

Part II  
**MARKINGS**

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**A—INTRODUCTION AND GENERAL SPECIFICATIONS**

**Section 2A-1 Functions and Limitations of Markings**

Markings have definite and important functions to perform in a proper scheme of traffic control. In some cases they are used to supplement the regulations or warnings of other devices such as traffic signs or signals. In other instances they obtain results, solely on their own merits, that cannot be obtained by the use of any other device. In such cases they serve as a very effective means of conveying certain regulations and warnings that could not otherwise be made clearly understandable.

Pavement markings have definite limitations. They may be entirely obliterated by snow, are not clearly visible when wet, and are not very durable when painted on surfaces exposed to traffic wear. In spite of these limitations they have the advantage, under favorable conditions, of conveying warnings or information to the driver without diverting his attention from the roadway.

Pavement markings that are otherwise warranted or prescribed cannot, of course, be applied to unpaved roadways.

**2A-2 Legal Authority**

**Markings shall be placed only by the authority of a public body or official having jurisdiction for the purpose of regulating, warning, or guiding traffic.**

Pavement and curb markings, being exclusively within the boundaries of public highways, should never be installed except under public authority. Delineators and markings on objects as a warning of their hazardous locations are also normally within the highway right-of-way, and should be subject to the same jurisdictional regulations.

A suitable model for the legal authority for the placing of markings is presented in the Uniform Vehicle Code (secs. 1-139, 11-201, 11-205, 15-104, 15-105, 15-106). Interference with official markings is prohibited in section 11-206 of the same code.

**2A-3 Standardization**

**Markings shall be uniform in design, position, and application.** As in the case of all other traffic control devices, it is imperative

that markings be uniform so that they may be recognized and understood instantly by all drivers.

## 2A-4 Types of Markings

Markings as defined for the purposes of this manual are of a number of types:

1. Pavement Markings:
  - (a) Center lines (secs. 2B-1, 2, 3).
  - (b) Lane lines (secs. 2B-4, 5, 6).
  - (c) No-passing-zone markings (secs. 2B-7 to 10).
  - (d) Pavement edge lines (secs. 2B-11, 12, 13).
  - (e) Paved-shoulder markings (sec. 2B-12).
  - (f) Pavement-width transitions (sec. 2B-14).
  - (g) Channelizing lines (secs. 2B-15, 16).
  - (h) Approaches to obstructions (secs. 2B-17, 18).
  - (i) Turn markings (sec. 2B-19).
  - (j) Stop lines (sec. 2B-21).
  - (k) Crosswalk lines (sec. 2B-22).
  - (l) Approaches to railroad crossings (sec. 2B-23).
  - (m) Parking space limits (sec. 2B-24).
  - (n) Word and symbol markings (sec. 2B-25).
  - (o) Lane-use control markings (sec. 2B-26).
2. Curb markings for parking restrictions (sec. 2B-27).
3. Object markings:
  - (a) Objects within the roadway (secs. 2C-2, 3, 4).
  - (b) Objects adjacent to the roadway (sec. 2C-5).
4. Reflector markers:
  - (a) Hazard markers (sec. 2D-2).
  - (b) Delineators (secs. 2D-3, 4, 5).

## 2A-5 Materials

The most common method of placing pavement, curb, and object markings is by means of paint. A continuous improvement in paints and in equipment and methods of application has resulted in a very extensive use of pavement markings. Equipment in general use is capable of placing single, double, or triple lines on a highway, solid or broken, in different colors, while operating at a speed of 6 to 10 miles per hour. Small self-propelled stripers are available that can lay a triple line, but their operating speed is only about 1½ miles per hour. The chief advantage of these small machines is that they can be readily transported to isolated projects in a light truck. Hand equipment can be used to place transverse or special markings, at intersections or elsewhere, at a reasonable cost.

The night visibility of pavement markings is increased by the



use of minute glass "beads" (actually true spheres) embedded in the pavement-marking material to produce a retrodirective reflecting surface.

The glass-beaded surface reflects a high proportion of the incident light from headlamps directly back toward its source in a narrow cone having enough divergence to reach the driver's eyes in his normal position above the headlamps, thereby causing the markings to appear luminous at night. Although the initial cost of such reflectorized markings is higher than for ordinary traffic paint, a number of highway departments have reported that the increased life of the markings, especially at heavily-traveled locations, more than compensates for the difference in cost.

Thermoplastic materials for pavement marking are finding increased use at locations subject to extreme traffic wear. Experience at heavy-traffic locations has indicated an average service life equivalent to eight applications of beaded traffic paint. Thermoplastic markings shall conform to the color, reflectorization, and dimension specifications for paint markings.

Flat units on or in the pavement surface shall be of permanent color as specified for pavement markings, and shall be set so that their upper surfaces are essentially flush with the pavement surface. They may be placed in continuous contact, or separated by small spaces approximately equal to the length of a single unit. Either type of line may be used where a solid line is prescribed in this manual. To insure a good appearance, particular care should be taken to see that alinement and spacing are accurate.

Metal inserts shall have a surface that will remain bright under the action of traffic, thus contrasting with the color of the pavement. Nonmetallic inserts shall be of permanent colors as specified for pavement markings. Inserts shall be not less than 4 inches in diameter if round, or of equivalent minimum area if of other shape, and shall be spaced not more than 16 inches apart, center to center. on transverse lines and not more than 36 inches apart on longitudinal lines They shall have rounded surfaces, presenting a smooth contour to the wheels of vehicles, and shall not project more than three-fourths inch above the level of the pavement. They shall be permanently fixed in place by anchor bolts, adhesive, or similar effective means.

The epoxy resin adhesives have proved extremely effective in attaching plastic or cement-bonded inserts to concrete or asphaltic pavements. These adhesives harden in from 15 to 30 minutes so that final mixing must be done on the job. To insure an effective bond, the pavement should be spot sandblasted or wire brushed and blown free of dust and loose materials.

Unit letters, symbols, or stripes may be attached to or set into the pavement surface, as an alternative type of pavement marking. These should be essentially flush with the pavement surface, and should not become unduly slippery when wet. **They shall be of permanent colors as specified for pavement markings.**

Metal and plastic inserts and flat marker units in or on the pavement surface are used principally in urban areas, where heavy traffic rapidly destroys painted markings, and frequent re-painting not only is costly but causes undue traffic delays. In rural areas speed of application makes painting the preferred form of marking.

While successful experiments have been reported with permanent built-in pavement markings of white or colored concrete or inlaid bricks or blocks, they are not adaptable to reflectorization nor to any change in layout for altered traffic conditions, and their use is not recommended.

The use on the pavement surface of small metal or plastic studs with inserted reflector buttons is not recommended. Experience has shown that they are destroyed by snow plows, they cannot be kept clean and effective, and they are a hazard to motorcycles.

Large "mushroom" buttons, or bars, of cast iron or concrete several inches high, with or without reflectors, lights, symbols, or messages, should not be used for pavement markings. They are sometimes used to designate pedestrian islands or to assist in channelizing traffic. In these applications they are, in effect, curbs or islands, and they should be restricted to such applications (part IV). They should not be located where they constitute an unexpected hazard for motor vehicles. The use of raised bars (commonly known as "jiggle bars") to discourage the use of certain pavement areas (sec. 4A-3) can be effective, provided that such bars are not so high as to cause hazard or damage.

Object markings are ordinarily painted directly on the surface of the obstruction. If the surface will not retain paint satisfactorily, some flat surface of wood or metal should be painted with the proper marking and attached to the obstruction. Where a reflectorized coating is desirable it will often be necessary to use a separate surface for satisfactory application. Reflecting buttons or clusters may be attached directly to the obstruction or installed on separate posts immediately in front of it.

Delineators and hazard markers may consist of single reflectors, clusters of reflectors, or small panels of uniform shape covered with a reflecting coating, mounted on separate posts (secs. 2D-2, 2D-4). To be effective they must be of retrodirective character and of adequate brilliance.

## 2A-6 Colors

**Pavement markings shall be white or yellow in color.** The use of black in the gaps of a broken pavement line is permissible where the pavement itself does not provide sufficient contrast. This use of black does not establish it as a standard color for pavement markings, but is only a means of achieving contrast on a light colored pavement.

The correct color for yellow traffic paint is the same as that specified for highway signs.<sup>10</sup>

### **White shall be used for:**

1. Center lines on two-lane rural roads and city streets.
2. Lane lines.
3. Pavement edge lines.
4. Paved-shoulder markings.
5. Channelizing lines.
6. Approaches to obstructions which may be passed on either side.
7. Turn markings.
8. Stop lines.
9. Crosswalk lines.
10. Parking space limit lines.
11. Word and symbol markings.

### **Yellow shall be used for:**

1. Double center lines on multilaned pavements.
2. No-passing barrier lines at:
  - (a) No-passing zones on two- and three-lane roads.
  - (b) Pavement-width transitions.
  - (c) Approaches to obstructions which must be passed on the right.
  - (d) Approaches to railroad crossings.
3. Curb markings:
  - (a) To show parking prohibitions covered by signs or ordinance.
  - (b) On islands in the line of traffic.

Yellow is prescribed for the markings indicated for several reasons: (1) It contrasts with the normal white center or lane lines and thus gives emphasis to the hazard; (2) Yellow has been accepted as a symbolic warning color in signs and signals; and (3) It is consistent with the standard for no-passing-zone markings approved by the American Association of State Highway Officials and is in use in more than two-thirds of the States for barrier lines.

<sup>10</sup> Color cards showing this "highway yellow" may be obtained from the Bureau of Public Roads on request.



Markings on vertical surfaces of objects within the roadway or dangerously close thereto may consist of alternate black and white stripes, or the surface may be painted white. **All white areas shall be reflectorized.**

Objects adjacent to the roadway, such as guardrails, trees, and rocks, may be painted white as a useful guide to night traffic.

Roadway delineators shall be white, except that yellow delineators may be used to mark expressway ramps in interchange areas. Hazard Markers (including clearance markers) shall be yellow or striped black and white.

## 2A-7 Types of Lines

A broken line shall be used for the center lines on two-lane rural roads and for lane lines, where these lines are only guide lines that may be crossed at the discretion of the driver. Center lines are of great importance for the guidance of drivers and to help separate traffic proceeding in opposite directions. On two-lane rural roads these objectives can be satisfactorily accomplished, with economy, by the use of broken lines. Similarly, lane lines which help keep vehicles traveling in the same direction in their proper lateral positions should be marked by broken lines.

A broken line, with segments and gaps well proportioned, is as effective as a solid line for guide purposes. The standard ratio of stripe to gap is 3 to 5. On rural highways, a commonly used standard is 15-foot segments with 25-foot gaps. However, on mountain or other roads with many short-radius curves, 9-foot segments with 15-foot gaps will maintain better continuity, particularly where maintenance patching occasionally eliminates a line segment. In the application of a given gallonage of paint per mile, such relatively short segments (9 to 15 feet) will give a better line than if longer segments, with correspondingly longer gaps, are used.

On urban streets the line segments and gaps may be considerably reduced in length but the 3 to 5 ratio of stripe to gap should be maintained.

High-speed striping machines have been constructed that are capable of repainting broken lines accurately and neatly.

A broken line permits a saving of more than 60 percent in the amount of paint required, as compared with a solid line, with little or no increase in the cost of application.

Solid white lines are used for guide lines where the line may not ordinarily be crossed at the discretion of the driver or where crossing of the line is to be discouraged. These include center lines on city streets, channelizing lines, pavement edge lines, and

approach markings to obstructions which may be passed on either side. Transverse pavement lines are also solid white lines.

Solid yellow lines are used for guide or regulatory lines to the left of which it is unsafe or illegal to travel. Where a combination solid and broken line is used, the solid yellow, or barrier, line has significance only if it is on the right-hand side of the combination line, as viewed by the driver, i.e., in or adjacent to the traffic lane to which it applies.

#### **2A-8 Width of Lines**

**Center lines, lane lines, and barrier lines shall be 4 to 6 inches wide.** The most common width is 4 inches, but 6-inch lines, favored by a number of highway departments, provide added visibility. Narrower 3-inch lines have been used as a means of economizing in paint, but they are not recommended.

