. Signs that do not apply to existing conditions shall be removed. Damaged, defaced, or dirty signs shall be cleaned, repaired, or replaced.

Barricades and sign supports shall be neatly constructed and shall not appear makeshift or hastily thrown together. They shall be repaired and cleaned or repainted as needed to keep up their appearance.

Oil-burning torches and lanterns shall not be placed so close to signs or barricades as to scorch them or deposit soot on them. Lantern globes shall not be allowed to become smoked or sooted. Special care shall be taken to see that weeds, shrubbery, construction materials or equipment, spoil, and snow are not allowed to obscure any sign, light, or barricade.

8—SIGNS

General

Section 5B-1 Design of Signs

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 road work. Special construction and maintenance signs follow the basic standards for all highway signs as to shape and color prescribed elsewhere in this Manual.

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 red flags 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 should be increased wherever necessary for adequate control and safety. On minor highways and secondary streets smaller signs may be used if authorized by competent authority.

Standard sign sizes and colors are here shown in the illustrations of the individual signs rather than in detailed specifications in the text.³²

5B-2 Illumination and Reflectorization

All signs that are to convey their messages 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. External illumination may be provided by incandescent or fluorescent lamps, or spotlights. Lamps should be properly shielded to protect drivers from glare. Torches or lanterns are for warning or guidance in themselves, and are not considered adequate for the purpose of sign illumination. Street or highway lighting is not regarded as meeting the requirements for sign illumination.

5B-3 Position of Signs

Signs must always be placed in positions where they will convey their messages most effectively without restricting lateral clearance or sight distance. Placement must therefore be accommodated to highway design and alinement. Signs must be so placed that the driver will have sufficient time to absorb the message before having to act.

As a general rule signs shall be located on the right-hand side of the roadway, with the near edge of the sign from 6 to 12 feet from the edge of the traveled way or at least 2 feet outside an unmountable curb. Where construction or maintenance operations are underway, however, it is often necessary to place signs on barricades within the roadway, or (usually as supplementary

³² Detailed working drawings of the signs specified herein are available on request from the Bureau of Public Roads.

or duplicate signs) on the left of the roadway. All signs should be mounted approximately at right angles to the direction of and facing the traffic they are to serve. Roadside signs should be mounted so that the bottom of the sign is approximately 5 feet above the pavement level. Where construction equipment or materials, or other obstructions, may be present this height should be increased to 7 feet. Standards for height and lateral clearance of roadside signs are shown in figure 5-1. Signs mounted on barricades, or temporary signs in the roadway, may be at lower heights as dictated by circumstances (fig. 5-2).

Regulatory signs are normally placed at the point where the regulations apply.

Where normal open highway speeds prevail on the approach to the work site, advance warning signs should be placed at least 750 feet in advance of the condition to which they are calling attention. Where a series of advance warning signs are used, the warning sign nearest the work site should be placed 500 feet from the point of restriction with the additional signs at 500-foot intervals. Where prevailing speeds are low in the approach to the hazardous area, signs may be placed at 300-foot spacings in the immediate vicinity of the work, and at even closer spacings in urban areas. On high-speed expressway-type facilities the advance warning distance should be increased to one-half mile or more. Typical sequences and spacings of advance warning signs are shown in figures 5-5 to 5-11.

5B-4 Erection of Signs

Signs are usually mounted on a single post, although those wider than 48 inches or larger than 10 square feet in area should generally be mounted on two posts.

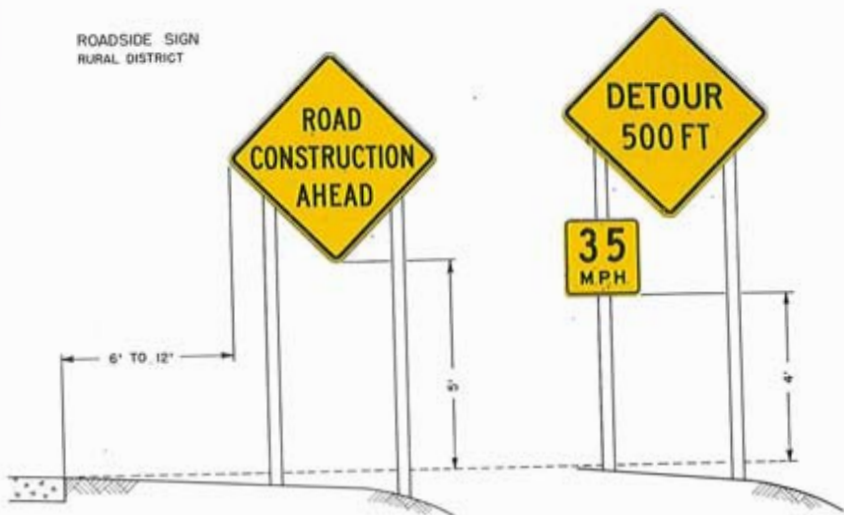
The Road Closed sign (sec. 5B-8) is normally mounted on the barricade that closes the road. The Advisory Speed plate, when used, is erected only in conjunction with a warning sign as prescribed in section 5B-34.

For maximum mobility on certain types of maintenance operations, a large sign may sometimes 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 paint-striping equipment.

Guide signs, although ordinarily erected on 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 5-2.

ROADSIDE SIGN
RURAL DISTRICT



WITH ADVISORY
SPEED PLATE

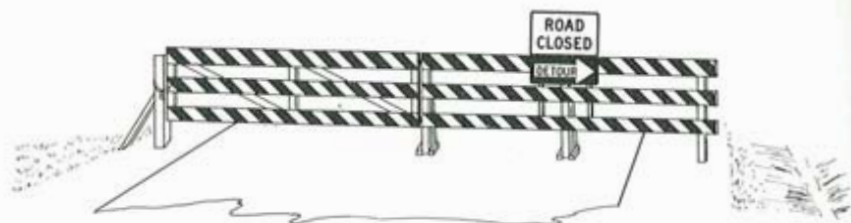
ROADSIDE SIGN
RURAL DISTRICT



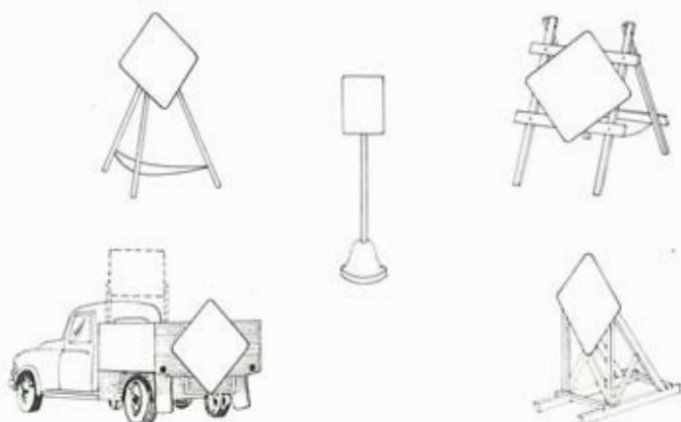
WITH ADVISORY
SPEED PLATE

Figure 5-1. Height and lateral location of signs—typical installations.

BARRICADE CLOSING A ROAD



PORTABLE AND TEMPORARY MOUNTINGS



WING BARRICADES

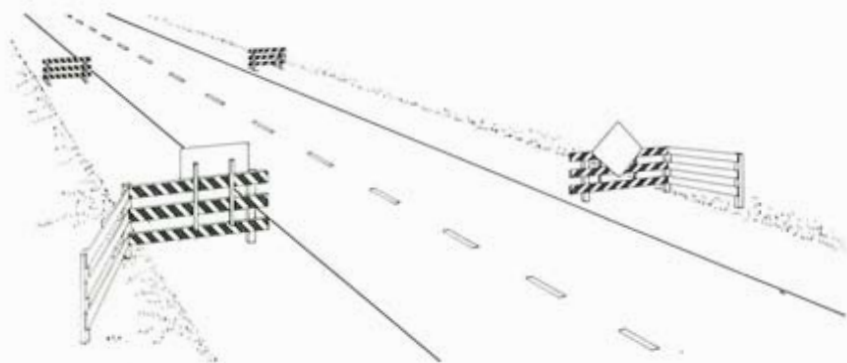


Figure 5-2. Methods of mounting signs other than on posts.

Regulatory Signs

Section 5B-5 Authority

Regulatory signs impose legal compulsions or restrictions on drivers. It is essential, therefore, that their use be officially authorized and that they conform to the standards officially adopted by the authorities having responsible jurisdiction.

5B-6 Design of Regulatory Signs

Regulatory signs are generally rectangular with their longer dimension vertical, and carry a black legend and border on a white background. There are, however, exceptions. The Stop sign is octagonal, and has a white legend and border on a red background. The Yield sign is a yellow inverted triangle with black legend and border. The One Way sign may be either a horizontal or a vertical rectangular plate, the latter being used more commonly in cities where space is limited. The Road Closed sign is usually mounted on a barricade, and its greater horizontal dimension is appropriate to such an application.

For regulatory signs 30 inches by 36 inches in size, or larger, white legend on a black background may be used.

5B-7 Application of Regulatory Signs

Construction and maintenance operations are usually temporary in duration, rarely warranting special official traffic control measures. Provisional control of traffic will ordinarily be accomplished through warning signs, while existing regulatory signs will usually remain in place. Control of speed through a construction or maintenance zone may be achieved by Advisory Speed plates (sec. 5B-34) in conjunction with warning signs. Passing can be discouraged by warning signs or channelization. One-way traffic can usually be directed by barricades, arrow signs, or flagmen.

