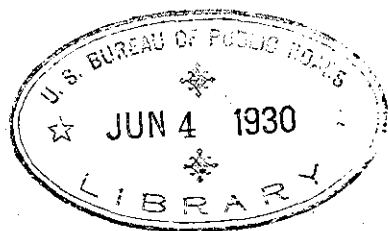


Report of the Committee  
of  
American Engineering Council  
on  
Street Traffic Signs, Signals, and Markings  
1929



Price 25 cents

### ACKNOWLEDGMENTS

The Committee on Street Traffic Signs, Signals, and Markings hereby expresses its sincere appreciation to the local committees, automobile associations, chambers of commerce, safety councils, and engineering societies, as well as to traffic directors, chiefs of police, consulting engineers, and others who have given so generously of their time and experience in the development of the fundamental data upon which this report is based. The active cooperation of the special Committee on Municipal Traffic Ordinances and Regulations of the National Conference on Street and Highway Safety, with which this committee's work has been constantly coordinated, is also appreciated.

A part of the fund necessary to defray the expenses of this study was generously provided by the American Automobile Association, Cleveland Railway Company, National Automobile Chamber of Commerce, and Pittsburgh Railways Company.

# STREET TRAFFIC SIGNS, SIGNALS, AND MARKINGS

## INTRODUCTION

The work of the National Conference on Street and Highway Safety showed that a valuable public service could be rendered by the establishment of greater uniformity in the use of street traffic signs, signals, and markings. The American Engineering Council, a body participating in the conference, offered to make a national survey of the existing conditions and to prepare a recommended practice. This offer was accepted, and the Council then appointed a Committee on Street Traffic Signs, Signals, and Markings. To this committee was assigned the task of obtaining the fundamental facts, compiling and analyzing them, and drafting a recommended practice.

The personnel of American Engineering Council's committee was made a part of a committee of the National Conference on Street and Highway Safety organized to draft a model municipal traffic ordinance. In its survey this committee maintained the closest contact and the fullest coordination with all agencies affected by the project.

After the work had been begun, the personnel of the committee was enlarged to function as a Sectional Committee on Traffic Signs, Signals, and Markings according to the procedure of the American Standards Association.

The object of this survey has been to determine the existing best practice in the use of street traffic signs, signals, and markings in all American cities having a population of 50,000 or more and in some selected smaller cities in which exceptional conditions have necessitated the adoption of exceptional practices that are worthy of consideration, and to formulate recommendations for the establishment of better and more uniform practice as a means of increasing safety and facilitating traffic on city streets.

The need of such a survey had been shown by many similar earlier efforts. Some substantial progress in this work had been made, one of its most notable results being the adoption of a Standard Highway Code by the Joint Board on Interstate Highways of the Bureau of Public Roads and the American Association of State Highway Officials. Under this code standard signs are now being installed on many Federal Aid and State Roads in the United States.

The density of traffic in many cities also emphasized the need of standardizing traffic signs, signals, and markings. In these cities the safety of everyone depends upon the instant and full recognition of the meaning of the message to be conveyed by traffic-control devices, but the diversity of use and meaning that now prevails causes great hazard and delay.

It was also felt that, as the art of controlling traffic by automatic signals is in a formative stage, a careful study of the subject would be helpful to all concerned. In a less degree this is true also of signs, markings, and safety zones. Moreover, it was evident that the use of more uniform traffic-control devices would insure large economies.

A local committee was organized in each city selected for study. The membership of these committees included engineers, safety men, automobile club members, and representatives of other groups. Carefully prepared questionnaires and instructions covering signs, signals, and markings were furnished to these committees. These questionnaires were divided into two parts. Part I was designed to elicit certain definite facts. This material was supplied by the city officials in charge of traffic-control devices. Part II was designed to obtain an expression of opinion from the members of the local committees as to the effectiveness of the equipment and practices now in use. A special effort was made to learn the defects that had caused the abandonment of any type of equipment or any method. For many cities the opinion of the committee was supplemented by that of city officials.

Surveys were made in 35 States, and the returns analyzed were collected in more than 100 cities, having a population of more than 33,000,000. It is believed that the returns cover all conditions and methods of traffic control.

Every effort has been made to produce a report which is a true expression of the best thought and largest experience. No recommendation has been made without careful consideration of every opinion held concerning the regulation of traffic. The committee has not invariably recommended the practice that is most general, because some of the newer practices, although less common, are deemed better than the older ones.

The recommendations prepared by the committee and presented in Part I of this report have been approved by American Engineering Council. The committee earnestly hopes that this recommended practice will rapidly attain general use throughout the United States, in order that the traffic on city streets may be made both safer and more convenient.

