Since these signs are for information purposes and do not ordinarily serve to regulate, warn, or guide traffic (except perhaps indirectly in the case of city limits, etc.) the need for uniformity in design to insure automatic response is not altogether essential. They should, however, be of standard shape and color.

In rural districts, the information sign should ordinarily be mounted from 6 to 10 feet from the pavement or roadway edge, and with the bottom not less than 2½ feet above the crown of the roadway. In residence and business districts the lowermost edge should be not less than 1 foot above the curb, and no portion of the sign should be less than 1 foot back from the curb. A sign giving the name of a river may be mounted on the end of a bridge truss.

Part II

MARKINGS

A—INTRODUCTION

Section 118.—Functions and Limitations of Markings

Markings have definite 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.

Markings also have definite limitations, especially when applied to pavement and curbs, where 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, however, they have the advantage under favorable conditions that they can convey warning or information to the vehicle driver without diverting his attention from the roadway.

Section 119.—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 by 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 of legislation for the placing of markings is to be found in Act V of the Uniform Vehicle Code (secs. 129, 30, 31, 32, 33, 37). Interference with official markings is prohibited in section 38 of the same act.

Section 120.—Standardization

Markings, where used, 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.

Section 121.—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. 128–130).
   (b) Lane lines (secs. 131–133).
   (c) No-passing-zone markings (secs. 134–136).
   (d) Pavement edges (sec. 137).
(e) Pavement-width transitions (sec. 139).
(f) Approach to obstructions (sec. 139).
(g) Streetcar clearance lines (sec. 140).
(b) Turn markings (sec. 141).
(1) Stop lines (sec. 145).
(j) Crosswalk lines (sec. 144).
(k) Route directions (sec. 145).
(1) Approach to railroad crossing (sec. 148).
(m) Parking space limits (sec. 147).
(c) Word markings (sec. 146).
2. Curb markings for parking restrictions (sec. 149).
3. Object markings:
(a) Objects within the roadway (secs. 151-155).
(b) Objects adjacent to the roadway (sec. 154).
4. Reflectors markers:
(a) Hazard markers (sec. 156).
(b) Delineators (sec. 157).

Section 122.—Materials

The most common method of applying 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 wide use of pavement markings. Equipment is in use that is capable of placing single, double, or triple striping on a highway, in different colors, and of solid or broken type of line, while operating at a speed of 10 to 15 miles per hour. Hand equipment can be used to place transverse or special markings, at intersections or elsewhere, at a reasonable cost.

A relatively recent development in pavement markings is 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 returns a greatly increased proportion of the incident light back in the direction of its source, and causes the markings to appear luminous at night under normal headlighting. While the beads have little or no effect in the daytime, the visibility of the markings by night is greatly improved. Although the initial cost of such retrodirective markings is considerably 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.

Pavement markings may also be in the form of small units of metal or other material attached to or set into the pavement surface. Such units may be rectangular, round, or of special shape, and may be assembled into solid or broken lines.

Flat units on or in the pavement surface shall be of permanent colors 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. Particular care should be taken to see that alinement and spacing are accurate, to insure a good appearance.

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 approximately equivalent area if of other shape, and shall be spaced not more than 16 inches apart, center to center, on transverse lines, nor 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 one-half inch above the level of the pavement. They shall be permanently fixed in place by anchor bolts or similar effective devices.

Similarly, 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, especially if they are of considerable area. They should 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 where frequent repainting 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, their use has not been widespread. 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 motor vehicles.

Large “mushroom” buttons, or bars, of cast iron or concrete several inches high, with or without reflectors, lights, symbols, or messages, are favored in some cities to mark pedestrian islands or to assist in channelizing traffic. In these applications they are, in effect, curbs or islands (secs. 322, 325, 341, 349, 350). They are not a suitable alternative to signs or pavement markings. They should not be used, because they constitute an unexpected hazard for motor vehicles, and their use on rural highways is strongly disapproved.

Object markings are ordinarily painted directly on the surface of the obstruction. If the surface will not retain paint readily, 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. To be effective they must be of retrodirective character and of adequate brilliance.

Section 123.—Colors

Pavement markings shall be either white or yellow in color.

The correct color for yellow traffic paint is the same as that specified for highway signs. Color cards showing this “highway yellow” may be obtained from the Public Roads Administration.