The width of a channelizing line (sec. 2B-15) may vary from the normal line width (4 to 6 inches) to a maximum of 12 inches, depending on the emphasis required.

**Pavement edge lines shall be 2 to 4 inches wide.**

Transverse lines on pavements must be much wider than longitudinal lines to be equally visible. Stop lines may have to be as wide as 24 inches where approach speeds are high.

#### **2A-9 Reflectorization**

**All pavement markings having application at night shall be reflectorized.** Reflectorization is not ordinarily essential where high-level illumination is present, but even on well lighted city streets it is generally desirable that markings which must be visible at night be reflectorized.

#### **2A-10 Maintenance**

**All markings shall be maintained in effective condition at all times.**

The frequency of repainting depends on the type of surface, composition and rate of application of paint, climate, and volume of traffic. Particular care should be taken, especially in the case of broken lines, to paint over the old markings as exactly as possible. Otherwise they will appear increasingly ragged after successive repaintings.

### **B-PAVEMENT AND CURB MARKINGS**

#### **Section 2B-1 Center Lines**

A center line is used to designate the center of the traveled part of a roadway carrying traffic in both directions. Under some



circumstances, as at a pavement-width transition, or where an extra uphill traffic lane is provided, it need not be at the geometrical center of the pavement. On all major rural highways having an even number of lanes, and on many urban streets and less important rural roads, center lines are necessary and should be applied throughout the entire length of the pavement. In urban locations and on some rural roads where a continuous center line is not required, short sections of center line are useful on approaches to busy intersections, marked crosswalks, or railroad crossings, and around curves or over hillcrests. When so used, the center line serves both to warn of any unusual condition and to organize and control traffic through a hazardous or congested zone.

Lines dividing a one-way roadway into two or more lanes are lane lines (sec. 2B-4).

### **2B-2 Center Lines on Rural Roads**

**The center line on a two-lane paved rural highway shall be a broken white line, not less than 4 nor more than 6 inches wide.** Where a solid channelizing line (sec. 2B-15) is used as a center line, however, the width of the solid line may vary from the normal line width to a maximum of 12 inches, depending on the emphasis required. Line segments having a 3 to 5 ratio of stripe to gap are standard and segments 15 feet in length, with 25-foot gaps, are recommended.

On four-lane undivided rural pavements, or on pavements of a greater even number of lanes, the center line shall consist of two solid yellow lines, each not less than 4 inches nor more than 6 inches wide, separated by a space of not less than 3 inches.

Since this center line is, in effect, a continuous no-passing line to the left of which it is, under the Uniform Vehicle Code and the laws of many States, illegal to drive (sec. 2B-7), it is logical that the two lines should be yellow.

As a guide to the application of center-line markings, the following warrants are suggested:

1. Center lines are desirable on all paved highways and as a minimum should be placed throughout the length of:

- (a) Two-lane pavements carrying average annual traffic volumes in excess of 1,000 vehicles per day.
- (b) Two-lane pavements narrower than 20 feet carrying average annual volumes in excess of 500 vehicles per day.
- (c) Two-lane pavements narrower than 18 feet but not less than 16 feet in width carrying average annual volumes



in excess of 300 vehicles per day. Center lines should not be used on pavements narrower than 16 feet.

(d) All four-, six-, and eight-lane undivided pavements.

2. Center lines should be placed at other locations where the accident record indicates the need for them, and on hard-surfaced roads in areas where driver visibility is likely to be reduced frequently, as by fog.

### **2B-3 Center Lines on Urban Streets**

The center line on a two-way city street with less than four lanes for moving traffic at any time shall be a solid white line. Such a line shall be not less than 4 nor more than 6 inches wide. For increased emphasis, a wider channelizing line may be used for the center line (sec. 2B-15).

The center line on a two-way street with four or more lanes for moving traffic at all times shall be a double solid yellow line except on a street involving reversible lane control. In such case a single solid white line (sec. 2B-15) may be used.

A line marking the center of a one-way street is a lane line and shall be a broken white line.

Applications of center lines are shown in various illustrations herein, particularly figures 1-8, 2-1, and 2-4.

### **2B-4 Lane Lines**

Lane lines are helpful in the organization of traffic in its proper channels, and in increasing the efficiency of the use of the roadway surface at congested locations. They should be used:

1. On all rural highways with an odd number of traffic lanes.
2. In addition to the double solid center line, on all undivided rural highways of four or more lanes.
3. At the approaches to important intersections and crosswalks, and in dangerous locations, on both rural highways and city streets.
4. At congested locations, particularly on city streets, where the roadway will accommodate more lanes of traffic than would be the case without the use of lane lines. These include:
  - (a) Locations between loadings islands and sidewalk curbs.
  - (b) Other locations where the normal lane width is decreased.
  - (c) Approaches to widened intersections.
5. On one-way streets or roadways where maximum efficiency in utilization of the roadway is desired.

Applications of lane lines are illustrated in figures 2-3 to 2-8, and 2-11.

## **2B-5 Lane Lines on Rural Roads**

Lane lines on rural roads shall be broken white lines, not less than 4 inches nor more than 6 inches wide. Line segments 15 feet long, with 25-foot gaps, are recommended. A solid channelizing line (sec. 2B-15) used in place of a lane line may vary in width from the normal line width to a maximum of 12 inches. The transverse spacing of lane lines, that is, the lane width, should not normally be less than 10 feet, with 12 feet as the desirable width.

## **2B-6 Lane Lines on Urban Streets**

Lane lines on city streets shall be broken white lines, not less than 4 inches nor more than 6 inches wide. Due to relatively lower speeds, the line segments and gaps may be shorter than in rural areas, maintaining a 3 to 5 ratio of length of stripe to length of gap. A solid channelizing line (sec. 2B-15) used in place of a lane line may vary in width from the normal line width to a maximum of 12 inches.

The lane width defined by lane lines should not normally be less than 10 feet, but a minimum of 9 feet is permissible where a maximum number of lanes must be made available, as at a signalized intersection where provision must be made for the most efficient storage of stopped vehicles.

**On wide, high-speed boulevards and on controlled-access highways in urban areas the standards for lane markings shall be the same as those for rural highways.**

## **2B-7 No-Passing Zones**

No-passing zones shall be established at vertical and horizontal curves and elsewhere on two- and three-lane highways, where passing must be prohibited because of dangerously restricted sight distances or other hazardous conditions.

The legal basis for the establishment of no-passing zones is set forth in section 11-307 of the Uniform Vehicle Code as follows:

(a) The (State highway commission) is hereby authorized to determine those portions of any highway where overtaking and passing or driving to the left of the roadway would be especially hazardous and may by appropriate signs or markings on the roadway indicate the beginning and end of such zones, and when such signs or markings are in place and clearly visible to an ordinarily observant person every driver of a vehicle shall obey the directions thereof.

(b) Where signs or markings are in place to define a no-passing zone as set forth in paragraph (a) no driver shall at any time



drive on the left side of the roadway within such no-passing zone or on the left side of any pavement striping designed to mark such no-passing zone throughout its length.

#### **2B-8 No-Passing Zone Markings**

A no-passing zone shall be marked by a solid barrier line placed as the right-hand element of a combination line along the center or lane line. This barrier line shall be yellow.

The barrier line shall be not less than 4 nor more than 6 inches wide, and shall be separated from the adjacent line by a space of not less than 3 nor more than 4 inches.

The combination line shall consist of either of the following, as illustrated in figure 2-1:

1. A normal broken white center or lane line continuing through the no-passing zone, with the solid yellow barrier line placed to the right of it. Where no-passing zones in opposite directions overlap on a two-lane roadway there will be a solid yellow barrier line on each side of the broken white center line. Where the no-passing restriction applies only in the opposing direction, the barrier line will appear to the left of the broken center or lane line.

2. A double line, of which the right-hand line is a solid yellow barrier line. The left-hand line will be either a normal broken white center line or a solid yellow barrier line governing the opposing direction of traffic. Where the solid yellow barrier line is on the left of a broken white line the passing restriction will apply only to the opposing direction of traffic.

#### **2B-9 Application of No-Passing Zone Markings**

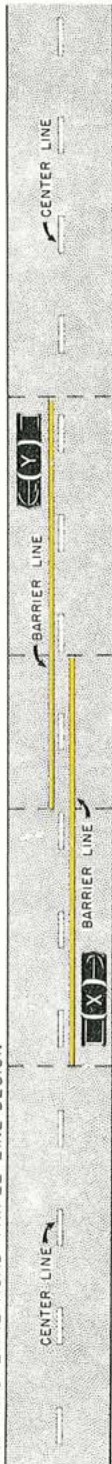
On a two-lane highway the combination no-passing line shall follow the center line throughout the no-passing zone. On a three-lane highway the combination line shall start in advance of the no-passing zone at the left-hand lane line of the center lane and shall extend diagonally across the center lane to the right-hand lane line at the beginning of the no-passing zone, and thence extend along the lane line to the end of the zone (fig. 2-1). The combination line shall extend across the center lane at an angle of not less than 20 to 1 where the offpeak 85-percentile speed is 40 m.p.h. or less, and at least 30 to 1 where speeds are greater than 40 m.p.h.

No-passing-zone signs (secs. 1B-21, 22) may be used to emphasize the existence and extent of a no-passing zone, in addition to the pavement markings here prescribed.

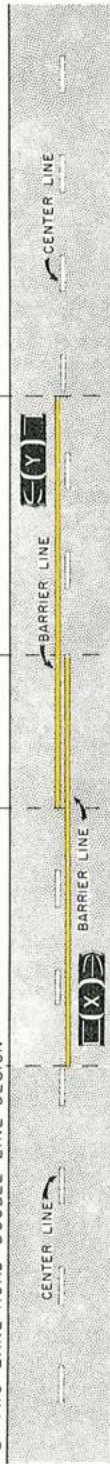
In no case shall the marking be less than 500 feet in length. If the actual no-passing distance is less than 500 feet, the ad-



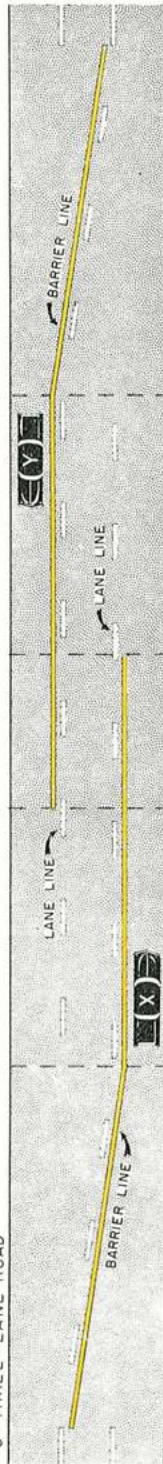
A - TWO-LANE ROAD - TRIPLE LINE DESIGN



B - TWO-LANE ROAD - DOUBLE LINE DESIGN



C - THREE-LANE ROAD



— ZONE OF LIMITED SIGHT DISTANCE, CAR "Y" —  
 — ZONE OF LIMITED SIGHT DISTANCE, CAR "X" —

Figure 2-1. Standard pavement markings for no-passing zones.

ditional length of marking shall be added at the beginning of the zone. Less than 400 feet of distance between successive no-passing zones is not sufficient for unrestricted passing. In such cases, the one-direction barrier line, or the two-direction barrier line, whichever is appropriate, should connect the zones.

It is assumed that on two-way roadways of four or a greater even number of lanes it is not necessary to cross the center line to overtake and pass other vehicles. The double yellow center line prescribed for such highways is to be regarded as a continuous no-passing marking, which must not be crossed from either side.

On urban streets it is not ordinarily necessary to mark no-passing zones. Speeds are generally low, and a center line is usually sufficient to keep vehicles in line. On boulevards or parkways, where no-passing zones may have to be marked, the standards should be the same as for rural highways.