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- C. W. STARK, Secretary of the Committee on Municipal Traffic Ordinances and Regulations of the National Conference on Street and Highway Safety. (For A. B. Barber.)
- R. A. REID, Assistant Engineer, Street Lighting Sales Engineer Department, General Electric Company, Lynn, Mass. (For James A. Cook.)
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- A. C. OLIPHANT, Assistant Secretary of American Engineering Council. (Served as secretary to the committee.)

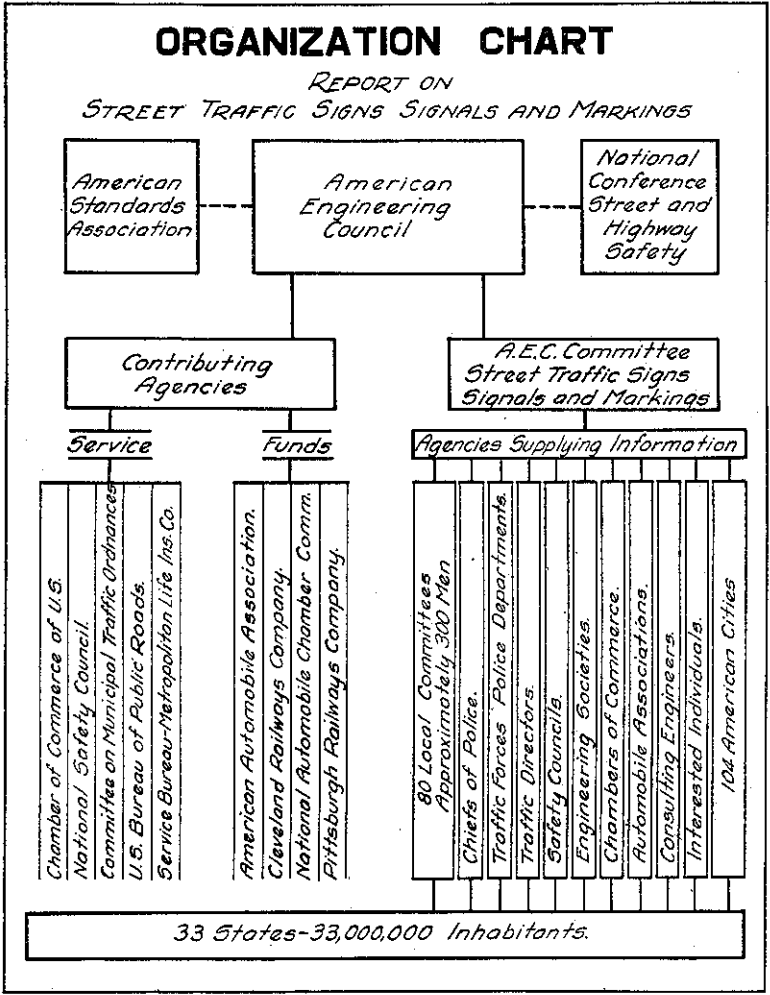
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# ORGANIZATION CHART

REPORT ON  
STREET TRAFFIC SIGNS SIGNALS AND MARKINGS



American Standards Association

American Engineering Council

National Conference Street and Highway Safety

Contributing Agencies

*A.E.C. Committee Street Traffic Signs Signals and Markings*

Service

Funds

Agencies Supplying Information

- Chamber of Commerce of U.S.
- National Safety Council.
- Committee on Municipal Traffic Ordinances
- U.S. Bureau of Public Roads.
- Service Bureau-Metropolitan Life Ins. Co.

- American Automobile Association.
- Cleveland Railways Company.
- National Automobile Chamber Comm.
- Pittsburgh Railways Company.

- 80 Local Committees
- Approximately 300 Men
- Chiefs of Police.
- Traffic Forces Police Departments.
- Traffic Directors.
- Safety Councils.
- Engineering Societies.
- Chambers of Commerce.
- Automobile Associations.
- Consulting Engineers.
- Interested Individuals.
- 104 American Cities

33 States-33,000,000 Inhabitants.

## PART I

### Recommended Practice

Some of the outstanding tendencies which this survey discloses justify an emphatic word of warning. It is clearly obvious that some cities are making two fundamental errors in installing street traffic signs, signals, and markings. These errors are:

1. Placing traffic control devices without adequate study of the conditions which their use is intended to improve, or of the evil effects produced at several and other intersections resulting from the attempt to correct undesirable conditions at one particular intersection.

2. Operating traffic control devices at places and times not justified by the conditions.

If these tendencies continue, the inevitable result will be a public recognition of the errors and a consequent neglect or unfriendliness toward street traffic signs, signals, and markings. This neglect will lead to the ultimate defeat of useful and effective methods of traffic control. Such fundamental errors can be avoided by obtaining expert engineering advice before any system of street traffic signs, signals and markings is established. A method of procedure for this purpose, which is now successfully employed in some cities, is outlined in the report of the Committee on Metropolitan Traffic Facilities of the National Conference on Street and Highway Safety, and provides for the creation of a traffic commission with a technical staff.