Bright metal buttons are to be regarded as the equivalent of white paint in pavement markings.
White shall be used for:
1. Center lines on two-lane rural roads and city streets.
2. Lane lines.
3. Pavement edges.
4. Streetcar clearance lines.
5. Turn markers.

For the following markings it is recommended that yellow be used, but white is permissible:
1. Double center lines on multi-lane 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 in the center of the roadway.
   (d) Approaches to railroad crossings.

The markings for which yellow is recommended are all solid guide lines or regulatory lines to the left of which it is unsafe or illegal to travel when they are applied as prescribed in this manual. Yellow is favored 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.
3. It is consistent with the standard for no-passing-zone markings hitherto approved by the American Association of State Highway Officials and in use in many States.

Curb markings to show parking prohibitions covered by signs or ordinance shall be yellow.

Markings on vertical surfaces of objects within the roadway or dangerously close thereto shall consist of alternate black and white stripes.

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

In reflector markers, delineators shall be white, and markers indicating the location of hazardous objects shall be white or yellow.

Section 124.—Types of Striping
A broken line shall be used for center or lane lines where these lines are only guide lines that may be crossed at the discretion of the driver.

Since most center and lane lines are only for guidance, the saving in paint through the use of broken lines is an important economy. High-speed striping machines have been constructed that are capable of repainting broken lines accurately and neatly, permitting a saving of more than 60 percent in paint, with little or no increase in the cost of application.

A broken line, with segments and gaps well proportioned, appears to be as effective as a solid line for guide purposes. On rural highways a commonly used standard is 15-foot segments with 20-foot gaps. In the application of a given gallonage of paint per mile, such relatively short segments will give a better line than if longer segments, with correspondingly longer gaps, are used. On the other hand, very short segments and gaps have been found to cause an unpleasant flickering sensation.

On urban streets the line segments and gaps, especially the latter, should be considerably reduced in length. Short sections of broken line, such as are used for intersection approaches, require the use of short segments, closely spaced.

Broken lines are also prescribed for streetcar clearance lines, and for turn markings (secs. 140, 141).

A solid line shall always be used for longitudinal markings where the line is of a regulatory character and is not to be crossed, that is, for center lines of two-way multi-lane roads with an even number of lanes, and for lines indicating no-passing zones.

In a combination striping of solid and broken lines, the solid or barrier line has significance only if it is on the right-hand side of the combination stripe, as viewed by the driver, i.e., in or adjacent to the traffic lane to which it applies.

Section 125.—Width of Lines
Longitudinal pavement lines shall be from 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 regarded as adequate for standard use.

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.

Section 126.—Reflectorization
Reflectorization for better night visibility is desirable for almost all markings, but it is neither a practicable nor necessary requirement in all cases. Reflectorization is of doubtful value on well-lighted city streets, for example, and it is not ordinarily essential for center or lane lines where there are no special hazards. At least the following markings should normally be reflectorized:
1. Center lines on multi-lane 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 in the roadway.
   (d) Approaches to railroad crossings.
3. Striping on vertical surfaces of objects in and adjacent to the roadway.

Section 127.—Maintenance
All necessary markings shall be kept in good order and clearly visible at all times. Unless this is done they may create serious hazards by giving a false sense of security, especially in the case of cross walks.

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 128.—Center Lines
A center line is used to designate the center of the traveled portion of a roadway carrying traffic in both directions. Under some circum-
stances, as at a pavement-width transition, 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.

A line marking the center of a one-way roadway is a lane line, as described in section 131.

Section 129.—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. Line segments 15 feet in length, with 25-foot gaps, are recommended.

Where a center line is applied only at special locations on a highway, it should generally be used where overtaking and passing is unsafe, as over hillcrests, around curves, and at railroad grade crossings and intersections, or wherever traffic control requires a clear indication of the roadway center. At intersections the line should extend in advance of the intersection a sufficient distance to keep vehicles definitely in the single lane while approaching. Short sections of center lines used for regulatory purposes, requiring that drivers keep to their proper lane, shall be solid white lines.

On four-lane undivided rural pavements, or on pavements of a greater even number of lanes, the center line shall consist of two solid lines, each not less than 4 inches nor more than 6 inches wide, separated by a space of not less than 2 inches. Such lines should normally be reflectorized.