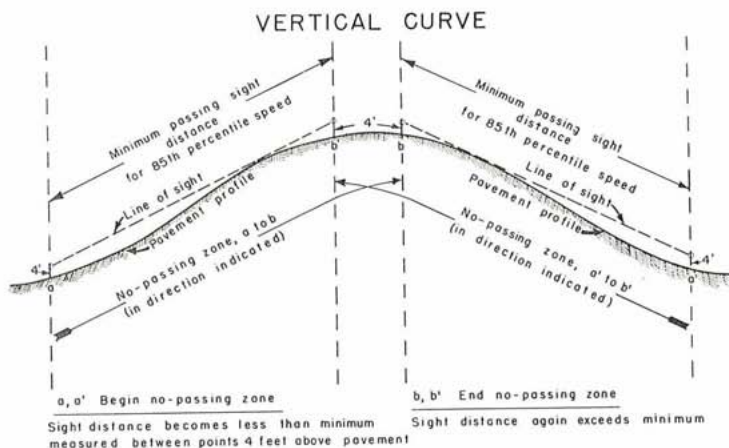
The no-passing barrier line is also used on two-way roadways at pavement-width transitions (sec. 2B-14) and on approaches to obstructions which must be passed on the right (sec. 2B-18). It may also be used on approaches to intersections.

## 2B-10 Warrants for No-Passing Zones at Curves

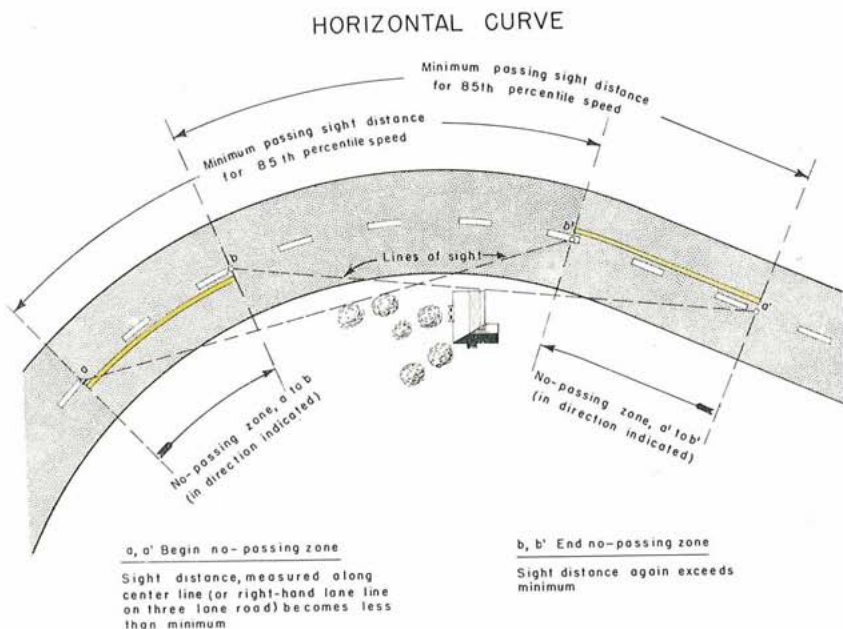
A no-passing zone at a horizontal or vertical curve is warranted where the sight distance as defined below is less than the minimum necessary for safe passing at the prevailing speed of traffic. Sight distance on a vertical curve is the distance at which an object 4 feet above the pavement surface can just be seen from another point 4 feet above the pavement, as illustrated in figure 2-2. Similarly sight distance on a horizontal curve is the distance measured along the center line (or right-hand lane line of a three-lane highway) between two points 4 feet above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (fig. 2-2). A curve shall warrant a no-passing zone and shall be so marked where the sight distance is equal to or less than that listed below for the prevailing (offpeak) 85-percentile speed:

85-percentile speed (m.p.h.):	Minimum sight distance (feet):
30	500
40	600
50	800
60	1,000
70	1,200

The beginning of a no-passing zone (point *a* in figure 2-2) is that point at which the sight distance first becomes less than that



Note: No-passing zones in opposite directions may or may not overlap, depending on alinement.



Note: No-passing zones in opposite directions may or may not overlap, depending on alinement.

**Figure 2-2. Method of locating and determining the limits of no-passing zones at vertical and horizontal curves.**



specified in the above table. The end of the zone (point *b*) is that point at which the sight distance again becomes greater than the minimum specified.

## 2B-11 Pavement Edge Lines

Pavement edge lines shall be solid white lines not less than 2 inches nor more than 4 inches wide. They shall be used only as a supplement to and not as a substitute for standard center and lane lines. Pavement edge lines are not a substitute for adequate road delineation markers.

The purpose of line markings on the edge of the pavement is generally threefold: (1) to reduce travel, particularly by the heavier vehicles, on shoulders of lesser structural capacity than the adjacent pavement, (2) to make driving more comfortable, particularly at night and during inclement weather, by providing a continuous guide for the driver, and (3) to reduce accidents.

## 2B-12 Right-Hand Edge Line and Paved-Shoulder Markings

The shoulder area on various types of highways varies greatly in both width and character, ranging from narrow and unpaved, not suitable for driving in emergencies, to high-type paved shoulders 10 feet or more in width.

The varied conditions require different edge-marking treatment. Insofar as possible, uniformity must be maintained. However, exactly the same treatment cannot be applied to all conditions of pavement edge and shoulder.

The need for placing a pavement edge marking also varies with the character of the pavement edge and the shoulder. The several conditions generally encountered are treated separately as follows:

1. *No shoulder or unsurfaced shoulder.*—Under these conditions, pavement margins are sometimes raveled and broken. The shoulder is frequently rough and unsafe for emergency use except at low speeds. With adverse light and weather, it is often difficult to distinguish the exact edge of the pavement.

With the unsurfaced shoulder, there is no evidence that edge lines have been mistaken for lane lines. The unpaved shoulder condition with the probability of roughness, loose material, or a drop-off at the pavement edge is a strong warrant for the use of a pavement edge line.

2. *Paved shoulders.*—Pavement edge marking presents a special problem where the pavement surfacing is extended over part or all of the shoulder width.

The most effective means of differentiating paved shoulders

from the traffic lanes is by a definite contrast in surface appearance, riding characteristics, and texture. The through traffic lanes and the shoulder area should be clearly defined at all times, particularly at night or in inclement weather when visibility is poor. This can best be accomplished by a design which specifies contrasting color and texture. Relatively coarse stone chips for the shoulder treatment are desirable to provide an audible warning to the driver as well as the contrast in color and texture.

Where the contrast is sharp enough there is no need for a line marking to indicate the edge of the traffic lane. However, there is no objection to its use if required for uniformity in areas where pavement edge markings are in general use.

Where the contrast is not sharp and the paved shoulder is 8 feet or less in width, the appearance of a traffic lane can be avoided to a considerable extent by placing the edge marking on the shoulder 1 to 2 feet from the edge of the traffic lane. This reduces the apparent width of the paved portion of the shoulder sufficiently to discourage its use as a driving lane. With a paved shoulder less than 8 feet in width, structurally adequate to carry all traffic, presenting no hazard due to stopped vehicles, and where it is not objectionable for traffic to encroach slightly on the shoulder, there is little evidence of need for edge striping; it may, however, be provided as an additional guide to drivers.

Where the contrast is not sharp and the paved shoulder is more than 8 feet in width, the problem is accentuated. Under these conditions, a line marking at the edge of the traffic lane causes the shoulder to appear to the driver as another lane for traffic. There is definite evidence of confusion under these conditions. Wherever there are wide shoulders with no sharp contrast between through lanes and shoulder, a hazard may exist due to stopped vehicles being hit by vehicles which wander onto the shoulder. Special treatment is required if moving traffic is to be confined to the traffic lane. Such conditions are a strong warrant for use of shoulder delineation with diagonal lines.

The pavement edge line under these conditions should be placed on the shoulder 1 foot from the theoretical traffic lane, with diagonal markings on the shoulder to show definitely that it is not intended for use as a traffic lane. These diagonal markings should be 12 inches in width with spacing varied from 20 feet in low speed areas to 100 feet in areas where operating speeds are 50 miles per hour or over.

A typical layout for these shoulder markings is shown in figure 2-3.



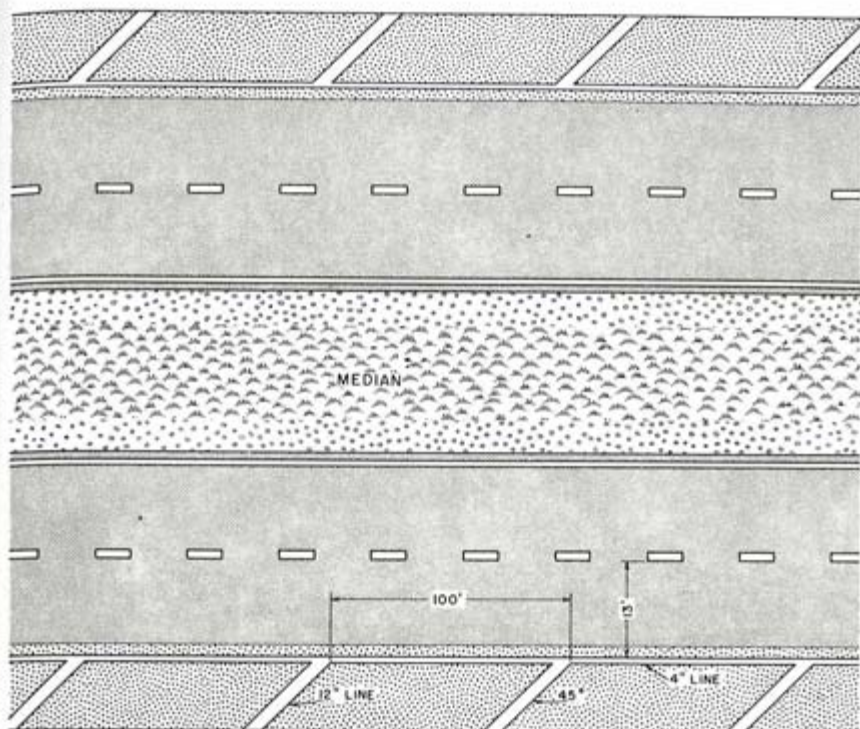


Figure 2-3. Typical paved-shoulder markings on wide paved shoulder with surface texture, riding quality, and color similar to traffic lanes.

### 2B-13 Left-Hand Edge Line

On a one-way roadway, a left-hand edge line frequently is helpful. This line marking should normally be a single solid white line 4 inches in width. This type of marking is an effective means of delimiting the median area of a divided highway (fig. 2-3). Where special emphasis is required adjacent to curbs, in areas of poor visibility, or on medians less than 16 feet in width the double yellow barrier line or solid channelizing line should be used. Where the median is paved flush with the traffic lanes, the double barrier line shall be used in all cases.

### 2B-14 Pavement-Width Transitions

Line markings should be used to guide traffic at points where the pavement width changes to a lesser number of lanes. Line markings at pavement-width transitions shall be not less than 4 nor more than 6 inches wide and of standard design for center, lane, or barrier lines. Converging lines shall have a length of not less than that determined by the formula  $L = S \times W$ , where



**L equals the length in feet, S the (offpeak) 85-percentile speed in miles per hour, and W the offset distance in feet.** On new construction, where no 85-percentile speed exists, the design speed may be used.

A number of situations are possible, as illustrated in figure 2-4, depending on which lanes must be offset or cut out, and the amount of offset. One or more lane lines must be discontinued, and the remaining center and lane lines must be connected in such a way as to merge traffic into the reduced number of lanes.

Through the transition area, in the direction of convergence, the line separating the opposing directions of traffic should be of no-passing-zone design, either the double solid center line of a multilaned road or a normal broken center line with an adjacent barrier line as prescribed for no-passing zones (sec. 2B-8).

Line markings at pavement-width transitions are not sufficient, in themselves, to guide traffic safely through such locations. Standard signs, and guardrails, edge lines, or delineators (sec. 2D-4) must be used in conjunction with the pavement markings.