The study shows clearly that there is wide variation in the practice of placing the official responsibility for the selection, placement, and maintenance of traffic signs, signals, and markings. The practice is so diverse that no general statement relating to it can be made. In most cities the responsibility is placed upon some branch of the police department. No standard official organization handles questions relating to traffic signs, signals, and markings, and this defect is perhaps one of the most serious features of the present condition.

As there is great variation in the State laws regarding signs and signals, it is obviously impossible to make recommendations that can be universally adopted until many such laws are amended. Consequently some municipalities may have to permit some deviations from these recommendations so as to make them conform to the requirements of State laws.

A vast amount of the equipment now in use does not conform to the recommendations here made, but most of such equipment can be made to conform substantially with the recommendations without excessive cost. Whenever new equipment is purchased or replacements are made because of the need of repairs or because of obsolescence, strict adherence to the preferred standards should govern the selection.



## Section 1. Street Traffic Signs

Adequate signs are great aids to the drivers of vehicles and are therefore important means of safeguarding and expediting traffic. To be adequate every traffic sign should be so thoughtfully designed and so carefully placed as to convey its message quickly and clearly at the exact time and place it is needed. These requirements mean simple wording; standard shape, color, lettering, and location; announcement of the official authority if that is legally required; and the removal of every unofficial sign that in any way conflicts with the requirements. No matter how effectively traffic signs may be designed and placed, the results desired will not be realized until the messages conveyed are carefully observed by drivers and the regulations implied are zealously enforced. With these facts in mind the committee has formulated and here submits some basic essential recommendations concerning the design, location, and use of street traffic signs.

### RECOMMENDATION 1.—*Material and Finish.*

(a) Select sign material and finish first for durability, second for economy.

(b) Use cast metal (either iron or aluminum), sheet metal (either steel or aluminum), or wood; *here named in the order of preference.*

(c) For all signs use the specifications proposed by the Joint Board on Interstate Highways of the Bureau of Public Roads, the American Association of State Highway Officials, and the United States Bureau of Standards. (See Appendixes A and B.)

### RECOMMENDATION 2.—*Shapes and Dimensions.*

The following shapes shall be used for the purposes indicated:

Railroad Crossing . . . . .	Cross Buck
Railroad Crossing Approach .	Circular
Stop . . . . .	Octagonal
Slow . . . . .	Diamond
Caution . . . . .	Square
One Way and Detour . . . . .	Arrow, or Arrow on Rectangle
Information . . . . .	Rectangular
Restriction . . . . .	Rectangular

All signs should be made in the dimensions hereafter specified if possible, but existing equipment that varies somewhat from the specifications may be used provided the general proportions are the same. Most of these dimensions are smaller than those given in the code of the American Association of State Highway Officials, because vehicles generally move slower in city traffic than on rural highways, and signs may be seen at shorter distances in cities; also because smaller signs occupy less space and do not so seriously interfere with the vision of pedestrians if placed below their average height.

RECOMMENDATION 3.—*Colors.*

The combinations of colors here specified shall be used for the purposes indicated:

Railroad Crossing.....	Black letters on white background
Railroad Crossing Approach..	Black letters on yellow background
Stop.....	Red letters on yellow background
Slow.....	Black letters on yellow background
Caution.....	Black letters on yellow background
One Way and Detour.....	Black letters on white arrow
Information.....	Black letters on white background
No Parking.....	Red letters on white background
Limited Time Parking.....	Green letters on white background
Pedestrian Restriction.....	Blue letters on white background
Other Restrictions.....	Black letters on white background

The colors recommended above for Stop signs combine a yellow background with red for the word "Stop," in conformity with the generally recognized meaning of that color in traffic control devices of other types. This combination avoids the disadvantage of black letters on a yellow background, recommended by the Joint Board of Interstate Highways, in which the black letters cannot be made luminous at night, a disadvantage that has led to the modification of the sign by the introduction of a black band across the sign on which is imposed the word "Stop" in white letters, making a three-color combination.

The stop sign recommended above also avoids the disadvantage of white letters on a red background, proposed by the Traffic Signal Color Code Committee, in which the red background is not clearly visible at night and the letters if illuminated appear white instead of red.

RECOMMENDATION 4.—*Lettering and Wording.*

The lettering, wording, and arrangement here specified shall be used for each type of traffic sign, but symbols may be added or equivalent words may be substituted if the standard size and arrangement are maintained. Suitable wording in small letters expressing local authority shall be placed on the bottom of all signs when specified by law or regulation.