A few standard regulatory signs, however, are necessary at times, the use of which must be officially authorized. Temporary intersections or intersections having temporarily altered traffic patterns may require Stop signs or Yield signs. Certain roadways may temporarily require One Way signs, Do Not Enter signs, or Do Not Pass signs. On long detours over existing roads it may be necessary to install additional controls of standard type to handle the augmented traffic. At some projects where traffic is maintained through the work site for an appreciable distance, it may be desirable in the interest of safety for the responsible authority to establish and post a legal maximum speed limit applicable throughout the entire section. Warning

signs with Advisory Speed plates should then be posted at those locations where the safe speed is lower than the imposed legal limit.

Regulatory signs of special importance for road work are the Road Closed sign, the Local Traffic Only sign, the Weight Limit sign, and signs calling attention to two-way operation.

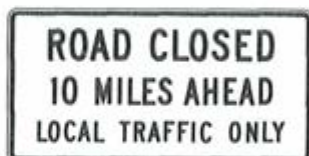
5B-8 Road Closed Sign (R10-2)

The ROAD CLOSED sign shall be used where the road is closed to all traffic except contractors' equipment and officially authorized vehicles. It should be erected at or near the center of the roadway on or above a Class I barricade (sec. 5C-3). 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 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 (R10-3) must be used (sec. 5B-9).



R10-2
48" x 30"



R10-3
60" x 30"

5B-9 Local Traffic Only Sign (R10-3)

The Local Traffic Only sign shall be used where through traffic must detour to avoid a closing of the highway at a construction or maintenance job some distance beyond, but where the highway is open for traffic up to the point of closure. It carries the legend ROAD CLOSED (10) MILES AHEAD—LOCAL TRAFFIC ONLY. It should be erected at the right of the roadway or, preferably, on a narrow barricade in the center of the roadway if the pavement width permits. Normally it will be accompanied by a Detour Arrow sign (sec. 5B-39) indicating the proper route for through traffic. The words BRIDGE OUT may be substituted for ROAD CLOSED where applicable. Where the sign faces through traffic it shall be preceded by an Advance Road Closed sign with the secondary legend AHEAD (sec. 5B-21) and, if applicable, an Advance Detour sign (sec. 5B-20).

5B-10 Weight Limit Sign (R10-4)

The Weight Limit sign shows the maximum gross weight of a vehicle that can safely be permitted on a road surface or bridge. Weight restrictions should not be imposed without the approval of the authority having jurisdiction over the highway, and a reasonable effort should be made to provide temporary facilities capable of carrying the traffic normally using the highway.



R10-4
18" x 24"



R6-3
24" x 30"



R6-5
24" x 30"

5B-11 Two Way Traffic Ahead Sign (R6-3)

The TWO WAY TRAFFIC AHEAD sign shall be used on a one-way roadway just in advance of a point where it becomes a two-way roadway. It may be supplemented by Keep Right or arrow signs, barricades, or other channelizing devices.

5B-12 Two Way Traffic Sign (R6-5)

The TWO WAY TRAFFIC sign is intended for use where a roadway designed or normally used for one-way traffic is temporarily being used for traffic in both directions, or where under any other circumstances it may be necessary to remind drivers that they are traveling on a two-way roadway. The sign should be placed at intervals of about one-half mile, but not exceeding one mile. Special care must be taken to place it at or just beyond any important access points.

5B-13 Special Regulatory Signs

Various other regulatory or quasi-regulatory signs may be called for by special operations in or around the roadway. Although it is not practicable to standardize many such signs in detail, they should conform to the general standard of a rectangular shape with a black legend on a white background. Their messages should be brief, legible, and clearly understandable. Typical examples are: KEEP OFF WET PAINT; BLASTING ZONE (OR AREA)—TURN OFF 2-WAY RADIO (OR NO RADIO TRANSMISSION); and NO STOPPING.

Warning Signs

Section 5B-14 Function of Warning Signs

Warning signs are the most important type of signs used to protect traffic, equipment, and workmen where road construction or maintenance operations are underway. Within the construction zone there may be various temporarily substandard facilities, where roadway width is reduced, a detour is necessary, open excavations are present in or near the roadway, or an unpaved section must be traversed. If drivers are properly alerted to possible dangers ahead and so reduce their speed to meet the anticipated hazards, they will be able to deal with whatever special conditions are present.

Many warning signs that may be required for road construction and maintenance operations are identical with those used for similar hazards elsewhere on the highway. In fact, almost every standard warning sign may at one time or another be needed on a construction or maintenance job or on detours temporarily provided.

5B-15 Design of Warning Signs

With few exceptions standard warning signs are diamond-shaped (square, with one diagonal vertical), having a black symbol or message on a "highway yellow" background. For the unexpected hazards caused by major road construction work it is important that the advance signs, at least, be of large size, for maximum visibility and legibility.

Where extensive or unusually hazardous construction or maintenance operations are to take place on major freeway or expressway facilities, extraordinarily large warning signs may be needed. Under some such conditions practical considerations may justify departure from the standard diamond shape, but such variances should have prior approval of the appropriate highway authority. **Such special warning signs may carry other than the standard messages, but they shall conform otherwise to the design standards for warning signs. This provision shall not be construed as permitting either a general use of rectangular warning signs or deviations from the standard messages where standard messages are applicable.**

As a special exception the warning signs described in sections 5B-27 to 32 may be square when they are mounted on, or as a part of, a small portable easel, for frequent moving on-minor maintenance operations.

The standard Advisory Speed warning plate is square for convenience in mounting it in conjunction with other warning signs.

Detailed specifications are here given only for the signs especially prescribed for construction and maintenance work and for a few other standard signs that are commonly required for similar application.

5B-16 Dimensions of Warning Signs

The standard sizes of warning signs shall be as shown with the sign illustrations herein. Where the messages of Construction Approach Warning signs (sec. 5B-17) are required at maintenance or minor construction sites, and where speeds and volumes are relatively low, they may be on 36-inch plates, provided that a minimum letter size of 5 inches can be accommodated on the plate.

Similarly, on minor roads or secondary streets where speeds are low, or where traffic has already been slowed by Construction Approach Warning signs, the use of plates 6 inches smaller on a side than the standard size, but not less than 24 inches, may be justified for other warning signs having short word messages or clear symbols.

If there is any question whether the standard size will be sufficiently conspicuous or legible, enlarged signs should be used.

5B-17 Construction Approach Warning Signs

Where major construction or maintenance is under way on a rural highway and any part of the roadway is obstructed or closed, it is necessary to give special advance warning, and for this purpose a series of Construction Approach Warning signs is provided in the following sections. **Because of their importance these signs shall have a standard size of 48 inches by 48 inches. They shall be of the standard diamond shape for warning signs, except as provided for in section 5B-15.**

5B-18 Application of Construction Approach Warning Signs

Construction Approach Warning signs are for the purpose of alerting traffic, well in advance, to serious obstructions or restrictions due to road work. In rural areas where space permits there should be at least three such signs, at 500, 1,000, and 1,500 feet, respectively, in advance of the point of restriction, erected as provided for in sections 5B-3 and 5B-4. These signs may be any appropriate combination of, or repetition of, the several approach signs (secs. 5B-19 to 25) or other suitable standard warning signs, typical applications of which are shown in figures 5-5 to 5-11. The advance distances specified are for relatively high-speed rural areas, and should be modified as necessary, as provided in section 5B-3.

It is recognized that circumstances may occur which will not

warrant the erection of these signs at specific advance distances, particularly where the work may not remain fixed at a definite point. The indication of an exact distance can be misleading or undesirable in cases where the restriction occurs in advance of the actual work-site, or where the first warning sign is of a general nature and more attention is desired for subsequent, more specific, signs. If it is not practical to indicate exact distances, the secondary legend AHEAD may be substituted for the distance expressed in feet, though it should not be used so far in advance as to lose significance. The secondary messages may be inserted by stenciling or by attaching a panel to the face of the sign.

Construction Approach Warning signs should be mounted on two posts, from 6 to 12 feet from the pavement edge (secs. 5B-3, 5B-4) or on wing barricades (sec. 5C-3), at appropriate advance distances. Where traffic is heavy, particularly on one half of a divided highway, the signs should be erected on both sides of the roadway.

5B-19 Advance Road Construction Sign (W20-1)

The Advance Road Construction sign is intended for use in advance of road construction projects as a general warning of possible obstructions or restrictions due to such work. It carries the legend ROAD CONSTRUCTION, followed by 1500 FT (W20-1a), 1000 FT (W20-1b), 500 FT (W20-1c), or AHEAD (W20-1d). Following its erection at 1,500 feet, it may be erected also at 1,000 feet and at 500 feet, or the more specific messages of other Construction Approach Warning signs may be used as may be appropriate.



W20-1c
48" x 48"



W20-2d
48" x 48"

5B-20 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, followed by 1500 FT (W20-2a), 1000 FT (W20-2b), 500 FT (W20-2c), or AHEAD (W20-2d). It may be used in repetition or in combination with other appropriate Construction Approach Warning signs.

5B-21 Advance Road Closed Sign (W20-3)

The Advance Road 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 CLOSED, followed by 1500 FT (W20-3a), 1000 FT (W20-3b), 500 FT (W20-3c) or AHEAD (W20-3d). It will normally be used in conjunction with other Construction Approach Warning signs, but where a local road is closed without provision of a detour it may be repeated at all three distances. In such a case there shall be erected, at the last preceding intersection where a detour is possible, the Local Traffic Only sign (sec. 5B-9).