Since this center line is, in effect, a continuous no-passing striping, to the left of which it is illegal to drive (sec. 134), it is recommended that the two lines be yellow. As an alternative, white lines are permissible.

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

1. Center lines should be placed throughout the length of:
   (a) Two-lane pavements carrying average annual traffic volumes in excess of 2,000 vehicles per day.
   (b) Two-lane pavements narrower than 20 feet carrying average annual volumes in excess of 1,000 vehicles per day.
   (c) Two-lane pavements narrower than 18 feet carrying average annual volumes in excess of 500 vehicles per day.
   (d) All four-, six-, and eight-lane undivided pavements.

2. Center lines should also be placed on all two-lane pavements carrying average annual traffic volumes in excess of 300 vehicles per day at the following locations:
   (a) On the approaches to the crest of a hill where the clear view ahead is less than 500 feet.
   (b) On the 100 feet in advance of and beyond every curve having a radius of less than 500 feet or where the sight distance is less than 500 feet.
   (c) On the approach to a traffic control signal or arterial highway for a distance of not less than 100 feet from the Stop line, and as much more as may be necessary to cover the distance within which vehicles are commonly aligned.
   (d) Center lines should also be placed at locations where the accident record indicates the need for them, and on hard-surfaced roads in areas where the entire roadway is likely to be obscured frequently, as by fog.

Section 130.—Center Lines on Urban Streets

Center lines on city streets shall be broken white lines, not less than 4 inches nor more than 6 inches wide. To preserve the effect of continuity where traffic is heavy, speeds are low, or blocks are short, the line segments, and especially the gaps, should be relatively short.

Long sections of such lines should not be used on streets providing less than two lanes for free-moving traffic in each direction, exclusive of parking lanes. This minimum street width does not apply to the use of short sections of center lines around curves, over hillcrests, or on approaches to important intersections and marked cross walks. Short sections of center line for regulatory purposes shall be of solid design.

Small units of metal or other material attached to or set into the pavement surface are frequently used in cities as an alternative to painted markings. These are discussed in section 122.

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

Applications of center lines are shown in various illustrations herein, particularly figures 5, 10, 12, 14, and 17.

Section 131.—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 regular center line, on all rural highways of four, six, or eight lanes.
3. 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 loading islands and sidewalk curbs.
   (b) Other locations where the normal lane width is decreased.
   (c) Approaches to widened intersections.
4. On important one-way streets or highways were maximum efficiency in utilization of the roadway is desired.

Applications of lane lines are illustrated in figures 14, 15, and 17.

Section 132.—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. The transverse spacing of lane lines, that is, the lane width, should not normally be less than 10 feet.

Section 133.—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 especially the gaps, should be shorter than in rural areas. In limited sections of lane lines, as at intersection approaches or between loading islands and sidewalk curbs, the line segments and gaps may be as short as 4 feet and of equal length.

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 in a street width reduced by the presence of a loading island.

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.

Section 134.—No-Passing Zones

No-passing zones should be established at vertical or 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.

A no-passing zone shall be marked by a solid barrier line placed as the right-hand element of a combination stripe along the center or lane line. It is recommended that this barrier line be yellow (sec. 123), although white is a permissible alternative.

The combination line may consist of either of the following, as illustrated in figure 12:

1. A normal broken white center or lane line continuing through the no-passing zone, with the solid 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 barrier line on each side of the broken 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 and will not have any controlling effect except on traffic in the opposing direction.

2. A double line replacing the single broken center line on a two-lane roadway, of which the right-hand stripe is the solid barrier line. Where no-passing zones in opposite directions overlap, there will be a double solid line, and where the no-passing restriction applies only in the opposing direction the solid line will be to the left of a broken line and will not have any controlling effect.

The barrier line shall be not less than 4 nor more than 6 inches wide, and shall be separated from the adjacent stripe by a space of not less than 2 nor more than 4 inches. It should normally be reflectorized for increased emphasis.