RECOMMENDATION 5.—*Illumination.*

All important traffic signs shall be clearly visible day and night. Signs that affect the safety of night driving should be adequately illuminated. Certain important directional signs that are intended primarily to facilitate traffic may be illuminated at night. In this report signs that require illumination at night are specifically mentioned. This illumination shall be provided by one of the methods listed below, named in the order of preference:

- (a) Attached lamps flooding the face of the sign.
- (b) Self-luminous letters.
- (c) Signs so located as to be illuminated by street lights.
- (d) Reflecting letters illuminated by headlights of vehicles.

Method (a) provides a positive means of illumination. Method (b) is less positive because of the possible accumulation of dust on the translucent lenses. Method (c) is subject to varying distances from the street lights, improper angles, swinging branches and other interferences. Method (d) is limited in use as indicated under Recommendation 7.

If beacon lights are used in conjunction with signs, the color of the beacon lights should conform to the code of the color meanings for Beacon Signals given on page 27.

#### RECOMMENDATION 6.—*Maintenance.*

All traffic signs shall be continuously kept in good order and clearly legible.

#### RECOMMENDATION 7.—*Height and Location.*

Traffic signs shall be located with due regard to the character of the message to be conveyed in order to obtain the maximum observance. The location of a sign giving warning of a hazard just ahead may be quite different from that of a sign giving an order to be obeyed at a particular point.

For the locations indicated below the signs shall be at the heights specified:

- (a) The center of a sign on a fixed post 12 inches back of the curb shall be 8 feet above the pavement and the sign shall not overhang the curb.
- (b) The center of a sign on a movable post in the roadway shall be 4 feet above the pavement.
- (c) The center of a reflecting sign used to mark an obstruction in the roadway shall be 3 feet above the pavement.

The location of curb signs at a standard height of eight feet is required in order to insure their visibility above pedestrians and vehicles. For the illumination of such signs, dependence cannot be placed on headlights alone.

#### RAILROAD CROSSING AND RAILROAD APPROACH SIGNS

The specifications for railroad crossing and railroad crossing approach signs are taken from the code adopted by the American Railway Association. It is recommended that they be used as standards where they do not conflict with State laws and that State laws which do conflict be amended.

RECOMMENDATION 8.—*Railroad Crossing.*

- (a) A railroad crossing sign shall be made of two arms mounted across each other in inclined positions to form a crossbuck.
- (b) The sign shall be placed not more than 15 feet from the railroad crossing.
- (c) The letters shall be black on a white background.

The railroad standard code provides two alternative locations for a sign, one at the side and one in the center of the highway. The location in the center is dangerous and is not recommended.

RECOMMENDATION 9.—*Railroad Crossing Approach.*

- (a) A railroad crossing approach sign shall be circular, 24 inches in outside diameter, and shall have a bead border around the edge.
- (b) The sign shall be divided into quadrants by one horizontal and one vertical line  $2\frac{1}{2}$  inches wide.
- (c) A letter R, 5 inches high by  $3\frac{3}{4}$  inches wide, shall be placed in each of the upper quadrants.
- (d) The sign shall be placed 100 feet or more from the railroad crossing.
- (e) If there is a street intersection within 100 feet, an additional sign or signs shall be so placed as to warn traffic approaching the crossing from each intersecting street.
- (f) The sign shall be clearly illuminated at night.
- (g) The letters shall be black on a yellow background. (Some States require white instead of yellow.)

STOP SIGNS

RECOMMENDATION 10.—*General Specifications.*

- (a) A stop sign shall be octagonal, 18 inches or 24 inches between parallel sides, as may be best suited to the location. The octagon shall be mounted with two sides horizontal and shall have a bead border around the edge.
- (b) The word "Stop," in 5-inch letters, on the 18-inch sign and in 6-inch letters on the 24-inch sign, shall be approximately centered on the horizontal center line of the octagon. (Figure 1.)
- (c) The upper and lower spaces may contain specific messages in 2-inch letters on the 18-inch sign and in 3-inch letters on the 24-inch sign, as indicated in recommendations 11 to 15. If, however, a reflecting, fixed or automatic illuminating device is introduced into the sign the outline, size, margin and color scheme as well as the height, shape and spacing of lettering of the principal words shall be retained and the design otherwise adjusted to fit the particular installation.

(d) The stop sign shall be placed at the point where the message is to be obeyed. At intersecting streets this point is on the property line of the protected street.

(e) A stop sign shall be clearly illuminated at night and shall be visible for a distance of 100 feet.

(f) The letters shall be red on a yellow background.

RECOMMENDATION 11.—*Through Traffic Street.*

A stop sign (Figure 1) bearing the words "Through" and "Traffic," or equivalent terms, in the message space, shall be used at every intersection on a through traffic street except those controlled by signals.