W20-3b
48" x 48"



W20-4a
48" x 48"

5B-22 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 (sec. 5E-7). It carries the legend ONE LANE ROAD, followed by 1500 FT (W20-4a), 1000 FT (W20-4b), 500 FT (W20-4c), or AHEAD (W20-4d). It may be used in repetition or in series with other Construction Approach Warning 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. 5E-7 to 11).

5B-23 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 (secs. 5E-1, 2). It carries the legend **RIGHT** (or **LEFT**) **LANE CLOSED**, followed by **1500 FT** (W20-5a), **1000 FT** (W20-5b), **500 FT** (W20-5c), or **AHEAD** (W20-5d). This sign may be used in repetition or in series with other Construction Approach Warning signs.

For construction and maintenance operations, where the closing of a traffic lane is not only unexpected but may be masked by the presence of existing pavement markings or delineators, the Lane Closed sign is preferred to the standard Pavement Width Transition symbol sign (sec. 1C-21). An appropriate standard symbol may be used, however, with the permission of the proper authority.



W20-5d
48" x 48"



W20-6b
48" x 48"

5B-24 Advance Single Lane Sign (W20-6)

The Advance Single Lane sign is intended for use in advance of a point where traffic moving in one direction must use a single lane. It carries the legend **SINGLE LANE**, followed by **1500 FT** (W20-6a), **1000 FT** (W20-6b), **500 FT** (W20-6c), or **AHEAD** (W20-6d). It may be used in repetition or in series with other Construction Approach Warning signs, particularly the Lane Closed sign.

This sign shall not be used where traffic in both directions must use the one lane that is open.

5B-25 Advance Flagman Sign (W20-7)

The Advance Flagman sign shall be used 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 FLAGMAN, followed by 1500 FT (W20-7a), 1000 FT (W20-7b), 500 FT (W20-7c), or AHEAD (W20-7d). It will normally be preceded by other Construction Approach Warning signs, but may be repeated at any or all of the indicated distances.



W20-7c
48" x 48"

It may be for relatively permanent or temporary use. In the former case it should be on a fixed mounting. If the flagging operation is to be of short duration a portable support should be used, or a temporary attachment to a wing barricade (secs. 5C-5, 6). The sign shall be promptly removed, covered, or turned to face away from the roadway whenever the flagman is not at his station.

5B-26 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 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.

5B-27 Men Working Sign (W21-1)

The MEN WORKING sign shall be used in conjunction with minor maintenance and public utility operations for the protection of men working in or near the roadway. Where there is any

obstruction in the traveled way, other appropriate warning signs and devices as described herein should be used. In low-speed urban areas the Men Working sign may be used at limited obstructions which are adequately marked and clearly visible, such as an open manhole with a fence around it.



W21-1
30" x 30"



W21-2
24" x 24"

5B-28 Fresh Oil Sign (W21-2)

The FRESH OIL (or FRESH TAR) sign shall be used to warn motorists that resurfacing operations have rendered the surface of the pavement temporarily hazardous, and that objectionable splashing on vehicles may occur.

5B-29 Road Machinery Ahead Sign (W21-3)

The ROAD MACHINERY AHEAD sign shall be used in areas where heavy road equipment, such as a grader, is operating in or closely adjacent to the roadway.



W21-3
36" x 36"



W21-4
30" x 30"

5B-30 Road Work Ahead Sign (W21-4)

The ROAD WORK AHEAD sign is intended for use in advance of maintenance or minor reconstruction operations in the roadway (fig. 5-10).

5B-31 Shoulder Work Ahead Sign (W21-5)

The SHOULDER WORK AHEAD 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"

5B-32 Survey Party Sign (W21-6)

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

5B-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 I of this Manual, that may find application in work areas. These include the following:

- Large Arrows (W1-6, 7, sec. 1C-9).
- Road Narrows (W5-1, sec. 1C-19).
- Divided Highway Ends (W6-2, sec. 1C-23).
- Bump (W8-1, sec. 1C-25).
- Dip (W8-2, sec. 1C-26).
- Pavement Ends (W8-3, sec. 1C-27).
- Soft Shoulder (W8-4, sec. 1C-28).
- Truck Crossing (W11-1, sec. 1C-33).
- Loose Gravel (sec. 1C-37).
- Rough Road (sec. 1C-37).
- Falling Rock (sec. 1C-37).
- Low Shoulder (sec. 1C-37).

The application of most of these signs is prescribed in detail in part I of this Manual, but is generally apparent from their legends.

5B-34 Advisory Speed Plate (W13-1)

In conjunction with any warning sign, and only in combination with a warning sign, an Advisory Speed plate (sec. 1C-36) may be used to indicate a suitable safe speed through the hazardous

area. The speed shown on the plate is not intended as an enforceable limit. The Advisory Speed plate should show, in multiples of 5 miles per hour, a reasonable speed for normal conditions of weather and lighting. Too low a speed indication will be ignored and breed disrespect for all such signs.



W13-1
18" x 18"

The plate shall be mounted on the same assembly with the standard warning sign, normally below it. With warning signs larger than 36 inches on a side, the 24-inch Advisory Speed plate should be used. In this case the warning sign should be mounted at a height of 6 feet above the level of the roadway, and the Advisory Speed plate should be mounted on the post nearer the roadway, its top level with the bottom corner of the warning sign.

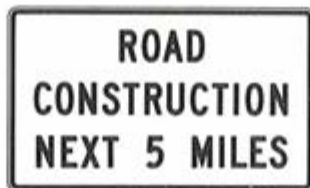
Guide Signs

Section 5B-35 Application of Guide Signs

Guide signs required at construction and maintenance operations include (1) normal directional signs and route markings, to the extent that temporary route changes are necessitated by road closings and detours, and (2) special informational signs relating to the work being done. The signs described in the following sections should be used where applicable.

5B-36 Length of Construction Sign (G20-1)

The Length of Construction guide sign shall be erected at the limits of any major road construction or maintenance job of more than 2 miles in extent, where traffic is maintained through the job.

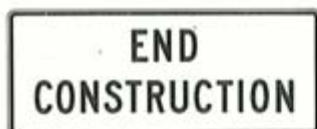


G20-1
60" x 36"

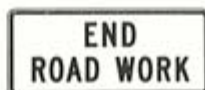
It carries the legend ROAD CONSTRUCTION NEXT (5) MILES. It can be effectively mounted on a wing barricade (sec. 5C-5).

5B-37 End Construction Sign (G20-2)

The END CONSTRUCTION sign shall be erected approximately 500 feet beyond the end of a major construction or maintenance job to indicate the limit of any restrictions or special precautions that have been imposed. Often it will suffice to place this sign on the back of the warning sign set up facing the opposite direction of traffic or on the back of a wing barricade (sec. 5C-5).



G20-2
60" x 24"



G20-3
42" x 18"

5B-38 End Road Work Sign (G20-3)

At minor maintenance operations marked by Men Working or Road Work Ahead signs, an END ROAD WORK sign should be used in a manner similar to the End Construction sign (sec. 5B-37) at the end of the work zone. Where the limits of the work zone are obvious, such as at a culvert repair job, a sign beyond the site will usually be unnecessary.

5B-39 Detour Arrow Sign (M5-7)

The Detour Arrow sign is used at a point where a detour roadway or route has been established due to the closure of a part of a highway to through traffic. It should normally be mounted just below the Road Closed sign (sec. 5B-8) or the Local Traffic Only sign (sec. 5B-9).



M5-7
48" x 18"

The Detour Arrow sign must be made with the arrow pointing to right or left as required at each location. Because it may be the only indication of the direction the detour takes, the standard size of this sign for construction and maintenance installations shall be 48 inches by 18 inches.

Where the detour is of any considerable length, it should be adequately marked with standard temporary route markers and

destination signs, as a responsibility of the highway department. Where an unmarked route is detoured, and on short detours in urban areas, the Detour Arrow sign in a 24- by 9-inch size (sec. 1D-24) may be used to indicate the points at which the detour changes direction.

5B-40 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 controlled one-way traffic through or around a road construction or maintenance project (sec. 5E-10). It carries the legend PILOT CAR—FOLLOW ME. A



G20-4
36" x 18"

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.

C—BARRIERS AND CHANNELIZING DEVICES

Section 5C-1 Function

Adequate barriers and channelizing devices, such as barricades, cones, drums, and sandbags, properly used, are essential to the safety of workmen and of the traveling public at most road construction and maintenance jobs. These devices, of themselves, convey no specific message, though a barricade may have signs mounted on it. They are intended to impose an obstacle, real or apparent, in the normal channel of travel, or to mark a limited channel of travel. They must be highly visible in themselves, but they should also be protected by adequate advance warning devices and by suitable lighting devices at night (secs. 5D-1 to 4). The provisions that follow are intended, in general, to apply to relatively high-speed, open highway situations.

Barricades

Section 5C-2 Application of Barricades

Barricades, as the name implies, are generally used to block off a part or all of a roadway, as illustrated in figures 5-5 to 5-9, and 5-11.

Where a road is closed to traffic, Class I barricades (sec. 5C-3)

shall be erected at the points of closure. They may extend completely across a roadway and its shoulders as a fence, but where the road must be open for access of equipment and authorized vehicles, 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 not invite public entry.