On unimportant two-lane roadways carrying little traffic, a center-line marking may be desirable although the marking of no-passing zones by means of barrier lines may not be economically warranted. Under such conditions a single-line marking, consisting of a broken white center line where passing is permitted and a solid white center line throughout no-passing zones in either direction, is recognized as a permissible alternative to the barrier-line design prescribed above. A single center line can be placed more cheaply, and on a narrow roadway is subject to less traffic wear than the double or triple barrier-line design. The single-line design, however, should be used with great caution. It lacks the directional characteristic of the barrier-line design for no-passing zones. Thus it forces the driver to stay on his side of the roadway for some distance after his sight distance has become adequate for passing, or it throws on him the responsibility for deciding when it is safe to pass, thus destroying the barrier significance of the solid line. Particular care should be taken to avoid an unnecessary and possibly confusing mixture of the two types of design in any given area.

Section 135.—No-Passing Zones on Two- and Three-lane Roadways

On a two-lane roadway the combination no-passing line shall follow the center line throughout the no-passing zone. On a three-
lane road the combination line shall start from the left-hand lane line of the center lane and shall extend at an angle of not less than 20 to 1 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. 12).

No-passing-zone signs (R-11, R-12; see 39, 40) may be used to supplement the pavement markings here prescribed.

It is assumed that on highways of four or a greater even number of lanes it is not necessary to cross the center line to overtake and pass other vehicles. No specifications, therefore, are provided for the marking of no-passing zones on such highways. The double center line is to be regarded as a continuous no-passing marking, consisting of two barrier lines which must not be crossed from either side.

Section 136.—Warrants for No-Passing Zones

The warrant for the establishment of a no-passing zone depends on the assumed design speed of the road and the minimum sight distance necessary for safe passing at that speed. Sight distance on a vertical curve is the distance at which an object 4½ feet above the pavement surface can just be seen from another point 4½ feet above the pavement, as illustrated in figure 13. Sight distance on a horizontal curve is determined in similar fashion, measuring around the embankment or other obstruction that cuts off the view on the inside of the curve. A curve shall warrant a no-passing zone, and shall be so marked, when the minimum sight distance for the assumed design speed is equal to or less than that listed below:

<table>
<thead>
<tr>
<th>Design speed (miles per hour)</th>
<th>Minimum sight distance (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>40</td>
<td>600</td>
</tr>
<tr>
<td>50</td>
<td>800</td>
</tr>
<tr>
<td>60</td>
<td>1,000</td>
</tr>
<tr>
<td>70</td>
<td>1,200</td>
</tr>
</tbody>
</table>

The beginning of a no-passing zone, point a in figure 13, is that point at which the sight distance first becomes less than that specified in the above table. The end of the marking, point b, is that point at which the sight distance again becomes greater than the minimum specified. In no case shall the marking be less than 500 feet in length. If the actual no-passing distance is less than 500 feet in length, the additional length of marking shall be added at the beginning of the zone.

For methods of determining the beginning and end of no-passing zones, see A Policy on Criteria for Marking and Signage No-Passing Zones on Two and Three Lane Roads, American Association of State Highway Officials; or the Traffic Engineering Handbooks published jointly by the Institute of Traffic Engineers and the National Conservation Bureau.

On urban streets it is not ordinarily necessary to mark no-passing zones. Speeds are generally low, and a normal 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.

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*Adapted from A Policy on Criteria for Marking and Signage No-Passing Zones on Two and Three Lane Roads, American Association of State Highway Officials.
Section 137—Pavement Edges

Line markings on the pavement have sometimes been used along the sides of the roadway, especially on bridges, to indicate the limit of safe approach to the edge of the pavement. Experience has shown that such lines are easily mistaken for center or lane lines, with the result that drivers attempt to pass to the right of them and so run off the road. They are therefore not recommended. Reflecter markings are much preferable for the purpose intended (secs. 136, 137).

Pavement edge lines shall be solid white lines, not less than 4 nor more than 6 inches wide. When used, they shall supplement rather than replace standard center and lane lines.

Section 138—Pavement-Width Transitions

Line markings should be used to indicate points where the pavement width changes to a lesser number of lanes. There are a number of situations possible, as illustrated in figure 14, 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.

Lines marking pavement-width transitions shall be not less than 4 nor more than 6 inches wide, and of standard center- or lane-line design. Converging lines shall have a length of not less than 20 times the offset distance.

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 multi-laned road or a normal broken center line with an adjacent barrier line as prescribed for no-passing zones (sec. 134). Such no-passing markings should normally be reflecterized.

Pavement-width transition lines, in themselves, are not a sufficient warning at such locations, and should be used only to supplement standard signs, guardrails, or delineators.