RECOMMENDATION 12.—*Dangerous Intersection.*

At dangerous intersections where a stop is mandatory use the stop sign (Figure 1) bearing the words "Cross" and "Street" in the message space.

RECOMMENDATION 13.—*Dead End Street.*

On a street that ends with no outlet use the stop sign (Figure 1) bearing the words "Street" and "End" in the message space. This sign is not to be used at "T" or "L" street intersections. (See Recommendation 22.)

RECOMMENDATION 14.—*Street Closed.*

To close a section of a street temporarily use the stop sign (Figure 1) bearing the words "Street" and "Closed" in the message space.

RECOMMENDATION 15.—*Signs for Other Locations.*

For all other locations at which vehicles should stop before proceeding farther use the stop sign (Figure 1) bearing a descriptive message. Example: "Car Line."

## SLOW SIGNS

RECOMMENDATION 16.—*General Specifications.*

(a) A slow sign (Figure 2) shall be a diamond formed by turning one diagonal of an 18-inch square to a vertical position. The sign shall have a bead border around the edge, and the corners may be rounded for safety, using a radius of  $1\frac{1}{2}$  inches.

(b) The word "Slow" may be placed in 2-inch letters at the top, or a flashing yellow beacon light may be used in the center of the upper space.

(c) Any specific message, such as is indicated in subsequent recommendations, shall be placed approximately in the center of the diamond, but if a symbol is used the message shall be above the center line and the symbol place below the word message.

(d) In order to give adequate warning of a hazard a slow sign shall be placed sufficiently in advance of the point where the potential danger begins.

(e) The letters shall be black on a yellow background.

**RECOMMENDATION 17.—*Safety Zone.***

(a) The slow sign (Figure 2), with the words "Safety Zone" in 3½-inch letters in two lines in the message space and a horizontal arrow pointing to the right below the words shall be used at every safety zone where traffic is prohibited from passing to the left. Where traffic is allowed to pass on both sides, a double-headed arrow shall be used on such a sign.

(b) The sign shall be placed at the end of the zone that the traffic approaches. (See section on Safety Zones, p. 31.)

(c) The sign shall be illuminated at night.

**RECOMMENDATION 18.—*Street Car Crossing.***

(a) The slow sign (Figure 2), with the words "Car Line," in 3½-inch letters in two lines in the message space, shall be placed at every crossing that is sufficiently hazardous to require caution.

(b) The sign shall be illuminated at night.

**RECOMMENDATION 19.—*Cross Street.***

(a) The slow sign (Figure 3), with the words "Cross Street" in 3½-inch letters in two lines in the message space and a symbol below to indicate the type of street intersection (+ or † or ‡), shall be placed at every crossing which is especially hazardous and requires unusual caution but does not warrant a stop sign.

(b) The sign shall be illuminated at night.

**RECOMMENDATION 20.—*Hill.***

(a) At the beginning of a down grade of 6 per cent or more use the slow sign (Figure 4), with the word "Hill" in 6-inch letters centered on center line in the message space.

(b) For grades exceeding 10 per cent the word "Hill" should be placed somewhat above the center of the sign and the words "Steep Grade" shall be placed below it in 2-inch letters.

(c) The sign shall be illuminated at night.

**RECOMMENDATION 21.—*Curve.***

(a) At every curve having a radius of not more than 600 feet where the conditions require a reduction of speed, use the slow sign (Figure 5) bearing the word "Curve" in 5-inch letters on the center line in the message space and a curved arrow in the lower space indicating the direction of the curve.

(b) The sign shall be illuminated at night.

RECOMMENDATION 22.—*Traffic Turn.*

(a) At a turn having a radius of less than 200 feet use a slow sign (Figure 6) bearing the word "Turn" in 5-inch letters on the center line in the message space and a bent arrow in the lower space indicating the direction of the turn.

(b) At a "T" intersection, the directions that may be followed shall be shown by a double-pointed arrow indicating both directions.

(c) The sign may be used at the approach to a regular street intersection where the main flow of traffic makes a sharp turn.

(d) The sign shall be illuminated at night.

RECOMMENDATION 23.—*Other Locations.*

Use slow sign with descriptive message for all other conditions that require vehicles to proceed at reduced speed. For example, "Narrow Bridge," "Viaduct Approach" and "Street Repair."

CAUTION SIGNS

RECOMMENDATION 24.—*General Specifications.*

(a) A caution sign (Figure 7), shall be an 18-inch square mounted with the sides in horizontal and vertical positions. This sign shall have a bead border around the edge and the corners may be rounded for safety.

(b) The word "Caution" may be placed in 3-inch letters at the top, or a flashing yellow beacon light may be used in the center of the upper space.