Oftentimes barricades close only a part of a roadway. In this case they must be placed across the entire width of the closed lane or lanes, including any adjacent travelable shoulder. They may be placed at an angle across the roadway, but generally it is preferable to place a barricade at right angles to the direction of approaching traffic. A barricade should never be placed in the line of traffic without advance warning devices. It is desirable to provide a line of cones or torches to guide traffic around a barricade which is in the path of traffic, if it is to be by-passed. To narrow a roadway gradually a series of barricades is often effective, with the first one on the shoulder and the succeeding ones each extending farther into the roadway (sec. 5E-1). A series of closely spaced cones or drums (sec. 5C-7), in line and preceded by a wing barricade (sec. 5C-5), can sometimes serve the same purpose. At horizontal or vertical curves where sight distances are inadequate, barricading should start sufficiently in advance of the curve to be fully visible to approaching traffic (fig. 5-5).

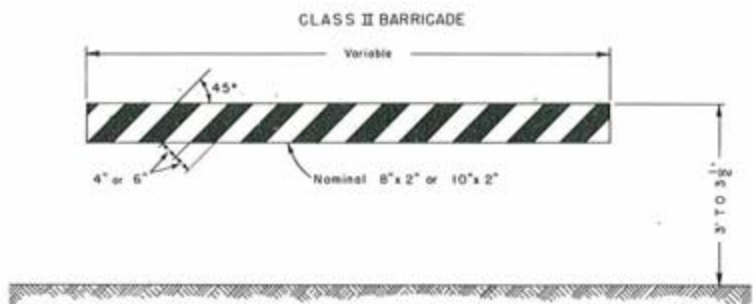
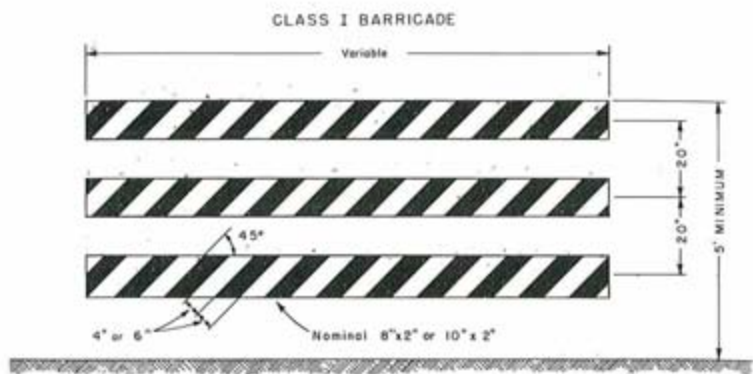
Beyond a barricade closing one or more lanes, it may be necessary to confine the traffic to certain lanes for some distance. Additional transverse barricades may be placed at close intervals in the closed lane or a series of Class II barricades (sec. 5C-3), cones, drums, or sandbags may be set in a longitudinal row along the edge of the closed area.

5C-3 Design of Barricades

The standard barricade shall be of either of two types, Class I or Class II, as here described (fig. 5-3).

A Class I barricade shall consist of three horizontal rails of nominal 8- or 10-inch width spaced vertically at approximately 20 inches, center to center, with the upper edge of the top rail at a height of approximately 5 feet above the roadway level. Barricades may be of variable length as required, and long barricades may be assembled from units of any convenient size. The Class I barricade is the type normally required for major operations, where the barricade must remain in place for extended periods.

A Class II barricade shall consist of a single horizontal rail of nominal 8- or 10-inch width, and length as required, with its



DRUMS

Adjustments due to odd size drums should
be divided between the upper and lower stripes

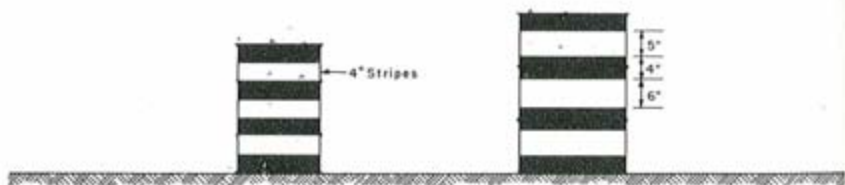


Figure 5-3. Standard barricade designs and drum markings.

top edge 36 to 42 inches above the roadway. This type is intended for use where the hazard is relatively small as, for example, on city streets, or for the more or less continuous delimiting of a restricted roadway, or for temporary daytime use.

The standard marking for barricades, as hitherto prescribed by this Manual, calls for alternate black and white sloping stripes. Although the effectiveness of this striping has been questioned, the evidence currently available does not appear to justify a recommendation for changing the standard. It is suggested, therefore, that pending further research the present standard be continued, but that the use of unstriped all-white barricades be permitted on an experimental basis. Similarly, the use of yellow in place of white on striped or unstriped barricades is permissible.

Where the striping is employed, each barricade rail shall be marked with alternate black and white (or yellow) stripes of 4- to 6-inch width at an angle of 45 degrees with the vertical, slanting downward toward the side on which traffic is to pass.

The direction of slope of the stripes cannot always follow the rule set forth above, as many barricades must not be passed on either side. Where a barricade extends entirely across a roadway, it is suggested 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 stripes should slope downward in both directions from the center.

All barricades used at night shall be effectively reflectorized. For increased emphasis at night lights or flashers may be mounted on barricades. Red flags may be similarly used during daylight hours.

5C-4 Construction of Barricades

Depending on the nature of the requirements, barricades may be fixed or movable. For fixed barricades the horizontal rails are mounted on posts set firmly in the ground. Fixed barricades are justified only for major construction or reconstruction work, particularly where local drivers have shown a propensity for evading movable barricades by shifting them to one side. They may also be necessary on rough ground or sloping shoulders, where a movable barrier will not stay in place. A type of fixed barricade is illustrated in figure 5-4.

Movable barricades are appropriate where the construction or maintenance operations are of short duration, or are progressively shifted along a roadway, or where occasional passage of equipment must be provided for. Various types of construction are suitable, some of which are illustrated in figure 5-4. The design

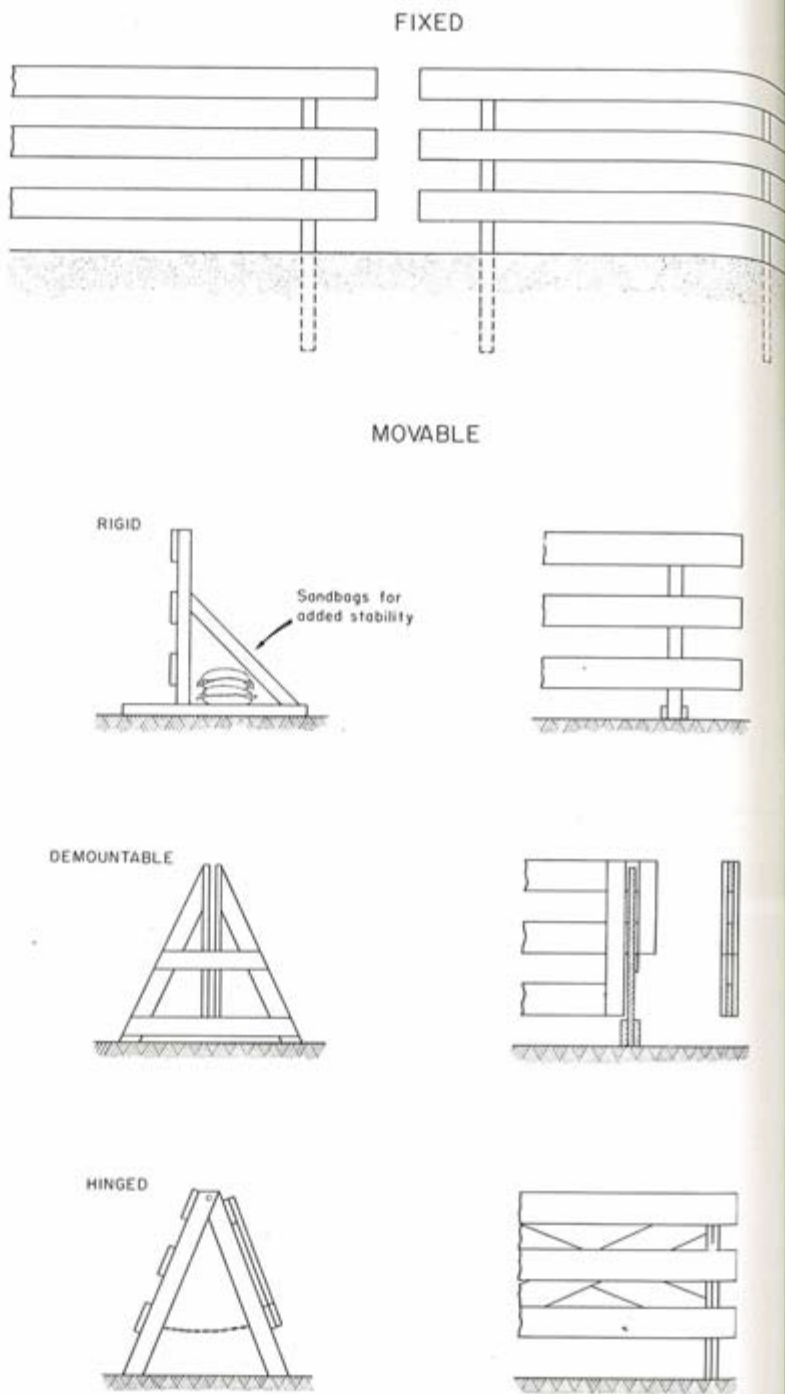


Figure 5-4. Class I barricade construction—typical examples.

of movable mountings must be such as to resist overturn by ordinary strong winds or by chance contact with vehicles.