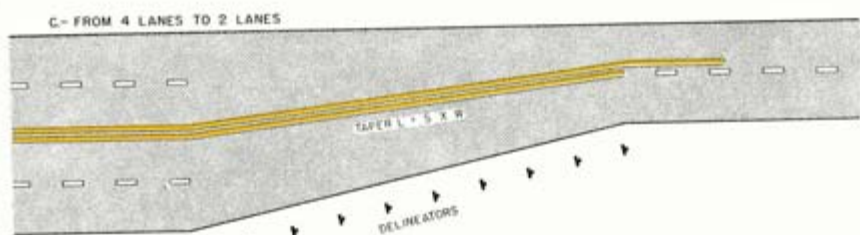
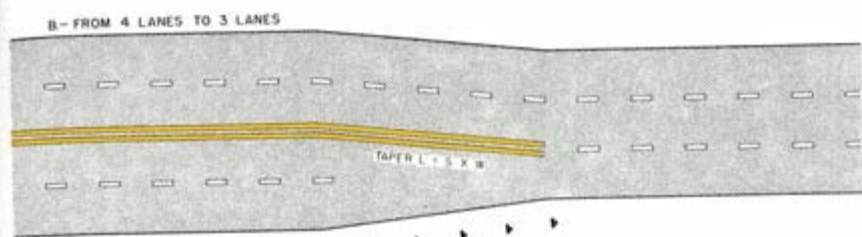
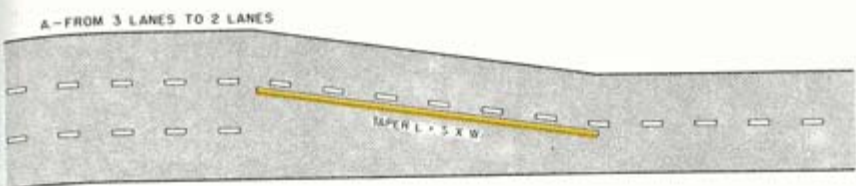
#### **2B-15 Channelizing Line**

**The channelizing line shall be a solid white line.** The width of the line may vary from the width of a normal center or lane line to a maximum of 12 inches depending on conditions and the emphasis required. Generally, 8 to 12 inches is desirable.

The wide solid traffic line is a useful traffic control device for channelizing traffic and discouraging lane changing. This device is used where traffic may proceed on either side, but where crossing the line is to be discouraged even if not legally prohibited.

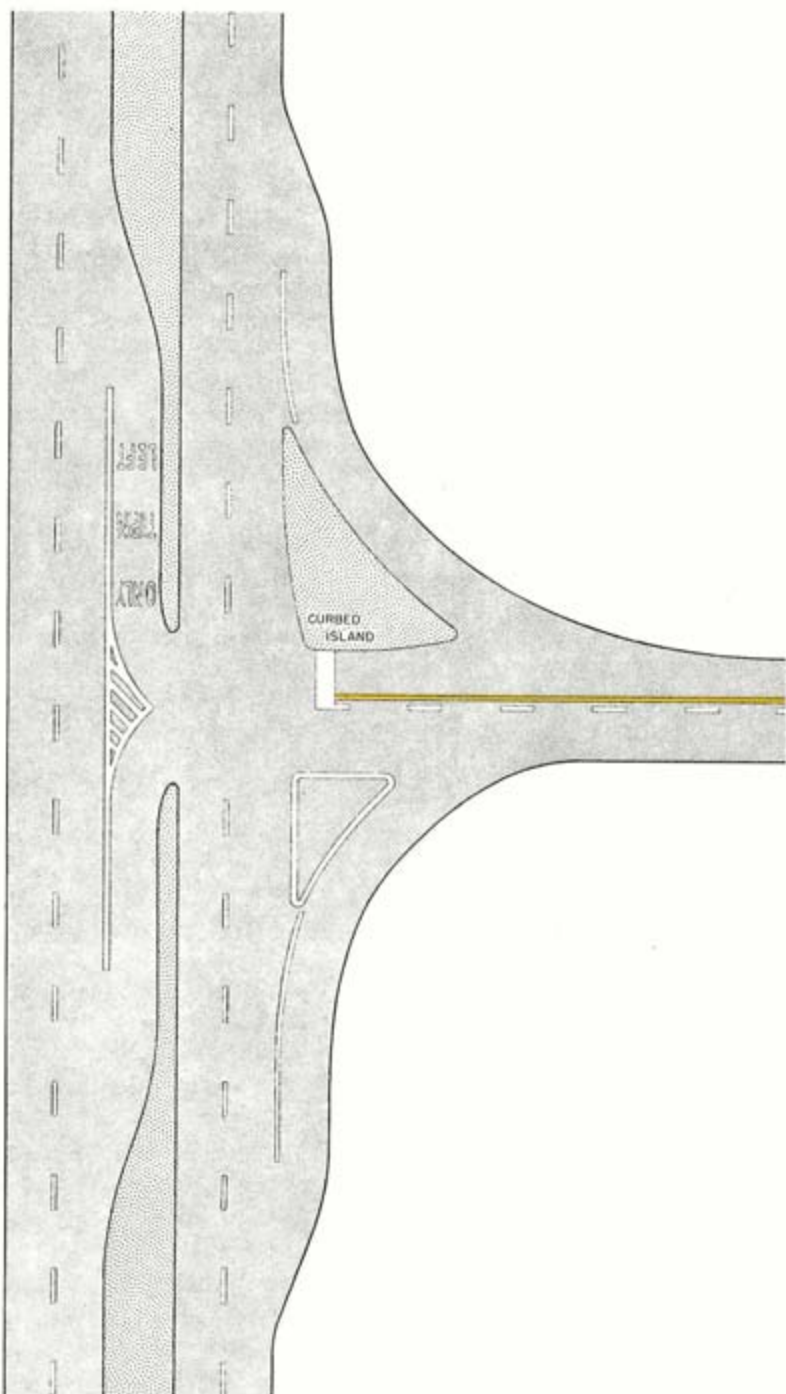
The channelizing line is useful to form traffic islands in a paved area and to separate turn lanes from the main traffic lanes, where a more restrictive barrier, such as a curb, is impractical or would create a hazard. The wide line will outline a neutral area and guide traffic, but the consequences are not severe if it is driven over inadvertently or to avoid an accident. The use of this marking is, of course, limited to locations where a positive restriction in the form of a physical barrier is not required.

The solid line may be used in lieu of the broken lane line to accentuate the lane marking in critical areas and more clearly define the traffic lanes where it is advisable to discourage lane changing. Typical locations for use of this marking are tunnels where width is restricted, interchange areas where unnecessary lane changing is detrimental to smooth traffic flow, and areas where visibility is poor due to weather conditions. The solid lane line is applicable to both one-way and two-way roadways.



L = Length in feet  
 S = 85th percentile speed  
 W = Offset in feet

Figure 2-4. Typical pavement-width transition markings and signs.



**Figure 2-5.** Typical applications of channelizing lines: marking right-turn acceleration and deceleration lanes, forming channelizing islands, and marking left-turn storage and inside acceleration lanes.



The wide solid line may also be used in lieu of the normal-width center line on urban streets to emphasize the center line or to distinguish it at points where solid lane lines are used. On a two-lane two-way road the solid line may be placed on the center line where emphasis is needed and a barrier stripe is too restrictive.

A single solid white line may be used to separate the primary traffic lanes from lanes for special use, such as uphill climbing lanes or transit lanes.

Another use of the channelizing line is in the marking of exit and entrance ramps (sec. 2B-16).

Typical examples of uses of the channelizing line are shown in figures 2-5 to 2-8, and 2-11.

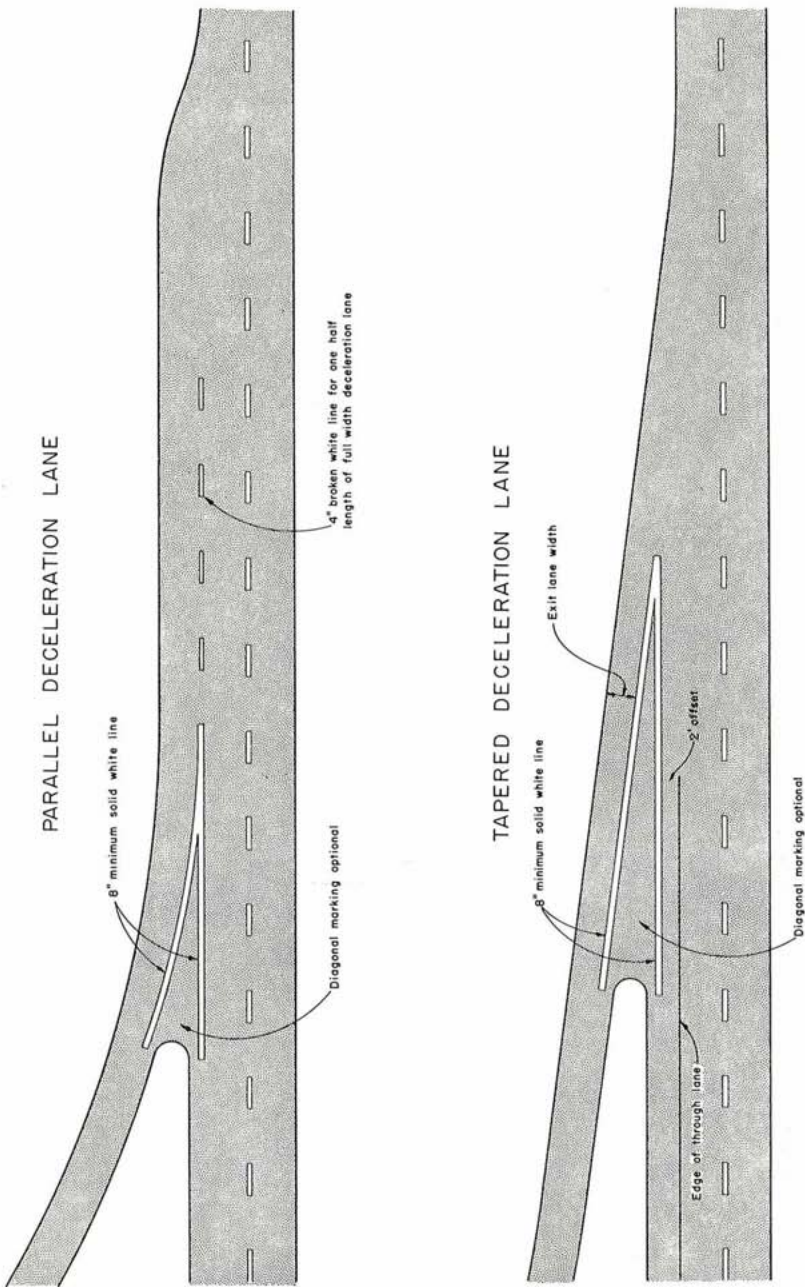
#### **2B-16 Marking of Exit and Entrance Ramps on Expressways**

Use of the channelizing lane at exit ramps of expressways provides a neutral area which reduces the possibility of conflict with the curb nose and also directs turn-off traffic at the proper angle for smooth divergence. At entrance ramps the line promotes safe and efficient merging with the through traffic. (See figures 2-6 and 2-7.)