(c) Any specific message, such as is indicated in subsequent recommendations, shall be in 5-inch letters and shall be placed approximately in the center of the square, if only one line is used.

(d) If a symbol is used in addition to the word message smaller letters should be used and the words so placed as to provide ample space for the symbol below the words.

(e) In order to give adequate warning of a hazard which is intermittent, a caution sign shall be placed sufficiently in advance of the point where the potential danger begins.

(f) The letters shall be black on a yellow background.

RECOMMENDATION 25.—*School Zone.*

At each end of a school zone use the caution sign (Figure 7), with the words "School Zone" in the message space.

RECOMMENDATION 26.—*Playground Zone.*

At each end of a playground zone use the caution sign (Figure 7), with the words "Play" and "Ground" in two lines in the message space.

RECOMMENDATION 27.—*Other Locations.*

At every place where vehicles should proceed cautiously use the caution sign bearing a descriptive message. Examples, "Theatre Exit," "Church Zone," "Men Working."

## ONE-WAY AND DETOUR SIGNS

### RECOMMENDATION 28.—*General Specifications.*

(a) A one-way sign (Figure 8) shall be arrow-shaped, 30 inches long by 6 inches high, or rectangular, 36 inches long by 8 inches high, with an arrow 30 inches long by 6 inches high on a black background. In either case the arrow shall be white with black letters.

(b) The message words, in 3-inch letters, shall be centered on the center line of the arrow.

(c) Care shall be taken to fix the sign so firmly that it cannot be turned in the wrong direction.

### RECOMMENDATION 29.—*One-Way Street.*

(a) On all four corners of every street intersection where one-way traffic regulations are in force, use a one-way sign (Figure 8), with the words "One-Way" on the face of the arrow.

(b) If the traffic at the intersection is controlled by an automatic signal the one-way sign shall be made a part of the signal.

(c) On a very narrow one-way street the arrow may be placed on only two corners of the street.

(d) The sign shall be illuminated at night.

### RECOMMENDATION 30.—*Detour.*

(a) A one-way sign (Figure 8), with the word "Detour" on the face of the arrow, shall be placed at the point where a detour begins and at all intersections and other points where any question might arise as to the course of the detour.

(b) At the point where a detour begins a temporary direction sign or route marker placed immediately below the detour sign is recommended to indicate the various destinations that are to be reached by following the detour instructions.

(c) The sign shall be illuminated at night.

## INFORMATION SIGNS

### RECOMMENDATION 31.—*General Specifications.*

(a) An information sign (Figure 9) shall be rectangular, with both dimensions multiples of 6 inches and shall have a bead border around the edge, and the corners may be rounded for safety.

(b) The horizontal dimension shall be less than the vertical dimension unless otherwise specified.

(c) The letters shall be black on a white background.

### RECOMMENDATION 32.—*Keep to Right.*

A sign (Figure 9) measuring 12 inches by 18 inches and bearing the words "Keep to Right," in 3-inch letters, shall be placed at the point where the message is to be obeyed.



RECOMMENDATION 33.—*No Turn.*

(a) A sign (Figure 10) measuring 12 inches by 18 inches and bearing the words "No Turn" or "No Left Turn" or "No Right Turn," in 3-inch letters, shall be placed at the point where the message is to be obeyed.

(b) If the intersection is controlled by an automatic signal, the sign forbidding the turn shall be attached to the signal and illuminated at night. The dimensions may be reduced to fit the signal housing, but the letters shall not be smaller than 2 inches.

(c) The sign shall be illuminated at night.

RECOMMENDATION 34.—*Dead End Street.*

(a) A sign (Figure 9) measuring 12 inches by 18 inches and bearing the words "Dead End Street," in 3-inch letters, shall be placed at the entrance to a street having no outlet.

RECOMMENDATION 35.—*Direction.*

(a) A sign indicating direction, measuring 18 inches by 24 inches, or proportionately larger if necessary to carry the message required, shall be so placed that it will be seen by a driver before he reaches the point at which he should take the direction to be followed. Such a sign is not intended to replace a standard highway route marker.

(b) The important items of the message shall be given in the largest letters possible and explanatory items in equivalent or smaller letters, the size depending upon the number of words used.

(c) An arrow about 16 inches long shall be placed below the message to indicate the direction to be taken. If two directions must be indicated a separate arrow should be used for each.

(d) The sign shall be illuminated at night.

RECOMMENDATION 36.—*Speed Limit.*

(a) A sign (Figure 11) 30 inches high by 24 inches wide, or a sign 24 inches high by 18 inches wide shall be used to show the speed limit at the point where the speed limit indicated begins. The larger sign shall be used at all entrances to cities, the smaller at other selected places within the city. Where used to restrict speed on a street within a city, speed limit signs shall be placed at intervals required by law or regulation. At the end of the restricted speed zone there shall be a sign showing the speed of the next zone or a special sign (Figure 12), 24 inches by 18 inches in size, bearing the words "End—Speed Limit." On this special sign the word "End" and the figures indicating the speed shall be 5 inches high and the words "Speed Limit" shall be in 4-inch letters.