Movable Class I barricades are generally of heavy rigid construction with a heavy base. Added resistance to overturning may be provided by sandbags. Where portability is of greater importance, a hinged and folding type is sometimes used.

Movable Class II barricades are commonly of the "horse" type, either rigid, hinged, or demountable. The rail on a horse barricade should be striped on both sides so that by reversing it the stripes will slope in the opposite direction.

Barricades need not, and ordinarily should not, be designed with sufficient strength to stop any vehicles that collide with them.

5C-5 Wing Barricades

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. Wing barricades are Class I barricades erected on the shoulder, on one or both sides of the pavement, to give the sensation of a narrowing or restricted roadway. 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 for flashers. Examples of wing barricades are shown in figure 5-2.

5C-6 Signs on Barricades

Barricades, particularly those of the fixed type, offer a most advantageous facility for the erection of signs (fig. 5-2). 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. The effectiveness of Construction Approach Warning signs can be enhanced by placing them on wing barricades adjacent to the roadway.

Auxiliary Barrier and Channelizing Devices

Section 5C-7 Cones and Drums

Where traffic volumes, speeds, and visibility are such as not to require the more substantial Class I or II barricades, effective use can be made of cones or drums. Cones and drums should not be regarded as an alternative to rail barricades. Under some circumstances, however, they can properly serve some of the same functions as barricades.

Cones, in particular, are often a useful adjunct to standard

barricades. They are especially useful during such temporary activities as pavement marking or tree trimming, where the portability of cones is a great advantage. In series, cones or drums can mark the outer limit of a travelable roadway adjacent to a ditch or an unfinished shoulder. Single drums can mark projecting manholes in a roadway under construction, or small but dangerous breaks in a pavement. Where portability is secondary, drums are preferable to cones in that they provide a heavier and more substantial barricade and encourage drivers to keep at a safe distance.

Particularly on rural highways, cones or drums should never be placed in the roadway without advance warning signs or wing barricades.

Cones are commercially available in various sizes from 18 inches to 30 inches in height, with a broadened base, and are made of rubber or other material to withstand impact without damage to themselves or to striking vehicles. Cones of the larger sizes should be used where speeds are relatively high or wherever else conspicuous guidance is necessary. Cones are usually yellow in color and often have black bases and red peaks. **It is here prescribed that yellow or yellow-orange shall be the predominant color on a cone.** Cones should be kept clean or brightly painted. Because cones can be easily moved or knocked down, they should be used only where there is sufficient supervision to see that they remain in place.

Drums are normally metal drums, of 30- to 50-gallon capacity, set on end. To be consistent with the present standard for obstruction markings, they should be conspicuously painted with at least two horizontal, circumferential white stripes, 4 to 6 inches wide (fig. 5-3). However, as in the case of barricades, solid white or solid yellow, or yellow stripes may be used on an experimental basis. **The white or yellow areas shall be reflectorized on drums used at night.**

5C-8 Sandbags

Where space is limited, sandbags can be an effective compromise between cones and drums, though sandbags are less portable than either. Drivers will not tend to shy away from them as much as from drums, yet they provide a more stable barrier than do cones. They are a very effective channelizing device, performing a function similar to that of curbing. Sandbags should be coated with reflectorized yellow paint, which can be applied in place.

5C-9 Delineators

Delineators, commonly used to indicate the alinement of roadways, have little application in road work areas where the devices described herein are effectively employed to guide and channelize traffic. They can be useful, however, in outlining a temporary roadway that is otherwise poorly defined.

5C-10 Pavement Markings

Where traffic control devices have been installed in accordance with the principles set forth in this Manual, the appropriate signs, arrows, barricades, and channelizers should suffice to move traffic through or around the work area in a safe and orderly fashion.

It may sometimes be necessary to remove existing center and lane lines that lead directly into barricades or work sites. New center lines, lane lines, channelizing lines, and no-passing lines may be desired on the approach to, and throughout the length of, a temporary road by-passing a closed portion of highway. **Such lines shall be reflectorized.** Pavement markings at temporary obstructions, however, are often impractical as they are not easily shifted to meet changing requirements. Where it is physically impossible to paint lines on the temporary road, appropriate delineators, in addition to Large Arrow signs, should be used to define the course of the roadway.

Pavement markings shall be approved by public authority prior to installation.

D-LIGHTING DEVICES

Section 5D-1 Hazard Warning Lighting

At night, when clarity and distance of vision are sharply curtailed, adequate artificial lighting is needed to call attention to and to indicate the actual location of obstructions and hazards. Recognition of reflectorized barricades and channelizing devices will occur only at limited distances and will also depend on the adequacy of the approaching headlamps. Therefore, independent light sources capable of being seen at long distances must be provided. These light sources include torches, lanterns, flashers, and electric lamps.

5D-2 Torches and Lanterns

Torches include all the single-unit, portable, constant-burning, low-intensity types of lights, either battery-powered or open-flame (pot torch) variety. Because they provide little illumination of other objects, and, except for the electric type, are not altogether

dependable under adverse conditions, torches should be used for the most part only to supplement other channelizing devices or barricades, and to outline obstructions or hazards. Used in this manner they function both as warnings and delineators in guiding traffic. Several torches may also be used to mark a flagman station. Drums with torches on top of them are an effective channelizing device.

Open-flame torches may be dangerous where pedestrians, and particularly children, can approach them too closely. Under such conditions consideration should be given to the use of electric torches or lighting.

Lanterns include all the enclosed-flame types of lights. Their value in illuminating other objects is negligible. They should be used for the most part only in low-speed urban areas to mark the location and extent of hazards and obstructions at the side of the roadway, and those to which pedestrians are exposed. Only red-globe lanterns should be used.

Torches and lanterns are often more effective if they are above ground level. They should always be placed on a solid support to prevent them from tipping over. Lanterns should be maintained in an upright position to prevent smoking and sooting of the globes.

Torches placed in a row across the path of oncoming traffic should be no more than 8 feet apart and usually not less than 4 feet apart. Torches or lanterns in a longitudinal row should be spaced from 15 to 25 feet apart.

Torches and lanterns should be in place and lighted from sunset to sunrise. Fuel-burning types should be inspected and filled daily.

5D-3 Flashers

Flashers are portable, power-operated, lens-directed, enclosed lights, illuminated by rapid intermittent flashes of short duration. They are alerting devices to be used for advance warning or for the marking of severe or unexpected hazards in or near the roadway. **The color of the light emitted by a flasher shall be yellow.** Flashers are best mounted on barricades in or near the roadway at a height of 4 feet or more. The use of flashers in series is not recommended. An array of random flashers can be disconcerting and may tend to obscure rather than delineate the traveled way. Instead, steadily burning lights should be used for delineation.

Data are not available on which to base more detailed specifications and standards of application. It is recommended, however,

that the rate of flash be regular with from 70 to 120 flashes per minute and that the "on" time be at least 25 percent of the cycle.

During the hours of darkness, the flash should be bright enough to be conspicuously visible at all distances up to 800 feet from the unit under normal atmospheric conditions. Where a unit with directional faces is used, this specification should be met at angles up to 10 degrees to the sides and up to 5 degrees above and below the photometric axis.

5D-4 Electric Lights

Where commercial power or a portable electric generator is available, electric lights may be used both for illumination and hazard marking.

Electric lights can be used for floodlighting dangerous conditions and illuminating signs, barricades, and flagman stations. **Lights used for illuminating signs or barricades shall be sufficient in size and number to provide effective illumination and legibility under normal atmospheric conditions.** Precautions must be taken when placing lights to insure the prevention of glare.

A series of low-wattage lamps may be used to mark obstructions and hazards. Lamps used for this purpose should be yellow. A line of yellow lights can be effectively used on a longitudinal fence-type barricade to delineate the traveled way. **When illuminated, hazard-marking lights shall burn steadily and shall not be flashed.**

E—CONTROL OF TRAFFIC THROUGH WORK AREAS

Lane Closures

Section 5E-1 Taper Rates

Under relatively normal conditions of speeds and volumes, and where adequate advance warning of a lane obstruction has been provided, a taper rate of 1:20 should be sufficient to permit traffic to shift safely from one lane to another. Where speeds or volumes are high this rate should be substantially decreased, to about 1:40; expressway-type facilities may require even longer tapers. Where traffic is stopped or considerably slowed in advance of the transition, as by flagmen, and where the lane change does not involve a merging of traffic streams, the taper may be very short, just long enough for traffic to turn comfortably into the appropriate lane (fig. 5-5).