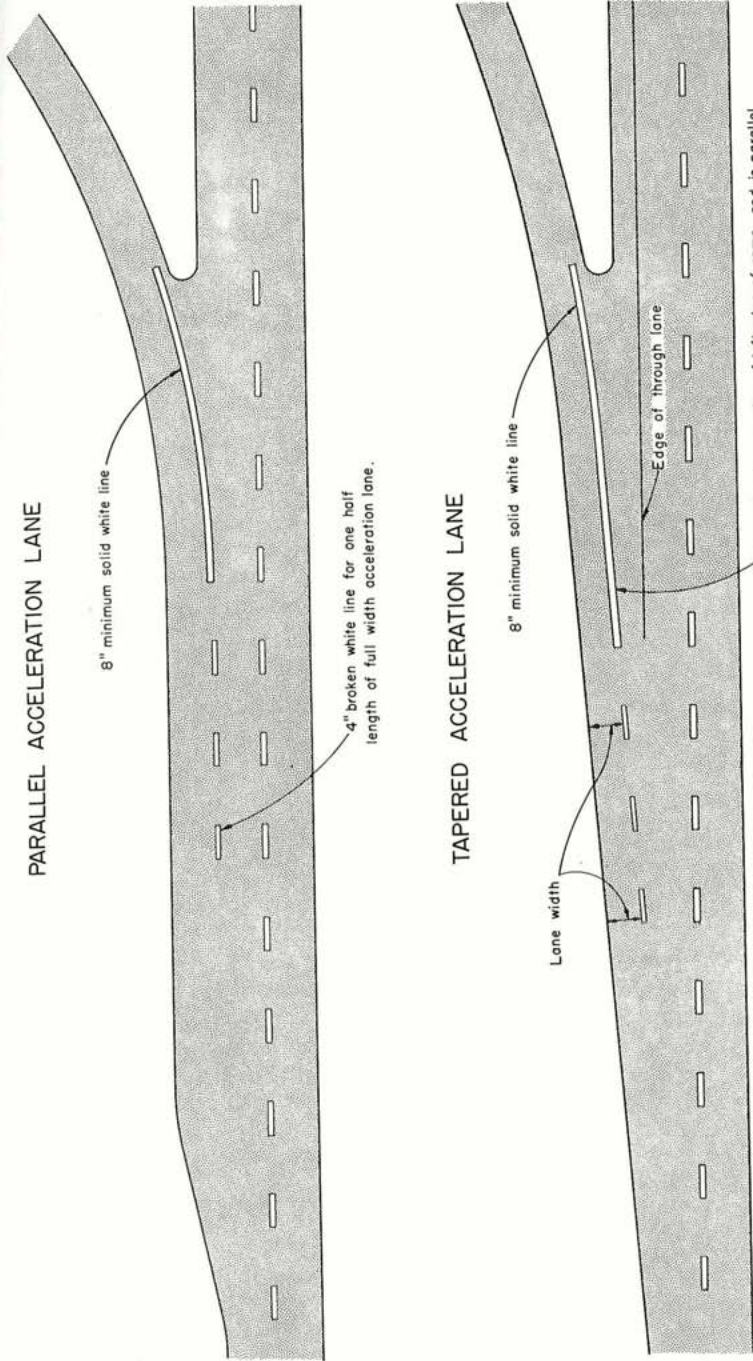
*Exit ramp marking.*—A solid white line at least 8 inches in width shall be placed along the sides of the triangular neutral area between the edges of the main roadway and the exit ramp lane at the gore of every exit ramp terminal. With a parallel deceleration lane, a broken white line shall be placed from the apex of the triangular area for a distance of approximately one-half the length of the full width deceleration lane. Where additional emphasis is desired, diagonal markings may be used within the neutral area.

*Entrance ramp marking.*—A solid white line at least 8 inches in width shall be placed along the side of the triangular neutral area adjacent to the ramp lane at the gore of every entrance ramp terminal. With parallel acceleration lanes, a broken white line shall be placed from the apex of the triangular area for a distance of approximately one-half the length of the full width acceleration lane. With tapered acceleration lanes a similar broken white line may be placed beyond the solid line but not beyond the point where the tapered line meets the outer edge of the near through lane.

*Interstate.*—The above-described exit and entrance ramp markings are those prescribed for use on the Interstate System.



**Figure 2-6. Standard exit ramp markings.**



Ramp line is extension of left edge of ramp, and is parallel to right edge. Solid line must be carried to within 6' of edge of through lane, or to end of ramp curve if closer. Broken line should continue to the edge of the through lane.

**Figure 2-7. Standard entrance ramp markings.**



## 2B-17 Approach to an Obstruction

Pavement markings shall be used to supplement standard signs and to guide traffic on the approach to fixed obstructions within a paved roadway.

Obstructions within the roadway are hazards that should not be permitted to exist if avoidable. Where they cannot reasonably be eliminated, everything possible should be done to prevent vehicles from colliding with them. An obstruction may be so located that all traffic must keep to the right of it, or it may be between two lanes of traffic moving in the same direction. The markings in either case must be designed to deflect traffic away from the obstruction by a diagonal line or lines of unmistakable meaning.

Obstruction approach markings shall be used only to supplement adequate markings on the obstruction itself as prescribed in section 2C-2.

## 2B-18 Obstruction Approach Markings

Obstruction approach pavement markings shall consist of a diagonal line, or lines, extending from the center or lane line to a point 1 to 2 feet to the right side, or to both sides, of the approach end of the obstruction (fig. 2-8). All lines used in obstruction approach markings shall be not less than 4 nor more than 12 inches wide.

The length of the diagonal markings should be determined by the formula  $L=S \times W$  where  $L$  equals the length in feet,  $S$  the (offpeak) 85-percentile speed in miles per hour, and  $W$  the width of the offset in feet. In no case shall the diagonal line be less than 200 feet in length in rural areas or 100 feet in urban areas.

If traffic is required to pass only to the right, the diagonal line shall be marked to the right and shall be of one of the following designs:

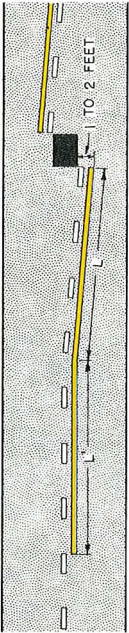
1. A normal broken center line flanked by a solid barrier line, as specified for no-passing zones (sec. 2B-8). The barrier line shall extend along the center line in advance of the diagonal line for an additional distance equal to the length of the diagonal line.

2. On roads of four lanes or more a simple continuation of the double center line prescribed for such roads (sec. 2B-2).

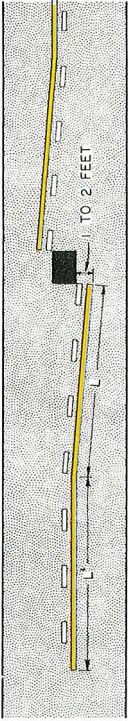
In addition, a solid white diagonal line may be extended to the left of the obstruction, to outline the triangular area from which traffic must be excluded for safety.

If traffic may pass either to right or left of the obstruction barrier lines cannot be used. In this case there shall be two solid white lines diverging from the lane line, one to either side of the

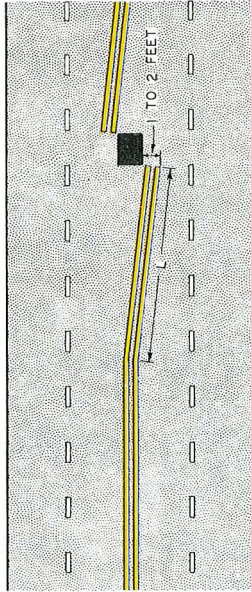
A—CENTER OF TWO-LANE ROAD WITH CONTINUOUS CENTER LINE



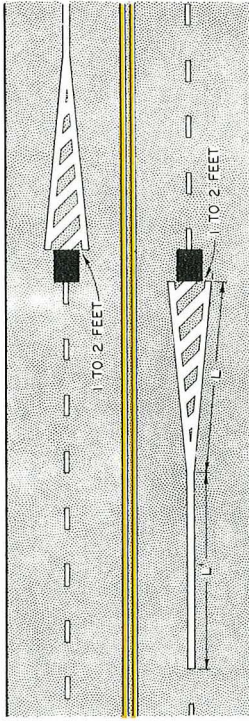
B—CENTER OF TWO-LANE ROAD WITHOUT CONTINUOUS CENTER LINE



C—CENTER OF FOUR-LANE ROAD



D—TRAFFIC PASSING BOTH SIDES OF OBSTRUCTION



$L = L$

$L = S \times W$

$L =$  Length in feet

$S =$  85th percentile speed in miles per hour

$W =$  Width of the obstruction in feet (offset distance)

Minimum length of  $L = 100$  feet in urban areas,

200 feet in rural areas

Figure 2-8. Approach markings for obstructions in the roadway.



obstruction for a length determined by the formula  $L=S \times W$ . In advance of the point of divergence a single solid white line shall be extended in place of the normal broken lane line for a distance equal to the length of the diverging lines.

As an added safeguard it is desirable, especially where traffic is permitted to pass to both right and left of an obstruction, to place broad transverse, diagonal, or longitudinal lines in the triangular area between the guide lines, as shown in figures 2-8 and 2-14.

Similar markings are desirable at channelizing islands not so designed as to divert traffic naturally from them.

### **2B-19 Turn Markings**

Markings to control and guide turning vehicles are sometimes used at intersections. Turn markings have not been satisfactorily standardized, but if used they should be so designed as to indicate the proper course for turning vehicles without being needlessly confusing to through traffic or traffic making other turns. **Such markings shall be white.**

### **2B-20 Transverse Lines**

Because of the low angle at which pavement markings are viewed from an approaching vehicle, it is necessary that all transverse lines be proportionately widened to give visibility equal to that of longitudinal lines, or to avoid apparent distortion where longitudinal and transverse lines are combined in symbols or lettering. This applies particularly to Stop lines, crosswalk markings, railroad-crossing markings, and word and symbol markings.

Particular attention must be given to the maintenance of transverse lines which, because of their position on the pavement, are subject to constant wear by every vehicle that passes.

### **2B-21 Stop Lines**

**Stop lines shall be solid white lines, not less than 12 nor more than 24 inches wide. They shall extend across all approach lanes (fig. 2-11).**

On urban streets where speeds are not high a width of 12 to 18 inches is usually sufficient.

Stop lines (or Limit lines) should be used in both rural and urban areas where it is important to indicate the point behind which vehicles are required to stop in compliance with a Stop sign, traffic signal, officer's direction, or other legal requirement.

Stop lines, where used, should ordinarily be placed 4 feet in advance of, and parallel to, the nearest crosswalk line. In the ab-



sence of a marked crosswalk, the Stop line should be placed at the desired stopping point, in no case more than 30 feet or less than 4 feet from the nearest edge of the intersecting roadway.

If a Stop line is used in conjunction with a Stop sign, it should ordinarily be placed in line with the Stop sign. However, if the sign cannot be located exactly where vehicles are expected to stop, the Stop line should be placed at the stopping point.

**The word STOP shall not be placed on the pavement in advance of a Stop line, unless every vehicle is required to stop at all times.**

## **2B-22 Crosswalk Lines**

Crosswalk lines, in both rural and urban areas, shall be solid white lines, marking both edges of the crosswalk. They shall be not less than 6 inches wide (fig. 2-10, 11, and 4-6). If no advance Stop line is provided, it may be desirable to increase the width of the crosswalk line on the approach side to as much as 24 inches, particularly where speeds are greater than 35 m.p.h. and in rural areas where crosswalks are unexpected.

**Crosswalks shall be marked at all intersections where there is material conflict between vehicular and pedestrian movement.** Marked crosswalks should also be provided at other appropriate points where there is substantial pedestrian movement, as at long loading islands, or where pedestrians are permitted to cross between intersections, or where pedestrians could not otherwise recognize the proper place to cross.

To promote acceptance of the crosswalk as a pedestrian safeguard, the limits of the crosswalks must be distinctly indicated, both to pedestrians and to drivers. For this reason, two lines are necessary to define the crosswalk area.

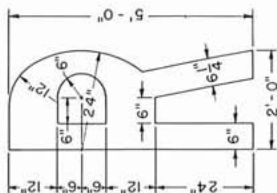
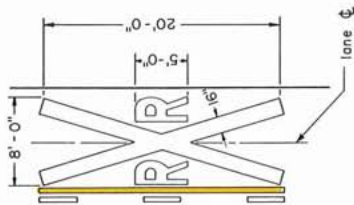
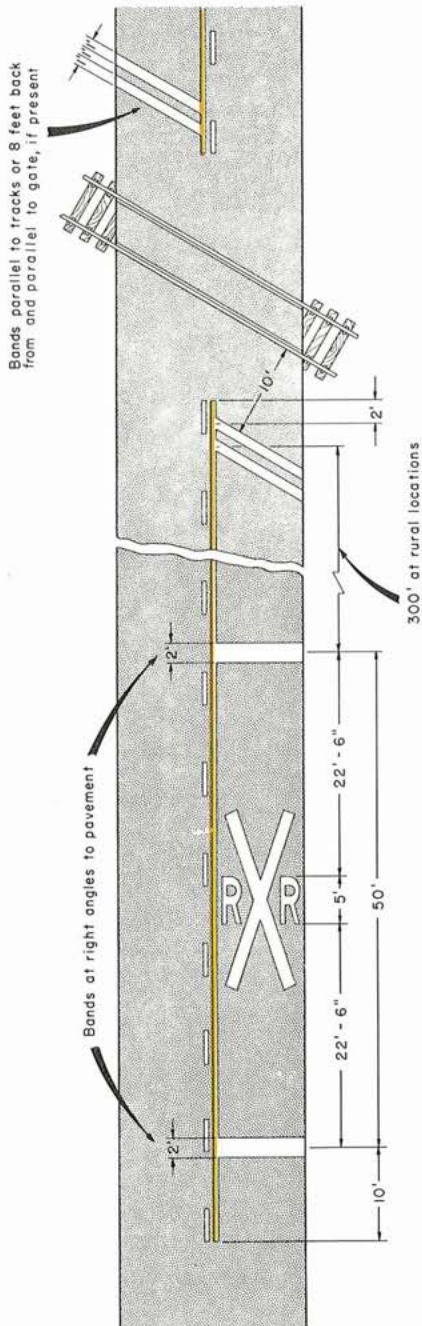
The width of the crosswalk between crosswalk lines is usually determined by the width of the sidewalks so connected. **The width shall in no case be less than 6 feet.**

Crosswalk lines on both sides of the crosswalk should meet the curb to discourage diagonal walking between crosswalks.