Section 139—Approach to an Obstruction

Pavement markings shall be used to warn of the approach to a fixed obstruction within a paved roadway.

Obstructions within the roadway are hazards that should not be permitted to exist if avoidable, but where they cannot reasonably be eliminated everything possible should be done to prevent vehicles from colliding with them. An obstruction may be in the center of the roadway, in which case all traffic must keep to the right of it, or it may be so located as to 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 pavement markings shall consist of a diagonal line, or lines, extending from the center or lane line to a point 1 foot to the right side, or to both sides, of the approach end of the obstruction (fig. 15).

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 design speed in miles per hour, and $W$ the width of the obstruction in feet.
In no case shall the diagonal line be less than 150 feet in length in rural areas or 50 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 one of the following designs:

1. A normal broken center line framed by a solid barrier line, as specified for no-passing zones (Sec. 134). The barrier line shall extend along the center line in advance of the diagonal line for a further distance equal to the length of the diagonal line.
2. On a roadway not marked with a continuous center line, a solid line which shall be extended, on the roadway center line, a further distance in advance equal to the length of the diagonal line.
3. On roads of four lanes or more a simple continuation of the double center line prescribed for such roads (Sec. 129).

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, there shall be two solid white lines diverging from the lane line, one to either side of the obstruction. In advance of the point of divergence a single solid line shall be extended in place of the normal broken lane line for a distance equal to the length of the diverging lines.

All lines used in obstruction approach markings shall be not less than 4 nor more than 6 inches wide. They should preferably be reflectorized.

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 grade lines, as shown in figures 15 and 90.

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

Obstruction approach markings shall be used only to supplement adequate markings on the obstruction itself as prescribed in section 151.

Section 140.—Streetcar Clearance Lines

It is often desirable to mark lines on the pavement to indicate the limits and the clearance of the overhang on turning streetcars.

Streetcar clearance lines shall be broken white lines, with segments and gaps of equal length not exceeding 2 feet. They shall be not less than 4 nor more than 6 inches wide.

On curves of short radius it is necessary to use very short dashes and spaces, to preserve the appearance of continuity in a broken line.

Section 141.—Turn Markings

Markings to restrain drivers from starting left turns before reaching the intersection, or to guide turning vehicles, are sometimes used at intersections. Such 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. Typical designs are shown in figures 16 and 42.

Lines used in turn markings shall be broken white lines, not less than 4 nor more than 5 inches wide. As in the case of street-
car clearance lines, they should be made up of short dashes and short spaces.

Section 142.—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, cross-walk markings, railroad-crossing markings, and word 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.

Section 143.—Stop Lines
Stop lines (or Limit lines) should be used in both rural and urban areas only 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 shall be solid white lines, not less than 12 nor more than 24 inches wide. They shall extend across all approach lanes, usually to the center line (figs. 3, 17).

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

Stop lines, where used, should ordinarily be placed 4 feet in advance of the nearest cross-walk line. In the absence of a marked cross walk, 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.

Section 144.—Cross-walk Lines
Cross walks should be marked at all intersections where there is material conflict between vehicular and pedestrian movement. Marked cross walks should also be provided at other appropriate points where there is substantial pedestrian movement, as at long loading islands (sec. 320), or where pedestrians are permitted to cross between intersections, or where pedestrians could not otherwise recognize the proper place to cross.

Cross-walk lines, in both rural and urban areas, shall be solid white lines, marking both edges of the cross walk. They shall be not less than 4 nor more than 12 inches wide (fig. 17). If no advance Stop line is provided, it may be desirable to increase the width of the Cross-walk line on the approach side to as much as 24 inches.

On urban streets, where speeds are relatively low, a width of 6 inches is usually adequate.

The width of the cross walk between Cross-walk lines is usually determined by the width of the sidewalks so connected. The width shall in no case be less than 6 feet.
To facilitate pedestrian cooperation in traffic regulation, pedestrians should know exactly where they are to cross the street, and should feel reasonable security not only against vehicles approaching the intersection, but also against those turning within it. Single-line crosswalk markings fail in this, and are strongly disapproved. Two lines are necessary to define the crosswalk area, and should always be used.