Cones, drums, or barricades shall be used to funnel traffic into the appropriate lane. Normally, barricades should be spaced at

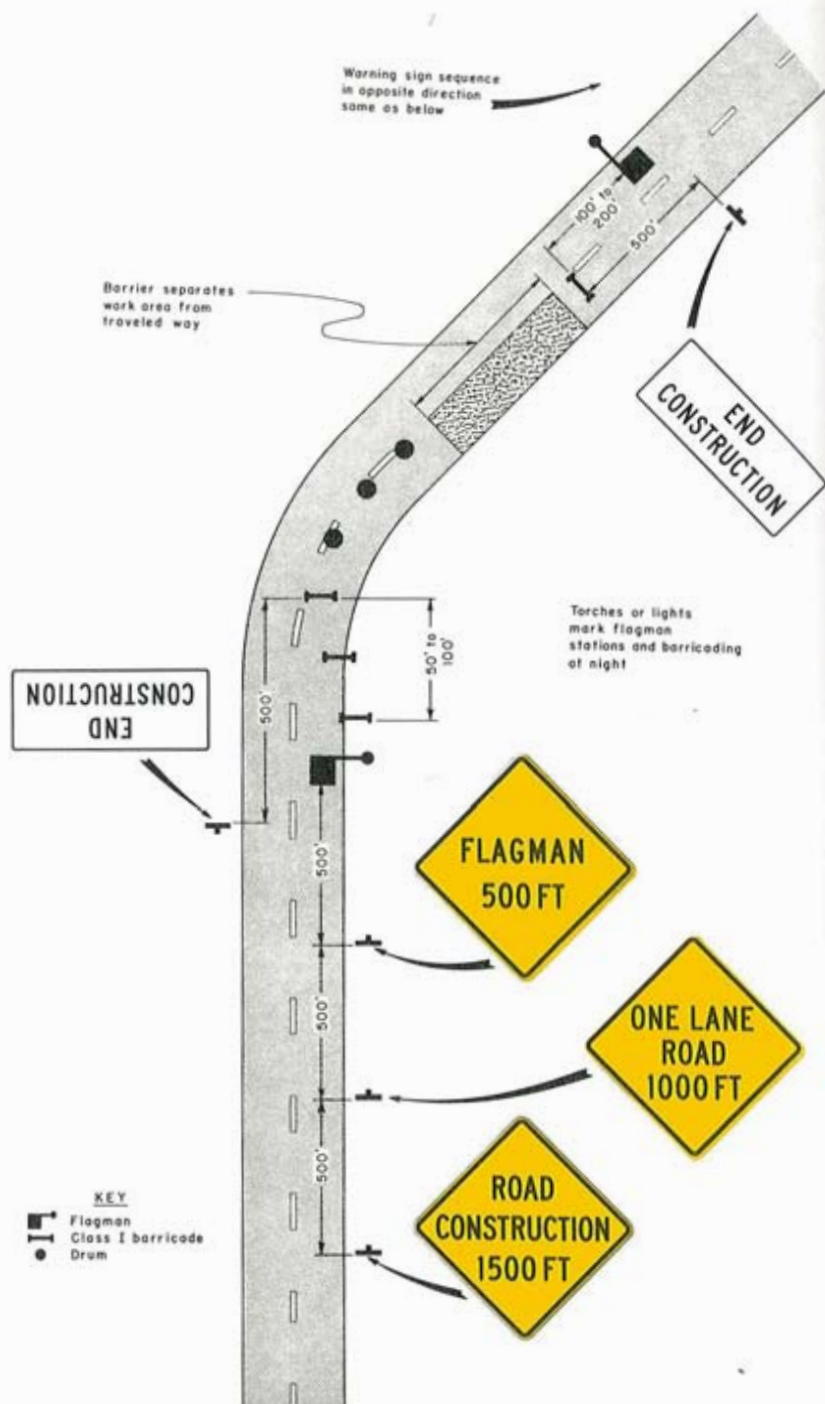


Figure 5-5. Typical applications of traffic control devices on 2-lane highway where one lane is closed. Barricading is extended to a point where it is visible to approaching traffic.

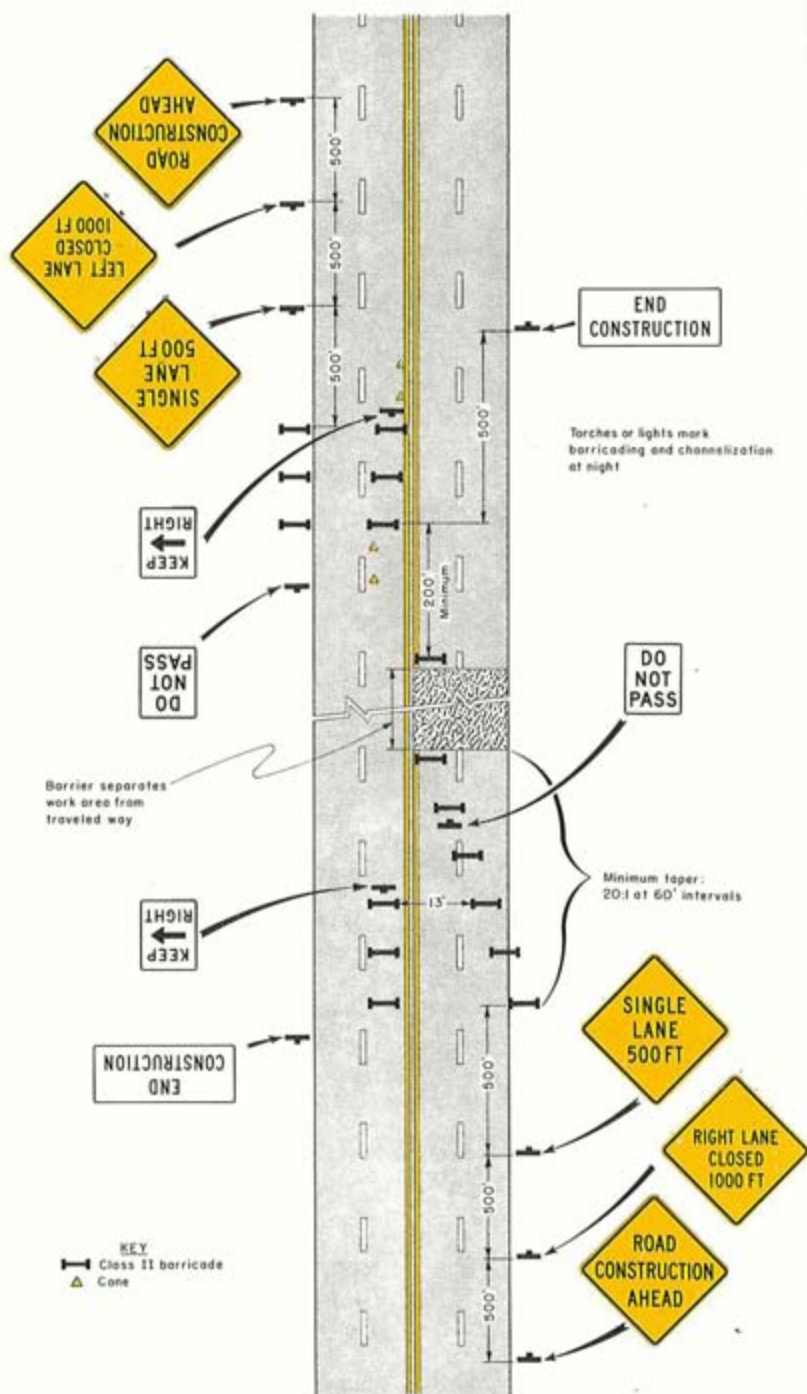


Figure 5-7. Typical applications of traffic control devices on 4-lane undivided highway where half the roadway is closed.

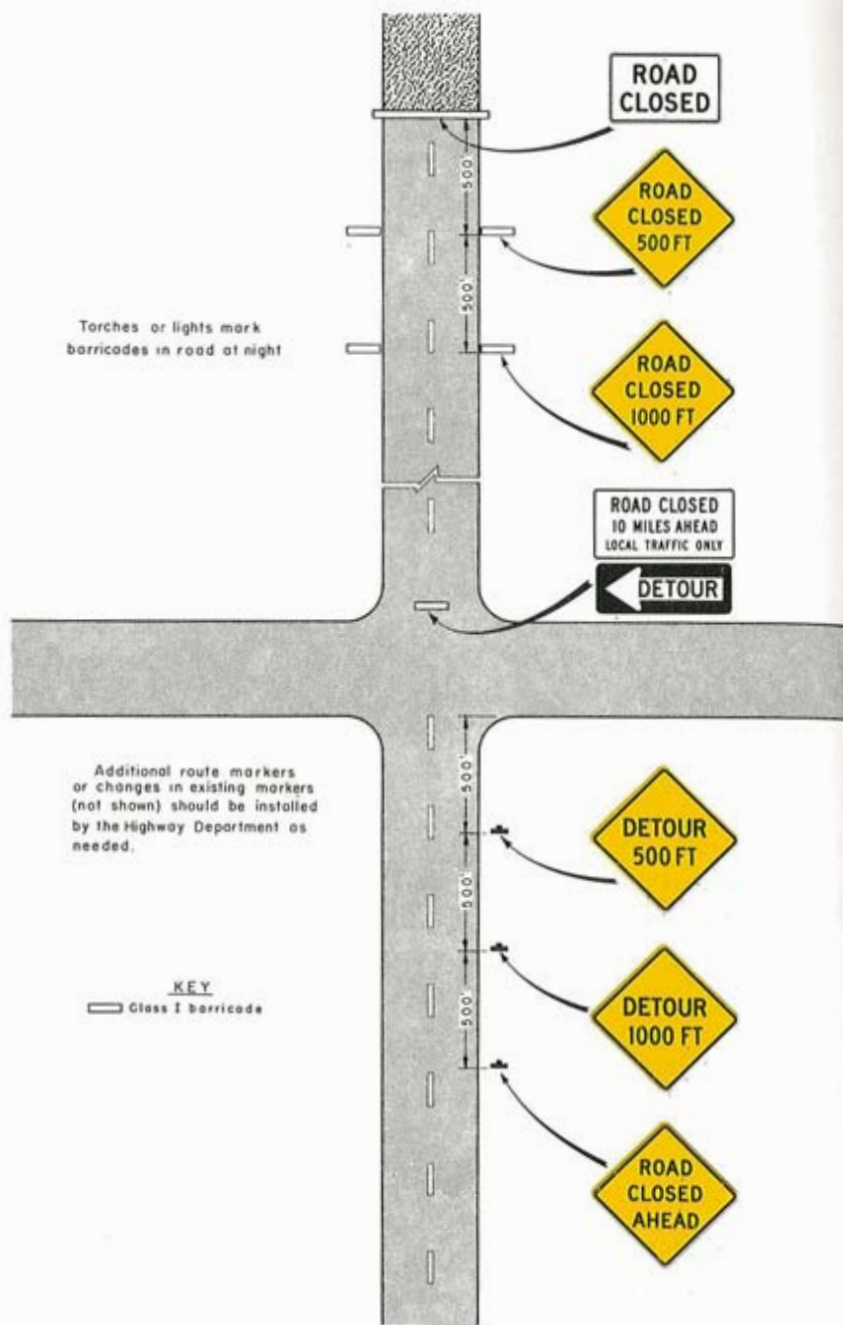


Figure 5-9. Typical applications of traffic control devices where a road is closed beyond a detour point.