## **2B-23 Approach to Railroad Crossing**

Pavement markings consisting of a cross, the letters RR, a no-passing zone marking, and certain transverse lines shall be placed on all paved approaches to railroad crossings, except at minor sidings in urban areas where other protection is afforded. Such markings shall be white except for the no-passing barrier line, which shall be yellow.

The design of railroad crossing pavement markings shall be essentially as illustrated in figure 2-9. The symbol and letters



The transverse spread of the "X" may vary according to lane width. A three-lane roadway should be marked with a center line for two-lane operation on the approach to a crossing. On a four-lane road the transverse bands should extend across the two right-hand lanes only to the center line, and a 10-foot "X" should be centered in the right half of the pavement. On roadways where one half the pavement width (or the width assigned to traffic in one direction) exceeds 30 feet, two or more of the R XR symbols should be symmetrically placed side by side on the right half of the pavement.

Figure 2-9. Standard pavement markings at railroad-highway grade crossings.

are elongated to allow for the low angle at which they are viewed.

While these markings have value as a means of attracting the attention of the driver to the proximity of a railroad grade crossing, because they are distinctively different from all other pavement markings, they are only auxiliary to the standard Railroad Advance Warning sign (sec. 1C-31) and the Crossbuck sign (sec. 1C-32), which must be used in every case, and crossing signals or gates.

## **2B-24 Parking Space Limits**

**All lines for parking spaces shall be solid white lines, not less than 4 inches nor more than 6 inches wide.**

The marking of parking space limits on urban streets encourages more orderly and efficient use of parking spaces, and tends to prevent encroachment on fire hydrant zones, bus stops, loading zones, approaches to corners, and clearance spaces for islands.

The ends of a parking zone may be indicated on the pavement by lines marked perpendicular to the curb and extending into the roadway the width required by a parked vehicle, usually 8 to 10 feet. As a further refinement a line may be placed parallel to the curb connecting the street ends of these perpendicular lines, indicating the outside boundary of the parking zone.

The zone may be further divided into stalls by the use of similar lines perpendicular to the curb and so spaced that each stall is long enough to accommodate one parked vehicle, usually 22-26 feet. Stalls at the ends of a zone may be 20 feet in length. A short line, parallel to the curb, may be placed at the end of each stall line, in place of the continuous line extending the length of the parking zone. For parking stalls along the left-hand curb of one-way streets, markings may be placed on the curb delineating the ends of the individual stalls. The marking of stalls is especially beneficial where parking meters are used.

Curb markings may also be used to indicate parking prohibitions (sec. 2B-27).

Typical parking space limit markings are shown in figure 2-10.

Angle parking is generally not desirable, though occasionally it may be justified as, for example, on a pavement over 70 feet in width where traffic is light and relatively slow moving. Where angle parking is permitted the marking of lines to indicate the limits of stalls enables all drivers to park at the same angle with a minimum of waste space.



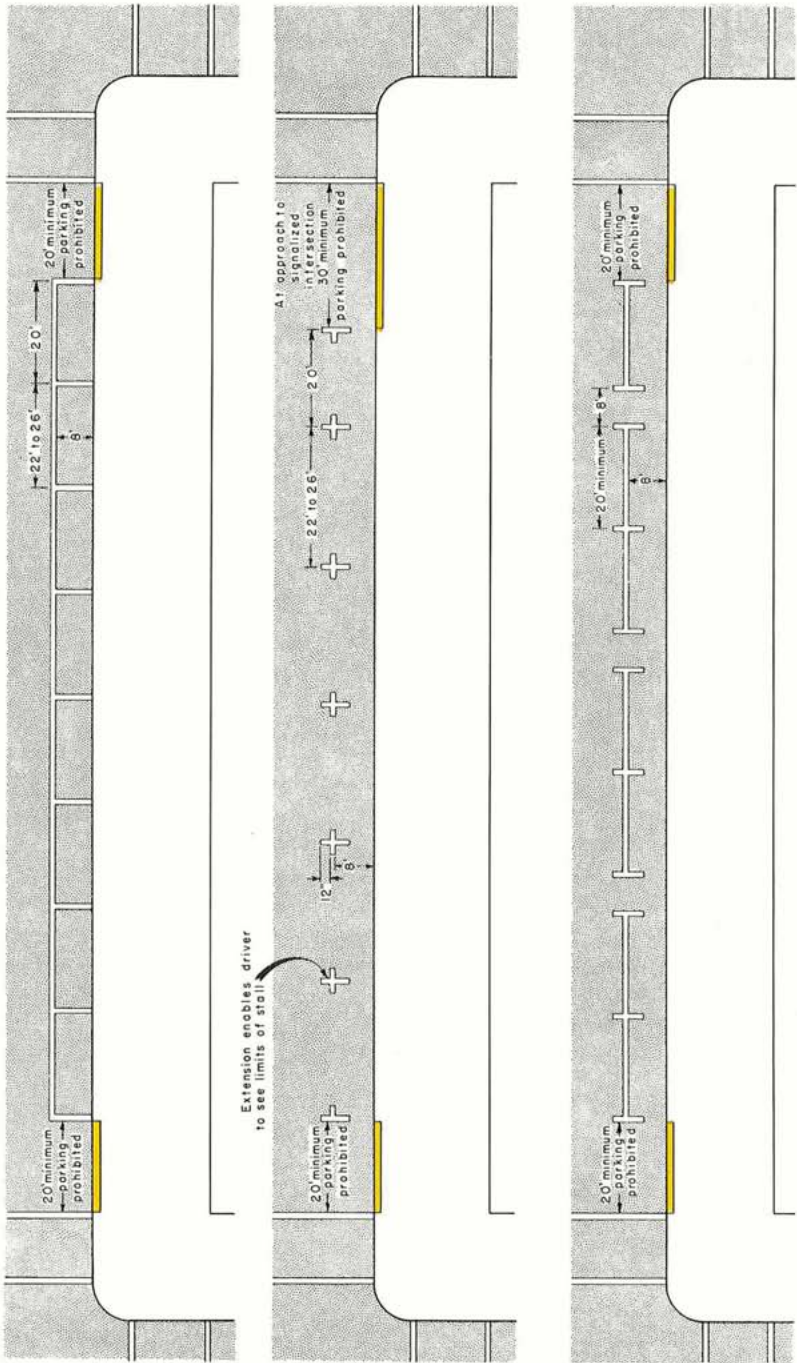


Figure 2-10. Typical parking-space-limit markings.

## **2B-25 Word and Symbol Markings**

Word and symbol markings on the pavement may be used for the purpose of guiding, warning, or regulating traffic. They should be limited to as few words as possible, never more than three.

**Word and symbol markings shall not be used for mandatory messages except in support of standard signs. They shall be white in color.**

The letters and symbols should be greatly elongated in the direction of traffic movement because of the low angle at which they are viewed by approaching drivers. Large letters and numerals should be used, 8 feet or more in height; and, if the message consists of more than one word, it should read "up," i.e., the first word should be nearest to the driver. Where speeds are low, somewhat smaller characters may be used. The space between lines should be at least four times the height of the characters. Recommended designs of elongated letters and arrows are shown in figures 2-12 and 2-13.

On high-speed roads, especially where traffic is heavy, messages of more than one line are undesirable and should generally be avoided.

Figures 1-2, 2-5, 2-9, 2-11, 4-11, and 4-17 show uses of word and symbol markings on the pavement.

## **2B-26 Lane-Use Control Markings**

Lane-use control markings should be used on the approach to an intersection to supplement Lane-Use Control signs (sec. 1B-18) indicating the types of movement that are permitted from specific lanes.

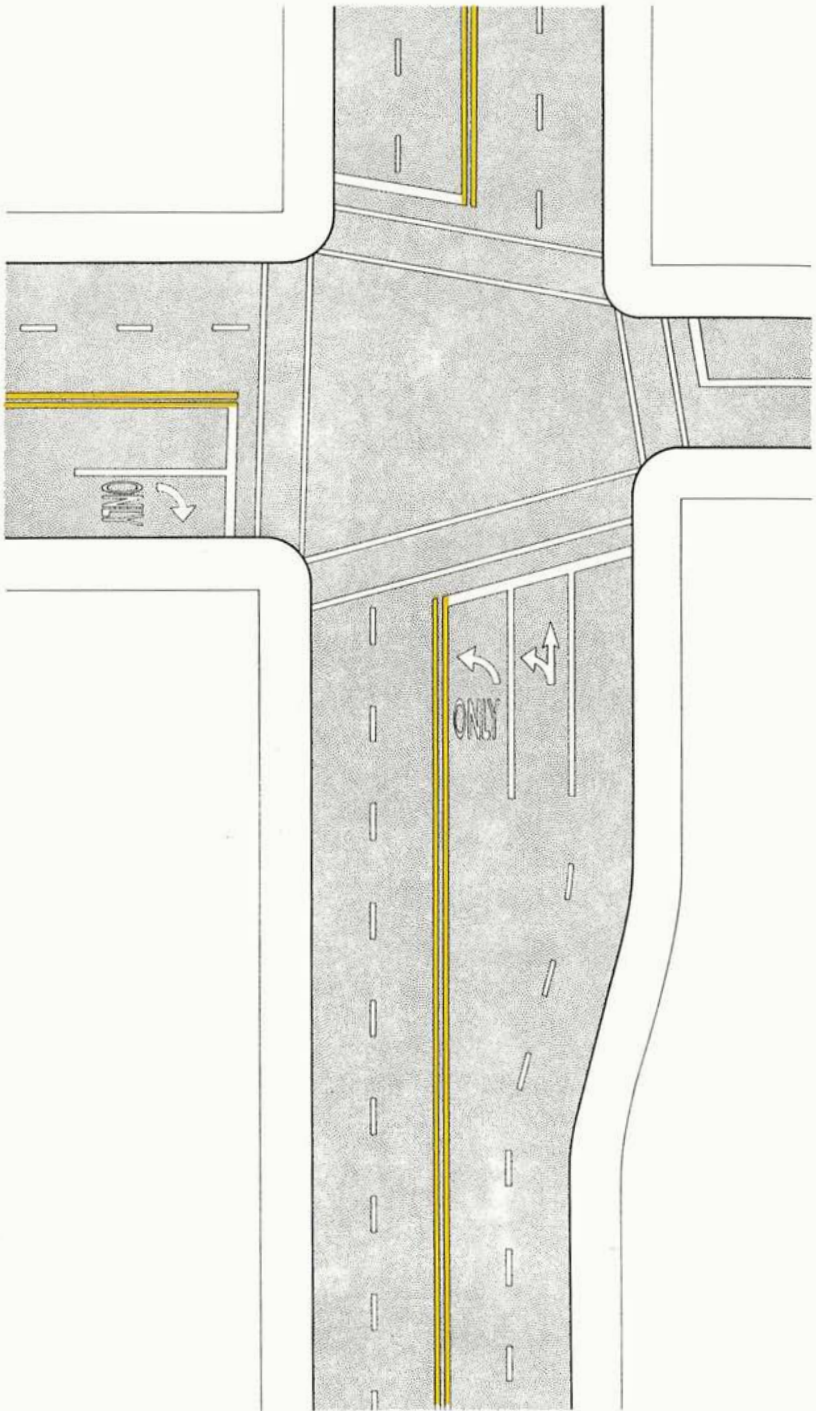
The recommended design of word markings and arrows which are applicable are shown in figures 2-12 and 2-13. Figure 2-11 shows typical applications of lane-use control markings.