(b) On the regular speed limit sign (Figure 11), the words "Speed Limit" in two lines of 3½-inch letters on the 30-inch by 24-inch sign and 3-inch letters on the 24-inch by 18-inch sign, shall be placed at the top,

the limit in 8-inch or 6-inch numerals respectively, slightly below the center and the word "Miles" in 3-inch letters at the bottom.

(c) The sign shall be illuminated at night.

**RECOMMENDATION 37.—*Quiet Zone.***

At each end of a quiet zone use a sign measuring 18 inches high by 18 inches wide with the word "Hospital" in 4-inch letters slightly above the center and the word "Quiet" in 3-inch letters below it.

**RECOMMENDATION 38.—*Other Information.***

(a) Information signs shall be used to convey any other necessary information, in conformity with the general specifications for information signs. Their dimensions shall be 12 inches by 18 inches, if possible.

**RESTRICTION SIGNS**

**RECOMMENDATION 39.—*General Specifications.***

(a) A restriction sign shall be rectangular, 12 inches wide by 18 inches high, with the principal words in 2½-inch letters at the top, and any necessary explanatory words below in equivalent or smaller letters, the size of the letters depending on the number and length of words used. The sign shall have a bead border around the edge and the corners may be rounded for safety.

(b) The sign shall be placed at the point where the message is to be obeyed.

(c) Where the restriction is to apply continuously for a considerable distance, the signs shall be placed at intervals of about 100 feet.

(d) The wording shall indicate the extent of the application; for example, "In This Block."

(e) Colors shall be:

- (1) No Parking.....red letters on a white background;
- (2) Limited Time Parking, green letters on a white background;
- (3) Pedestrian Restriction, blue letters on a white background;
- (4) Other restriction signs, black letters on a white background.

**RECOMMENDATION 40.—*No Parking.***

In places where parking is to be forbidden use a restriction sign (Figure 13) with the words "No Parking" at the top and with time limits or other qualifications, if any, below.

**RECOMMENDATION 41.—*Street Intersection.***

(a) At a street intersection use a restriction sign (Figure 13) with the words "No Stopping" at the top and the words "Here to Corner," in 2-inch letters, below.

To avoid the erection of an additional post, a sign reading "No Stopping Within — Feet of Corner" affixed to an existing pole or tree may take the place of this sign. In such a case the point beyond which stopping is prohibited shall be indicated on the pavement or curb.

**RECOMMENDATION 42.—*Fire House Zone.***

In a fire house zone use a restriction sign (Figure 13) with the words "No Stopping" at the top and the words "Fire House" in 2-inch letters below.

**RECOMMENDATION 43.—*Loading Zone.***

In a loading zone use a restriction sign (Figure 13) with the words "No Parking" at the top and the words "Loading Zone" in 2-inch letters below.

**RECOMMENDATION 44.—*Passenger Zone.***

(a) In a passenger zone use a restriction sign (Figure 13) with the words "No Standing or Parking" at the top and the words "Passenger Zone" in 2-inch letters below.

The limits of a zone may be indicated better by curb markings than by a sign at each end of the zone, especially if zones are close together. (See code of colors in section on Markings, p. 29.)

**RECOMMENDATION 45.—*Other No Parking Signs.***

For any other conditions that require restrictions applicable to the parking of vehicles use the restriction sign (Figure 13) with the appropriate prohibitive words at the top and other necessary explanatory words below. Examples, "Taxi Stand," "Bus Stop." The letters shall be red on a white background.

**RECOMMENDATION 46.—*Limited Time Parking.***

(a) To indicate the time limit of parking, use the restriction sign (Figure 14), with the time limit (for example, "One Hour") at the top and the word "Parking" and other qualifications below.

(b) The letters shall be green on a white background.

Angle parking is better indicated by pavement markings than by signs. (See section on Markings, p. 28.)

**RECOMMENDATION 47.—*No Pedestrian Crossing.***

(a) Where there is exceptional danger to pedestrians use the restriction sign with the words "No Crossing," in 2½-inch letters, at the top and any necessary explanatory words below in 1 or 2 inch letters, the size depending upon the number of words used.

(b) The sign shall be so placed as to apply solely to pedestrians. For example, the sign may be suspended between short posts and arranged parallel or approximately parallel to the curb line.

(c) The letters shall be blue on a white background.

This sign is not intended to prohibit pedestrians from crossing streets generally throughout a large area. Educational work against so-called jay walking may be done better by posters than by permanent signs.