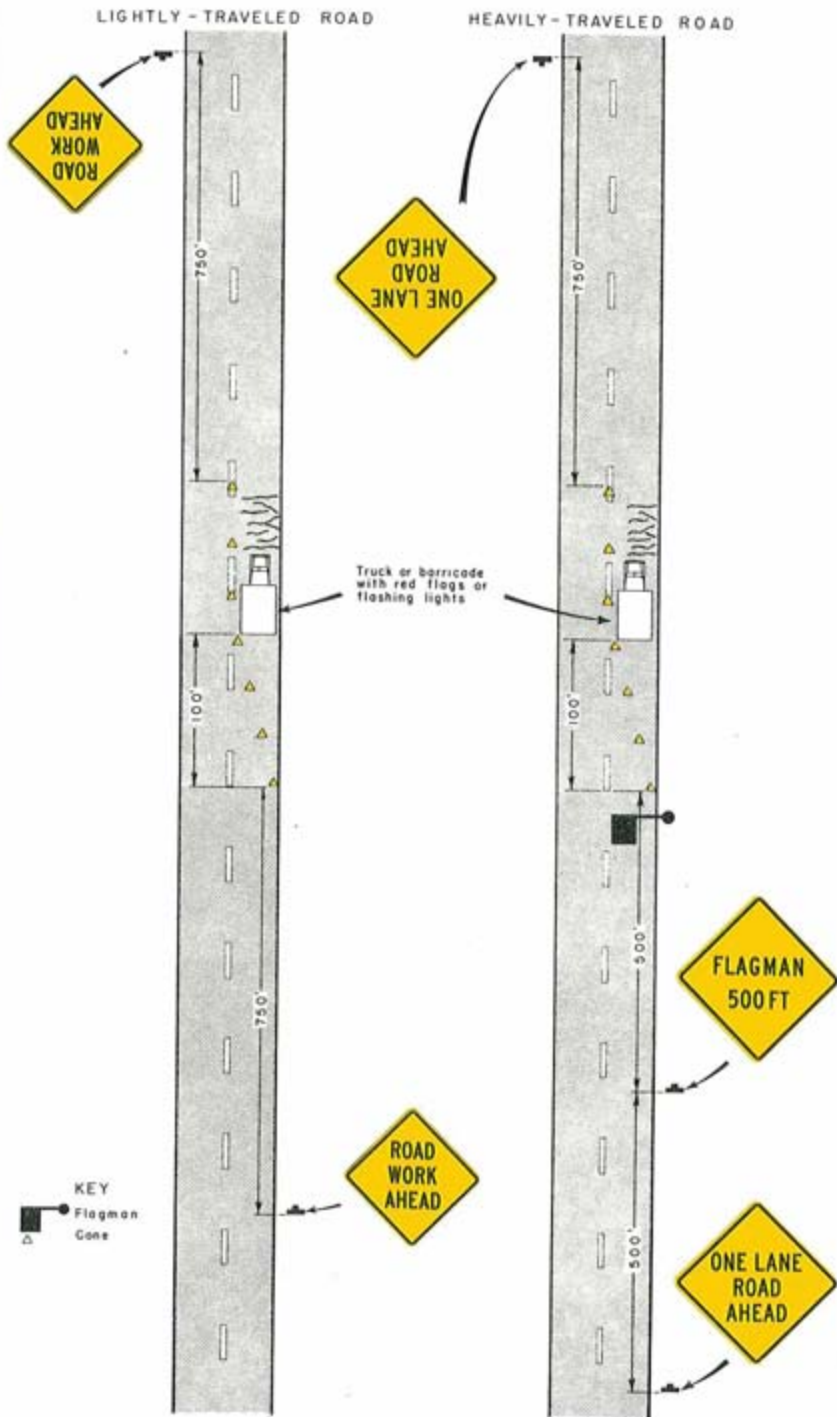


Figure 5-10. Typical applications of traffic control devices at minor maintenance operations of short duration.

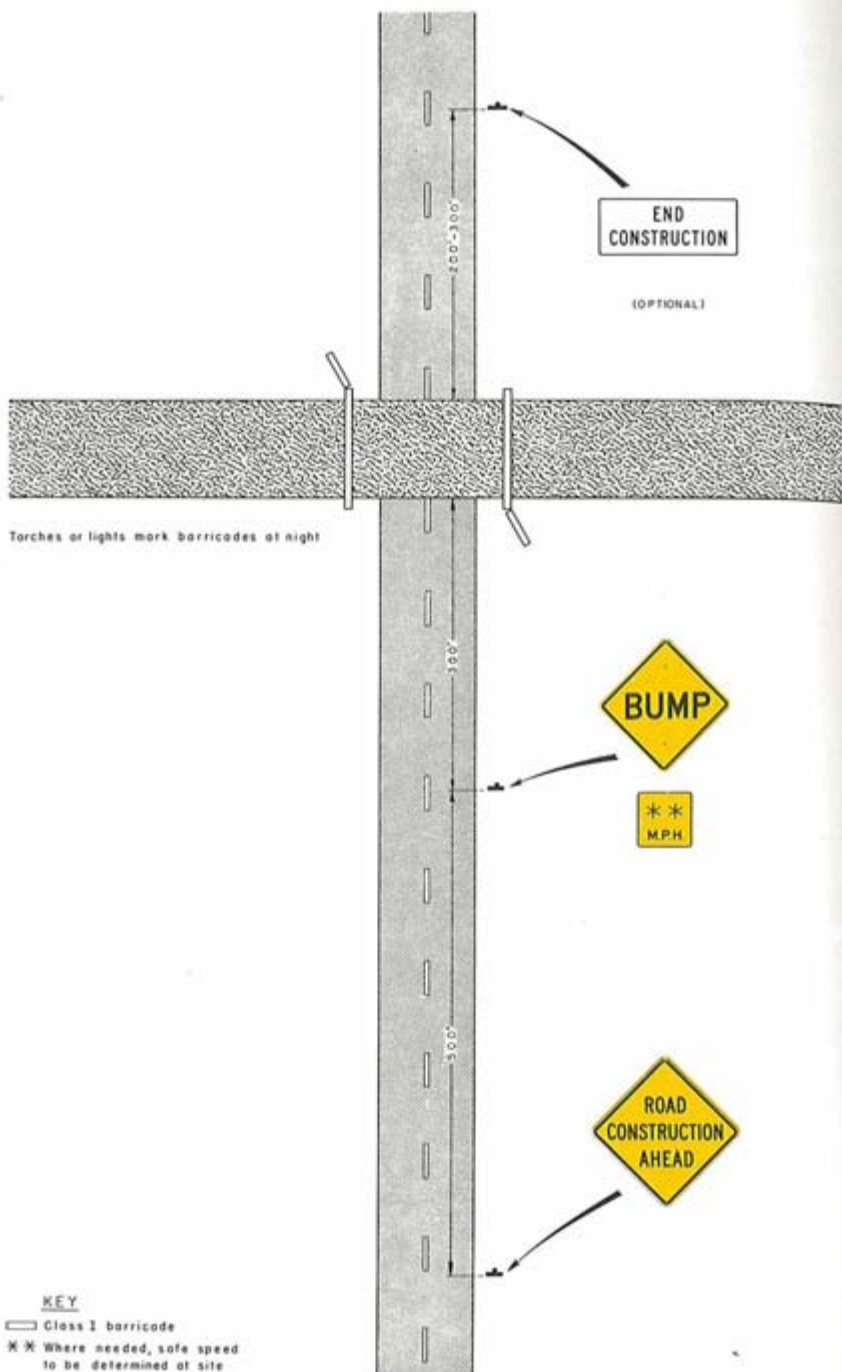


Figure 5-11. Typical applications of traffic control devices on a road crossing a construction job.

approximately 60-foot intervals; the smaller cones or drums should be more closely spaced.

5E-2 Multiple Closings

Where two or more lanes of a multilane highway are to be closed, traffic should not be forced to vacate more than a single lane at any one point, i.e., the points of closure of each lane should be separated in distance to prevent the compounding of merging maneuvers. This distance should be on the order of 500 feet. Additional Construction Approach Warning or other appropriate signs should be placed between the points of closure. A continuous taper across two or more lanes is permissible, however, where traffic already moving in a single line is required to shift lanes (fig. 5-7).