Section 145.—Route Directions

As a supplement to standard route markers, or where directions cannot be satisfactorily indicated by any other means, special directional markings can sometimes be used on the pavement. These may consist of one or more arrows, with or without route numbers, in the center of the lane. A typical example is illustrated in figure 17.

Directional markings shall be white in color.

Section 146.—Approach to Railroad Crossing

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

The design of railroad-crossing pavement markings shall be essentially as illustrated in figure 18. The symbol and letters 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 signs or signals (secs. 88, 89) which must be installed in every case.

Section 147.—Parking Space Limits

The marking of parking space limits on urban streets tends to prevent encroachment on fire hydrant zones, bus stops, loading zones, approaches to corners, and clearance spaces for islands. Such parking space limits 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 7 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 divided into stalls by the use of lines perpendicular to the curb and so spaced that each stall is long enough to accommodate one parked vehicle, usually 20 feet. In this case 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 (fig. 17).

The marking of stalls is especially beneficial where parking meters are used.

Angle parking is generally not desirable, though occasionally it may be justified as, for example, on an unusually wide pavement where passing 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.
All lines for parking spaces shall be solid white lines, not less than 4 nor more than 6 inches wide.

Section 148—Word Markings

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

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

The letters should be greatly elongated in the direction of traffic movement because of the low angle at which they are viewed by approaching drivers. One method of designing elongated letters and numerals is illustrated in figure 19.

On high-speed roads, especially where traffic is heavy, messages of more than one line are undesirable and should generally be avoided. It is difficult to read and understand a message when the words are necessarily spread over so great a distance that they are not all legible at one time.

Where prevailing traffic speeds are greater than 35 miles per hour, 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 the driver. The space between lines should be at least four times the height of the characters.

On the other hand, where prevailing traffic speeds are 35 miles per hour or less, it is possible to use smaller letters and numerals, and to space the lines closer together so that an entire message of as many as two or three lines can be seen and read at one time. In this case, a message of two or three lines should be arranged to read “down,” i.e., with the first word farthest from the driver. The spacing between the lines should be equal to the height of the characters.

The word STOP shall never be used on the pavement in advance of a Stop line, unless every vehicle is required to stop at all times.

Figures 3, 16, and 17 show uses of word markings on the pavement.

Section 149—Curb Markings for Parking Restrictions

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

The curb marking shall be of a solid yellow color, covering the face and top of the curb.

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 150—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 or signal supports, loading islands, barricades to close roads, railroad and drawbridge gates, end posts of narrow bridges, underpass piers and abutments, culvert head walls, guard rails, sign posts, 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, obstructions are occasionally placed in roadways under 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.

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.

Section 151.—Objects Within the Roadway

Obstructions in the roadway shall be marked with not less than five alternating black and 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 figures 1, 20, and 38.

A curb at the end of an island would not require stripes of more than the 4-inch minimum width, while a large surface, such as a bridge pier, might require stripes of 12-inch or greater widths 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 advance of the object.

Appropriate signs (R-14, W-30; secs. 42, 86) 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, as prescribed in section 139.

Section 152.—Lighting or ReflectORIZATION of Obstructions

Where an obstruction lies in the direct line of traffic, 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, the object markings should be effectively reflectorized. A reflectorizing coating should be applied to the white stripes or there should be placed on the obstruction one or more large yellow reflectors or clusters of yellow reflecting buttons at least 10 inches in diameter.
Section 153.—Object Markings on Curbs
Alternate black and white stripes should be placed on the curbs of all islands located in the line of traffic flow. They may also be helpful on curbs directly ahead of traffic at T and offset intersections. Because of the ordinarily low height of curbs, the stripes should be vertical on the curb face, rather than sloping as on other obstructions (fig. 40).
Where the curb is naturally dark, sufficient contrast may be obtained by painting only the white stripes.

Section 154.—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 head walls. They should be marked with the diagonal stripe design described in section 151.
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 155.—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 alignment 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 guide lines, and for the purposes of this manual are treated as such.