Additional markings of the same design should also be placed at a sufficient distance in advance of the intersection so that motorists can select the appropriate lane before reaching the end of the line of waiting vehicles.

## **2B-27 Curb Markings for Parking Restrictions**

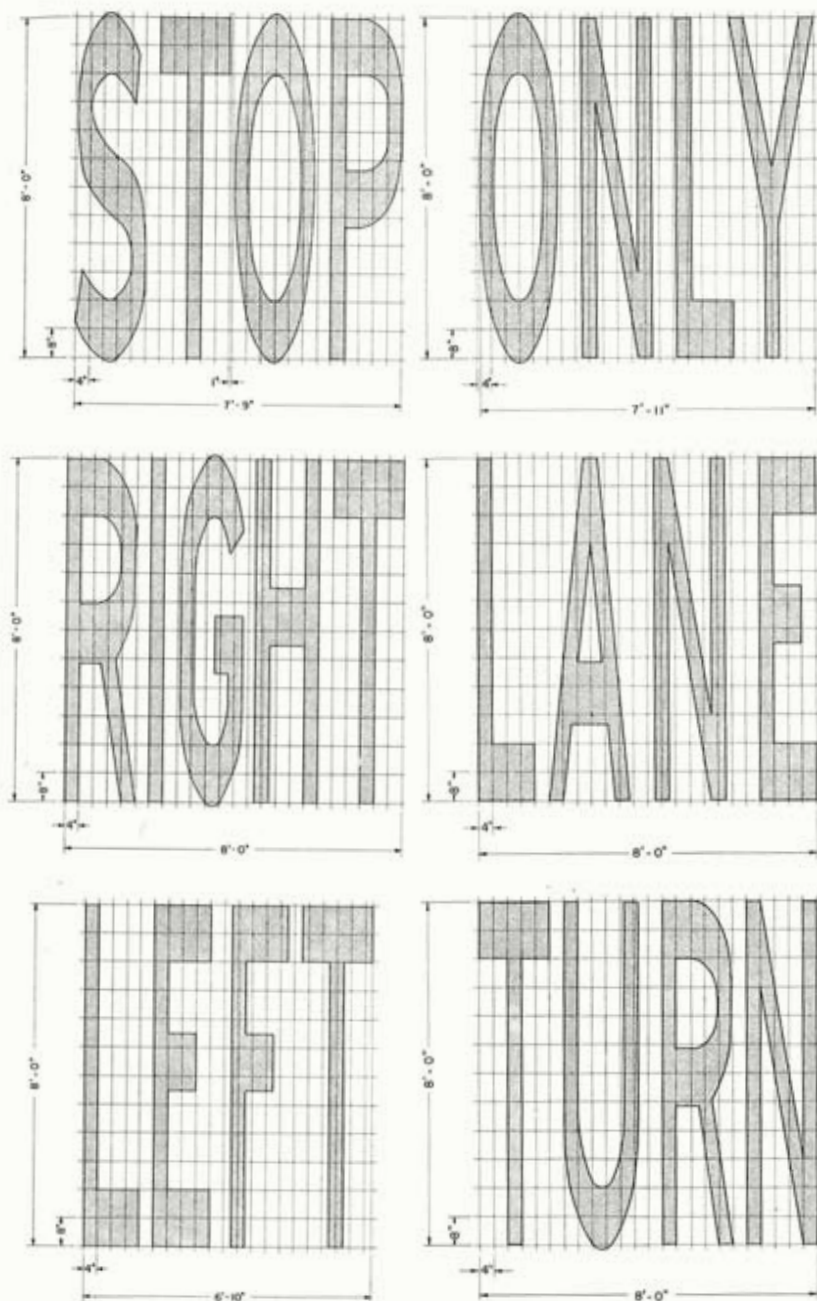
**The curb markings for parking restrictions shall be of a solid yellow color, covering the face and top of the curb.**

Curb markings may be used to show where parking is prohibited at all times. They should not be used except on curbs along which parking is legally prohibited, either by general ordinance,



**Figure 2-11. Typical applications of lane-use-control markings.**





**Figure 2-12. Elongated letters for pavement markings.**

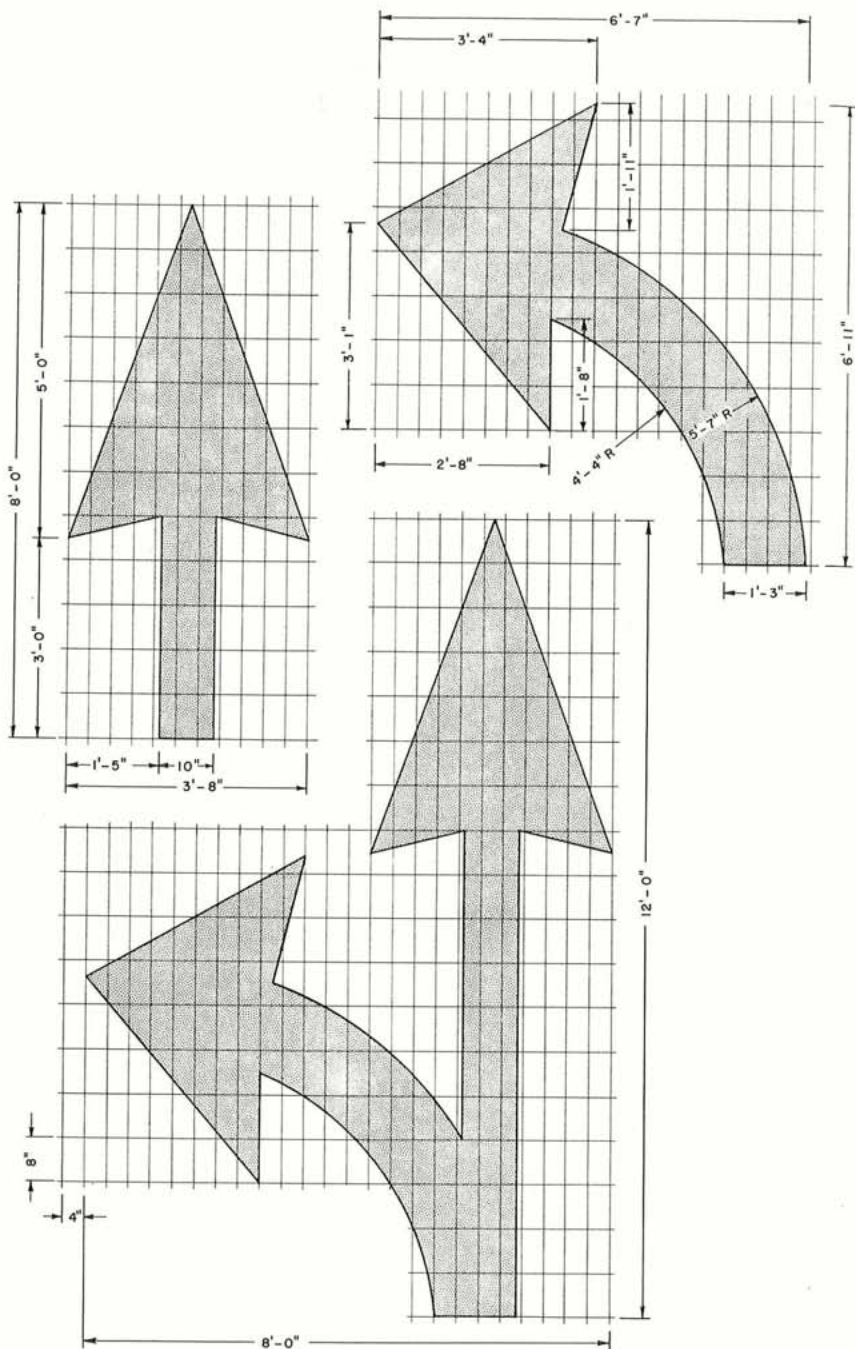


Figure 2-13. Elongated arrows for pavement markings.

as at fire hydrants, adjacent to corners, and opposite loading islands, or by the erection of standard no-parking signs.

Experience has shown that the public does not easily understand a color code where several colors are used in curb marking to indicate different types or degrees of parking restrictions. Curb markings are accordingly recommended only to show that parking is prohibited at all times. Other restrictions should be shown by standard parking signs.

## C—OBJECT MARKINGS

### Section 2C-1 Application of Object Markings

**Physical obstructions in or near a roadway that constitute serious hazards to traffic, including installations designed for the control of traffic, shall be adequately marked.**

Typical obstructions of this character are bridge supports, monuments, traffic islands, beacon, signal, and overhead sign supports, loading islands, railroad and drawbridge gates, end posts of narrow bridges, underpass piers and abutments, culvert headwalls, poles, trees, and rocks, and structures giving restricted overhead clearance.

Only such immovable obstructions as bridge supports and necessary islands should be permitted to remain within the roadway. Even at the present time, other obstructions are occasionally placed in roadways in the mistaken belief that they will serve as aids to the control of traffic. Such installations include signal pedestals in the center of intersections, sign or signal posts at railroad crossings, and large "mushroom" buttons in active traffic areas. These should invariably be removed for safety. It is often necessary, however, to place barricades and similar devices in or near the roadway in emergencies or at construction or maintenance sites. The proper application and marking of these devices is described in part V (secs. 5C-1 to 8).

Judgment must be exercised in the marking of objects off the roadway, but it may be noted that, even where they are theoretically at a safe distance from the roadway, marking them may prevent serious accidents and facilitate night driving.

In addition to markings, a guardrail should be placed in advance of solid obstructions such as bridge supports, overhead sign supports, and end posts of bridges. The purpose of the guardrail is to deflect vehicles and reduce the severity of impact. Guardrails should be painted white and may be reflectorized.



## **2C-2 Objects Within the Roadway**

**Obstructions in the roadway, if not illuminated, shall be marked with reflectorized hazard markers (sec. 2D-2).**

For additional emphasis it is advisable also to mark such obstructions, except islands, with reflectorized white paint or not less than five alternating black and reflectorized white stripes. **The stripes shall slope downward at an angle of 45 degrees toward the side of the obstruction on which traffic shall pass. The alternate stripes shall be uniform and not less than 4 inches in width.** They may be as much wider as may be necessary to make a good appearance and to provide sufficient visibility, depending on the size of the object and speed of approaching traffic. Typical markings are illustrated in figure 2-14.

Where the vertical clearance of an overhead structure is less than 1 foot more than the maximum legal height of vehicles, the clearance in feet and inches should be clearly marked on the structure.

A large surface, such as a bridge pier, may require stripes of 12-inch or greater width, depending on its area. The wider stripes are easier and less expensive to apply.

If the obstructing object is such that it does not lend itself readily to the application of painted markings, the striping may be placed on an independent surface attached to or mounted immediately in front of the object.

Appropriate signs (secs. 1B-25, 1C-34) directing traffic to one or both sides of the obstruction should also be used, as applicable.

**In addition to the markings on the face of an obstruction in the roadway, warning of approach to the hazard shall be given by line markings on the pavement (sec. 2B-18).**

## **2C-3 Obstructions in the Line of Traffic**

**Where an obstruction lies in the direct line of traffic, it shall be marked, whether or not it is illuminated.** The obstruction and markings thereon should, if possible, be illuminated by a floodlight so constructed that it will adequately light the object but will not throw a glare in the face of traffic approaching from either direction. When floodlighting is not practical, reflective hazard markings (sec. 2D-2) shall be used. A flashing yellow beacon may be used at unusually hazardous obstructions.

## **2C-4 Object Markings on Curbs**

Reflectorized solid yellow should be placed on the curbs of all islands located in the line of traffic flow. It may also be helpful on curbs directly ahead of traffic at T and offset intersections.

## **2C-5 Objects Adjacent to the Roadway**

In some cases objects may not be actually in the roadway, but may be so close to the edge of the roadway as to constitute a definite hazard. These include such encroachments as underpass piers and abutments and culvert headwalls. **Such objects shall be marked with standard clearance markers (sec. 2D-2)** and may be marked in addition with white paint or a diagonal stripe design (sec. 2C-2).