Flagging Traffic

Section 5E-3 Hand Signaling Devices

A number of hand signaling devices, such as red flags, STOP and GO signs, and red lights are used in controlling traffic through work areas. The red flag is the most common device used during the daylight hours. The sign paddle bearing the clear regulatory messages STOP, GO, or SLOW is also used. Use of the paddle, however, requires the flagman to divert some of his attention from the traffic he is controlling to the manipulation of the paddle. Furthermore, the paddle cannot be used where a single flagman must stop traffic in both directions simultaneously.

Flags used for signaling purposes shall be a minimum of 18 by 18 inches in size, made of a good grade of bright 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 shall be at least 15 inches wide, with bold lettering at least 5 inches in height. A rigidly fixed 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 the background of the GO face shall be dark green with white letters. If SLOW is used instead of STOP the background shall be highway yellow with black letters.

To increase the visibility of the flagman, the use of a yellow cap and a yellow vest worn over the outer clothing is recommended. For nighttime conditions the use of similar outside garments or belting, preferably reflectorized, is recommended. In

addition, flagman stations should be adequately illuminated to attract attention.

5E-4 Choice of Flagmen

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

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

5E-5 Flagman Stations

Flagman stations should be located far enough from the work site so that vehicles will have sufficient distance to slow down before entering the project but not so far that vehicles will tend to speed up into the work site.

Normally the flagman will stand either on the shoulder adjacent to the lane of 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. Under no circumstances should he stand in the traffic lane. In rural areas he should be clearly visible to the traffic he is controlling for a distance of 500 feet. For this reason he must stand alone, never permitting a group of workmen to congregate around him. Flagman stations must be adequately protected and preceded by proper advance warning signs.

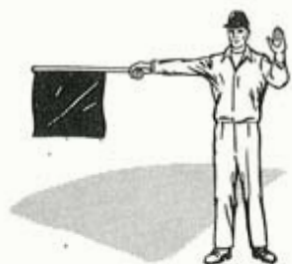
In urban areas flagmen will usually be needed only to provide for the passage of equipment. The flagman, therefore, is able to choose an appropriate time to stop traffic safely. **Where for any length of time the flagman must continuously control traffic, the provisions pertaining to flagman stations in rural locations shall apply.**

5E-6 Flagging Procedures

The following methods of signaling shall 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.

FLAG



To stop
traffic



Traffic
proceed



To slow
traffic



To alert
traffic

PADDLE



Figure 5-12. Use of hand signalling 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. Red flags shall not be used to signal traffic to proceed.

3. To slow traffic, the flagman shall display the stop signal and give the signal to proceed before the vehicle comes to a stop.

4. Where it is desired to alert traffic by means of flagging, but where a substantial reduction in speed is not necessary, 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. Figure 5-12 illustrates the use of the red flag and sign paddle.

Red lanterns or lights should be used to flag traffic at night. To stop traffic the light should be waved back and forth across the path of the approaching vehicle. The signal to proceed should be given verbally or by a hand motion. Adequately reflectorized sign paddles or flags may be used at night provided that the reflectorization is of a type that will retain its brilliance when wet. **Daytime flagging procedure shall be followed whenever such 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.

One-Way Traffic Control

Section 5E-7 Coordinating Movements

Where traffic in both directions must for a limited distance use a single lane, some provision must 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 must 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 must 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:

- Flagman control.
- Flag-carrying or official car.
- Pilot car.
- Traffic signals.

5E-8 Flagman Control

Where the one-lane section is short enough so that the approaches to both ends are intervisible, 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 ends of the one-lane section are not intervisible, the flagmen may maintain contact by means of 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 number.

5E-9 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, 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 delays associated with dispatching and delivering the flag and also eliminates the possibility of loss of the flag.

5E-10 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 must also be made for identification of the last vehicle in the column.

The vehicle selected for pilot-car duty should be lightweight and easy to handle and should have the name of the contractor or contracting authority prominently displayed. **The Pilot Car sign (sec. 5B-40) shall be mounted on the rear of the vehicle.**

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

5E-11 Traffic Signals

Short one-way detours, such as bridge construction by-passes, can sometimes be controlled by means of traffic signals. Use of traffic signals at longer one-way zones may result in longer delays than will be accepted by motorists.

If used, the traffic signals shall be installed at each approach to the one-lane section, and drivers shall be apprised of their presence by means of the Signal Ahead sign (sec. 1C-16) preceded by appropriate Construction Approach Warning signs.

The signals should be timed so that a short green interval will allow traffic to enter the one-way zone while the opposing traffic is halted. Upon expiration of the green time the signals at both ends must show red for a sufficient time for traffic to clear the zone at the minimum normal speed expected through the zone. The signal should then show green for the opposite movement.

It may be found desirable to use a traffic-actuated signal or manual control to compensate for unbalanced flow. Whatever signal scheme is used, however, a simultaneous red phase in both directions is inescapable.

Traffic signals shall consist of standard three-lens units and shall be installed and timed only with the approval of the responsible highway authorities. They shall be erected to the right of traffic approaching the work site, or overhead, at a point where vehicles can be stopped without encroaching on the opposite lane. The bottom of the housing of the signal face shall be at a height of not less than 8 nor more than 15 feet above the roadway, or not less than 15 nor more than 17 feet where vehicles must pass under the signal housing.

F—URBAN APPLICATIONS

Section 5F-1 Urban Characteristics

The general principles outlined in the previous sections of this Manual are applicable to both rural and urban areas. Discussion of their application, however, has emphasized rural conditions.

The differences between rural and urban situations warrant some separate treatment of urban traffic-control requirements, though basically it is possible only to point out certain ways in which the standards already set forth can be adapted to peculiarly urban problems.

Urban traffic conditions are characterized by relatively low speeds, high traffic volumes, limited maneuvering space, frequent turns and cross movements, and a significant pedestrian movement. Traffic obstructions particularly in the form of parked vehicles, are common. 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.

There is already ample conflict inherent in urban traffic movement, and further conflict due to construction or maintenance operations should be kept to a minimum. On arterial streets such work should, if possible, be restricted to off-peak hours. Some cities have resorted to extensive night work in order to minimize interference with traffic.

The amount of street space taken up by construction and maintenance work should be no more than is absolutely necessary, though this does not justify any failure to use such signs, warning devices, and channelization as may be required in the roadway for public protection and guidance.

5F-2 Signs

Changes in operation may be necessary to maintain traffic movement through an area where a major street is closed or partly obstructed. Additional regulatory signs, such as One Way signs (sec. 1B-28), Do Not Enter signs (sec. 1B-26), and No Parking signs (sec. 1B-31), will be needed to control traffic under such conditions. Because of the unfamiliar and possibly unusual conditions, larger sizes may be warranted than the standard sizes normally specified for these signs in urban use. Where a street must be closed to through traffic but where access to adjacent property can be maintained, a special sign with the suggested message LOCAL TRAFFIC ONLY should be used in connection with any detour signs or barricades that are present at the points of closure.

Because of the lower speeds associated with urban traffic conditions as compared with rural, fewer advance warning signs are required. The messages of most of the warning signs described previously are applicable, with the substitution of "street" for "road" if desired. Under some circumstances warning signs

may not be necessary, but other devices capable of being clearly seen and recognized at a safe distance are essential.

Warning signs of standard size should generally be used. Construction Approach Warning signs (secs. 5B-19 to 5B-25), however, may be 36 inches by 36 inches in size. On minor streets where speeds and volumes are low, other warning signs may be 24 inches by 24 inches in size. Larger signs may be needed than are called for by speed criteria alone due to high traffic volumes, wide streets, and competition from advertising displays and distracting backgrounds.

Warning signs should be placed at distances of 150 to 250 feet in advance of the condition to which they are calling attention, the actual distance being determined by such factors as speeds, volumes, degree of hazard, and sight distance.

Standards for warning signs on urban expressways should be essentially the same as for rural highways, as previously described.

Detour routings will not often be needed except for numbered routes and major arterial routes. Short detours may be marked with the standard Detour Arrow sign (sec. 5B-39). Because of the circulatory characteristics of urban traffic, a variety of information and guide signs may be needed on the approaches to the work site. Traffic desiring to use an arterial street which is closed or on which travel is restricted may have to be informed of such restrictions and of alternate routings far in advance.

Regulatory, guide, and information signs can usually be erected at the curbs, although it may sometimes be more advantageous to place them on barricades, pedestals, or other temporary supports in the roadway. Warning signs are usually placed in the roadway, where they will have maximum visibility. They should be of such a height as to be visible above preceding vehicles.

5F-3 Barrier, Warning, and Channelizing Devices

All of the devices described in sections 5C-1 to 5C-10 are applicable to urban situations. Because of space limitations, cones may find greater use than barricades.

Class I barricades (sec. 5C-3) should be used where a street is closed to all traffic except authorized vehicles or to all but local traffic.

Class II barricades (sec. 5C-3) should be used to separate work areas, excavations, equipment and materials, and spoil from traffic areas and to separate pedestrian walkways from vehicular traffic areas. Where space permits, they may be used for channelization.

Where space is limited, or where they are needed for short durations, cones or drums (sec. 5C-7) may be used for channelization or to mark the safe approach to obstructions adjacent to traffic areas.

During the day, red flags may be used to call attention to signs (so long as they do not interfere with a clear view of the sign face), barricades, or equipment. A tripod device may be used to display flags or, at night, flashers or electric torches, high enough to be visible over preceding vehicles.

Although most city streets are lighted at night, special attention must be called to the existence of obstructions and hazards, due to construction or maintenance work, during hours of darkness. The devices described in sections 5D-1 to 5D-4 are appropriate for this purpose.