Section 156.—Hazard Markers
Reflector markers may be mounted on or immediately in advance of obstructions, or at sharp changes in alignment, to indicate the presence of hazards. Hazard Markers should be of such design as to be clearly visible under ordinary atmospheric conditions from a distance of 500 feet when illuminated by the upper beam of standard automobile headlamps.
Hazard Markers should reflect yellow light. They should be mounted at a height of approximately 3½ 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 limited overhead clearance or a low culvert head wall.
Single small reflector buttons are not ordinarily effective as Hazard Markers. Clusters of buttons arranged in suitable patterns, small plates covered with reflecting coatings, or other units of characteristic design should be used. No single standardized design has been developed for these markers. Since their meaning is nonspecific, however, the important thing is that they be large enough and brilliant enough for clear visibility. For obstructions closely adjacent to the roadway, markers having three 1¾-inch buttons arranged vertically, or their equivalent, are recommended. For obstructions within the
roadway larger clusters or reflecting areas up to 12 inches in diameter may be desirable. Similar large units may be used at the end of a dead-end street, directly ahead of traffic at a T intersection, or on the outside of an unexpectedly sharp turn. On overhead structures, or on curbs in the line of traffic, rows of buttons, suitably spaced, or strips of reflectorized coatings may be used. Standard signs (R-14, W-11, W-90; secs. 48, 68, 86) should also be used, where applicable.

Section 137.—Delineators

Road-delin eation 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 vertical or horizontal alignment, particularly where the alignment might be confusing. An important advantage of Delineators, in certain areas, is that they remain visible when there is snow on the ground.

Delineators shall consist of reflector units mounted on suitable supports, the units being capable of reflecting light of the same color as that of the source and being clearly visible under normal atmospheric conditions from a distance of 1,000 feet when illuminated by the upper beam of standard automobile headlamps. The heads or reflector units shall be not more than 3 inches wide and 10 inches high nor less than 2 inches wide and 6 inches high. The reflectorizing elements or surface may consist of glass or plastic buttons, a glass-bead reflecting coating, or other suitable reflecting material.

When used on long continuous sections of undivided roadway, bidirectional Delineators (i.e., Delineators with two faces, visible from opposite directions, or two Delineators mounted back to back) shall be installed on both sides of the roadway. When used on divided roadways and at certain isolated locations such as pavement-width transitions not included in a continuous delineated section of highway, monodirectional delineators shall be installed. On divided roadways such monodirectional delineators shall be used on both sides of each roadway. At isolated pavement-width transitions they shall be used only on that side of the roadway affected by such a transition.

Delineators shall be installed at a height such that the center of the reflecting head is 3½ feet above the near pavement or roadway edge. They shall in no case be more than 10 feet nor less than 2 feet outside the roadway or pavement edge, the most desirable location being uniformly 8 feet, leaving a clear shoulder wide enough for the parking of a vehicle. On roadways with shoulders less than 8 feet wide, Delineators, if used, shall be installed at the 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.

Normally, Delineators should be spaced 200 feet apart. Where such spacing is interrupted by driveways, crossings, 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 five Delineators always visible to the right of the center line of a two-lane pavement, or of the right-hand lane line of a multi-lane pavement. Table 1 shows the recommended spacing for horizontal curves.

The recommended spacing for vertical curves is shown in Table 2.

### Table 1.—Spacing for highway delineators on horizontal curves

<table>
<thead>
<tr>
<th>Degree of curve</th>
<th>Spacing on curve</th>
<th>Spacing in advance of and beyond curve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feet</td>
<td>Feet</td>
</tr>
<tr>
<td></td>
<td>First space</td>
<td>Second space</td>
</tr>
<tr>
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</tr>
<tr>
<td>10</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

1. The spacing, S, on the curve is found from the formula $S = 1.2 \sqrt{L}$, where $L$ is the length of the curve in feet. The spacing to the first delineator in advance of and beyond the curve is 1.5S, or 2S, to the next delineator 3S, and to the next 6S, but not to exceed 300 feet.

### Table 2.—Spacing for highway delineators on vertical curves (summits)

<table>
<thead>
<tr>
<th>Algebraic difference in percent of grade</th>
<th>Delineator spacing, in feet, when length of vertical curve is—</th>
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<td>175</td>
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<tr>
<td>10.0</td>
<td>235</td>
</tr>
</tbody>
</table>

1. The spacing, S, on the curve (to a maximum of 200 feet) is found from the formula $S = 1.2 \sqrt{G}$, where $G$ is the algebraic difference in percent of grade. The spacing to the first delineator in advance of and beyond the curve should be 1.5S, or 2S, to the next delineator 3S, and to the next 6S, but not to exceed 300 feet.

100