Other adjacent objects that are not likely to be hit unless a vehicle runs well off the roadway, such as guardrails, trees, and rocks may be painted solid white.

## **D-REFLECTOR MARKERS**

### **Section 2D-1 Application of Reflector Markers**

Reflector markers, consisting of single reflecting buttons, clusters of buttons, small panels covered with reflecting coatings, or similar devices, are widely used in marking obstructions and other hazards, or, in series, to indicate alinement of the road. In the latter application they are known as Delineators. Although, like signs, such reflecting units are mounted on posts and convey a warning to the driver, they are much more closely related to obstruction markings or guidelines, and for the purposes of this manual are treated as such.

### **2D-2 Hazard Markers**

Reflector markers may be mounted on or immediately in front of obstructions, or at sharp changes in alinement, to indicate the presence of hazards. Hazard markers should be of such design and should be so placed as to be clearly visible to approaching drivers under ordinary atmospheric conditions from a distance of 1,000 feet when illuminated by the upper beam of standard automobile headlamps.

They should be mounted at a height of approximately 4 feet above the pavement, except when they are applied directly to a hazardous object which by its nature requires higher or lower mounting, such as a low culvert headwall.

**The following system covering the use of reflectorized hazard markers shall be used:**

**1. For obstructions located within the roadway, the hazard marker shall consist of (a) A horizontal strip containing three 3-inch yellow reflectors arranged horizontally or an equivalent strip of yellow reflective material; or (b) Where greater emphasis is needed, in the head-on position, nine 3-inch yellow re-**

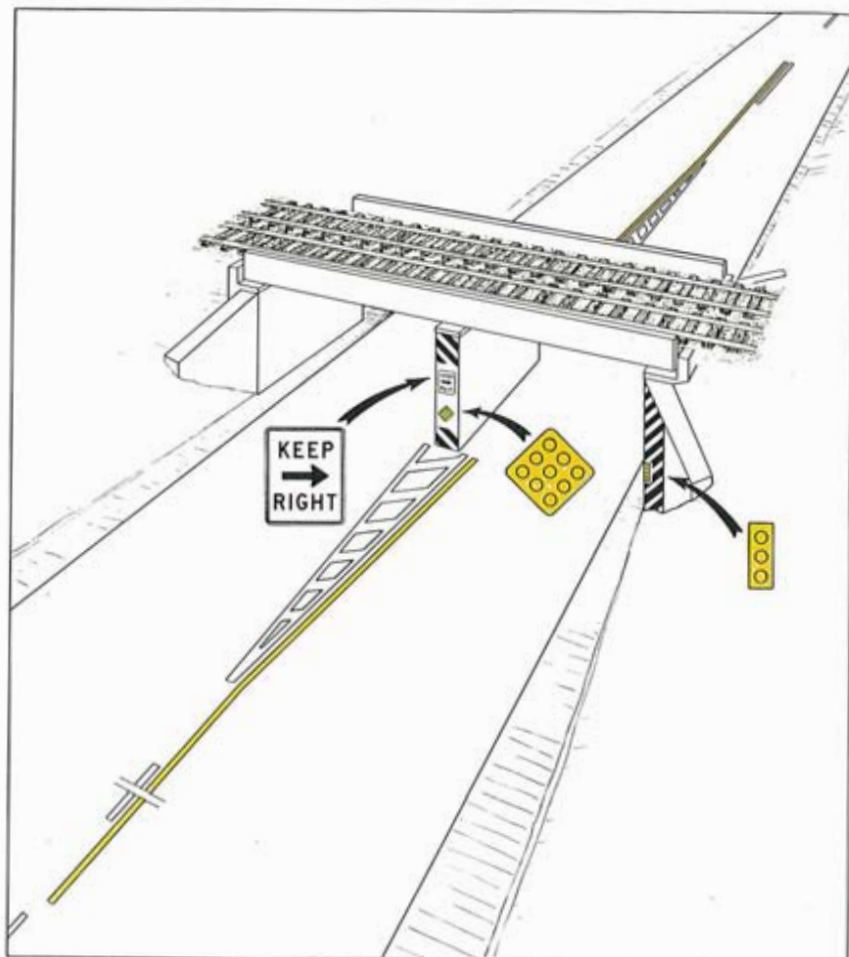


Figure 2-14. Typical markings for obstructions in and adjacent to the roadway.

flectors arranged in a diamond pattern or an equivalent diamond of yellow reflective material.

The horizontal reflector is generally applicable to channelizing islands, etc., whereas the larger reflective units are more applicable to piers or other more hazardous obstructions or at dead-end locations.

2. To delineate bridge ends, underpass abutments, and all other obstructions closely adjacent to the edges of the roadway, the hazard marker, more specifically designated in this application as a clearance marker, shall consist of (a) Three 3-inch yellow plastic reflectors arranged vertically, or an equivalent strip of yellow reflective material; or (b) A vertical rectangle, approximately 1 foot



by 3 feet in size, having alternating black and reflectorized white stripes sloping down at an angle of 45 degrees toward the side of the obstruction on which traffic shall pass. The minimum stripe width shall be 2 inches.

The inside edge of the clearance marker shall be in line with the inner edge of the obstruction.

Better appearance of the striped vertical marker can be achieved if the black stripes are made slightly wider than the white stripes.

Standard signs (secs. 1B-25, 1C-9) should also be used, where applicable.

Typical applications of hazard markers are shown in figures 1-1, 2-14, and 4-11.

### 2D-3 Delineators

Road-delineation markers are effective aids for night driving. Delineators are to be considered as guide markings rather than warning devices. They may be used on long continuous sections of highway or through short stretches where there are changes in horizontal alinement, particularly where the alinement might be confusing, or at pavement-width transitions. An important advantage of delineators, in certain areas, is that they remain visible when there is snow on the ground.

### 2D-4 Delineator Design and Application

Delineators shall consist of reflector units capable of reflecting light clearly visible under normal atmospheric conditions from a distance of 1,000 feet when illuminated by the upper beam of standard automobile headlamps.

Glass or plastic prismatic reflective elements or plastic elements with reflective sheeting sealed therein used for delineators shall be approximately 3 inches in diameter or may be another geometric shape so long as the area of the unit will contain an inscribed circle having a diameter of approximately 3 inches. For multiple application as described below, elongated reflective units of appropriate size may be used in place of the two or three circular units.

If exposed reflective coating is used, the single unit should be approximately 3 inches by 8 inches in size, mounted vertically. Multiple delineators of exposed reflective coating should consist of 5-inch by 5-inch squares, mounted as diamonds, in a vertical arrangement.

*Interstate.*—Design specifications for delineators on the Interstate System are the same as those prescribed above.

When used on through roadways delineators shall be single white reflector units. They shall be placed on the right-hand side of two-way roadways, and on the right or on both sides of one-way roadways. They may be placed on the left of two-way roadways only at hazardous right-hand curves. At sharp curves delineators are more effective if placed on the outside of the curve.

Where delineators are used on the left at a hazardous right-hand curve on a two-way roadway, they may be bi-directional, i.e., delineators with two faces, visible from opposite directions, or two delineators mounted back to back. **All other delineators shall be mono-directional.**

At pavement-width transitions, a delineator installation may be used to indicate the narrowing of the pavement where an outside lane merges into an adjacent lane (fig. 2-4). The delineators should be on the side of the roadway adjacent to the lanes affected and should be so spaced as clearly to show the narrowing. Where the narrowing occurs on the side of the roadway that does not carry traffic in the direction of convergence (as on the left-hand side of a two-way roadway) there is no need for this installation. Similarly, such an installation is unnecessary for traffic moving in the direction of the wider pavement. On a highway with continuous delineation, the normal delineator spacing should be carried through the transition except where a closer spacing is warranted (sec. 2D-5).

Delineators should be used at vertical curves where there is an abrupt change in grade or where there is a change in both vertical and horizontal alinement.

The following system of delineation is prescribed for use where delineation is desired on expressway-type facilities:

**Single white reflector units shall mark the through roadways, and double or vertically elongated yellow reflectors shall mark the interchange ramps and the speed-change lanes. A triple or correspondingly elongated yellow delineator shall be placed at the end of an acceleration lane.**

Delineators shall be placed continuously along the right side or on both sides of the through roadways, and on the outside or both side of interchange-ramp connections. Delineators need not be used where fixed-source lighting is installed and in operation. At speed-change lanes, the delineators shall be installed on the right for right-hand connections, and on the left for left-hand connections.

*Interstate.*—Standards for delineation on the Interstate System are consistent with the above except that  
(a) delineators shall be placed only on the right side of



through roadways, (b) delineators shall not be placed on those sections between interchanges where fixed-source lighting is installed and in operation, and (c) delineation is to be installed on all roadways at all interchanges whether or not the interchanges are lighted.

To indicate clearly the alinement where delineation on one side of the roadway ends and delineation on the other side appears, as at interchange ramps curving to the right, the delineators should be overlapped so that for a short distance the driver will be between two rows of delineators.

#### **2D-5 Delineator Placement and Spacing**

Delineators shall be mounted on suitable supports at a height such that the top of the reflecting head is 4 feet above the near pavement or roadway edge. They shall in no case be more than 12 feet nor less than 2 feet outside the roadway or pavement edge. On roadways with shoulders, delineators, if used, shall be installed 2 feet beyond the outer shoulder edge. Along curbed sections of roadway, delineators, if used, shall be placed not less than 2 feet nor more than 5 feet from the curb face.

*Interstate.*—On the Interstate System metal posts are prescribed for delineator mounting. Delineators shall be placed 2 feet beyond the shoulder edge or 2 feet outside the face of an unmountable curb.

Normally, delineators should be spaced 200 to 400 feet apart. Where normal spacing is interrupted by driveways, crossroads, etc., and where, under the normal spacing, a delineator would fall within such an area, that delineator may be moved in either direction a distance not exceeding one quarter of the normal spacing. If such delineator still falls within that area, it should be eliminated.

On the approaches to and throughout horizontal curves, the spacing should be such as to make several delineators always visible along the curve, ahead of the driver. Table 1 shows the recommended spacing for delineators at horizontal curves.

Where delineators are used on expressway-type facilities, delineator spacing shall be 200 feet along the through roadways. The yellow delineators shall be spaced at 100 feet at acceleration and deceleration lanes and along relatively straight portions of the interchange ramps. Delineators on the outside of interchange ramp curves shall be placed at the appropriate spacing as set forth in table 1.

*Interstate.*—Standards for the spacing of delineators on the Interstate System are the same as those for expressway-type facilities described above.



Table 1.—Spacing<sup>1</sup> for highway delineators on horizontal curves

Degree of curve	Radius in feet	Spacing on curve	Spacing in advance and beyond curve		
			First space	Second space	Third space
	10,000	<i>Feet</i> 200	<i>Feet</i> 200	<i>Feet</i> 200	<i>Feet</i> 200
1	5,000	152	200	200	200
	3,000	141	200	200	200
2	2,500	109	196	200	200
	2,000	106	191	200	200
3	1,800	99	178	200	200
	1,600	88	158	200	200
4	1,400	86	155	200	200
	1,200	81	151	200	200
5	1,000	78	140	200	200
	900	74	133	200	200
7	800	74	133	200	200
	700	68	122	200	200
9	600	66	119	198	200
	500	62	112	186	200
12	400	58	104	174	200
	350	55	99	165	200
15	300	55	99	165	200
	300	51	92	153	200
18	250	48	86	144	200
	200	47	85	141	200
21	150	42	76	126	200
	100	41	74	123	200
25	100	37	67	111	200
	100	36	65	108	200
30	100	35	63	105	200
	100	33	59	99	198
40	100	32	58	96	192
	100	30	54	90	180
	100	28	50	84	168
	100	28	50	84	168
	100	24	43	72	144
	100	24	43	72	144
	100	20	36	60	120
	100	19	34	57	114
	100	14	25	42	84

<sup>1</sup> The spacing  $S$  on the curve is found from the formula  $S = 2\sqrt{R - 50}$ , where  $R$  is the radius of the curve in feet. The spacing to the first delineator in advance of and beyond the curve is  $1.8 S$ , to the next delineator  $3S$ , and to the next  $6S$ , but not to exceed 200 feet. Minimum spacing is 10 feet.