**RECOMMENDATION 48.—*Additional Restriction Signs.***

Additional restriction signs may be needed for special purposes and shall conform to Recommendation 39.

## Section 2.—Street Traffic Control Signals

### REASONS FOR THE INSTALLATION OF SIGNALS

The principal reasons why signals to control street traffic should be installed are: (a) to increase the safety of pedestrians and vehicles at congested intersections; (b) to facilitate the movement of traffic with a minimum of delay at congested intersections; (c) to provide for the continuous movement of traffic throughout a heavy route; (d) to interrupt a heavy traffic stream at intervals so as to afford opportunity for cross traffic to move.

The most generally effective mechanical device used to increase safety and to facilitate traffic at intersections on city streets is the automatic traffic control signal, but there is a tendency to use traffic control signals unnecessarily. Some are installed indiscriminately, without a thorough analysis of the conditions and of the probable effects of their installation. Many are installed and operated where and when their use is not justified. The unnecessary use of signals produces serious results. For example:

(a) Impatient and reckless drivers disregard an unnecessary "Stop" signal, and their habit threatens the usefulness of all traffic control signals, the value of which depends upon the public confidence based upon their supposed general observance.

(b) There is likely to be a general diversion of traffic from main thoroughfares to unsignaled side streets, which would increase the volume of traffic and the danger of accidents there, especially to children.

An effort was made to obtain data upon which to base an authoritative statement as to the volume of traffic and the other conditions that justify the installation and operation of an automatic traffic control signal. As no general formula has yet been established as to traffic control signals, the authorities responsible for their installation should examine carefully each proposed installation and base their decision upon the volume and the type of traffic moving in each direction at the point considered in comparison to the number of lanes of roadway width, the layout of the intersection, the method of operation possible, and the like. Where expedition of traffic rather than safety is the paramount consideration care must be taken in installing traffic control signals, because an unwise regulation will retard rather than expedite traffic. Some traffic control signals that are installed to control the peak traffic, such as exists at certain hours of the day, or on Sundays and holidays, should not be operated at other times when the volume of traffic does not warrant such control.

A proposed solution of this problem is the use of a timing device that will automatically pass a small volume of traffic from time to time as it ap-

proaches and will automatically go into a fixed cycle when the volume increases sufficiently to require the signal.

## DEFINITION OF TERMS

The use of traffic-control signaling is new; it is in a formative state, and there is confusion as to the meaning of the terms used in connection with it. In the interest of clarity the following definitions are recommended:

### RECOMMENDATION 49.—*Traffic Control Signal.*

“A Signal” shall be defined as comprising all signal lights that are operated together to control traffic at an intersection, whether the signal is mounted in one unit or more.

### RECOMMENDATION 50.—*Types of Housing.*

The types of housing shall be defined as follows:

- (a) Vertical.....Lights one above another
- (b) Horizontal.....Lights side by side
- (c) One-Way.....Lights visible in only one direction
- (d) Two-Way...Lights visible in two directions, either opposite or at angles.
- (e) Three-Way.....Lights visible in three directions
- (f) Four-Way.....Lights visible in four directions
- (g) Multi-Way...Lights visible in more than four directions at various angles.

### RECOMMENDATION 51.—*Types of Support.*

The types of support shall be defined as follows:

- (a) Post—Housing supported on top of a post or pedestal.
- (b) Bracket—Housing supported on a bracket projecting from the side of a pole.
- (c) Cable—Housing suspended over the roadway by one or more cables.

### RECOMMENDATION 52.—*Methods of Operating Traffic Control Signal Systems.*

The methods of operating traffic control signal systems shall be defined as follows:

- (a) Manual.....Direct control by a hand switch
- (b) Automatic...Control by motor, clock work, or other mechanism
- (c) Combined...Automatic control that can also be operated manually

## CLASSIFICATION OF TRAFFIC CONTROL SIGNAL SYSTEMS

Traffic control systems should be classified according to the character of the traffic movement resulting from the system rather than the type of apparatus employed. The use of the following classification, which is stated in terms of traffic flow and arranged in the sequence of the development of the art, is therefore recommended.

### RECOMMENDATION 53.—*Types of Systems.*

Traffic control signals and signal systems shall be classified as follows:

(a) *Independent.* The operation of the signal is not related to the operation of any other signal. Isolated intersections that are controlled by independent traffic signals, not related in operation to any other signals, cannot be said to form a traffic control system.

(b) *Synchronized.* A type of coordinated control in which all signals show the same color in the same direction simultaneously.

(c) *Limited Progressive.* A form of progressive system in which the signals are grouped, the alternate groups showing opposite colors in a given direction and all signals changing simultaneously.

(d) *Flexible Progressive.* A form of progressive system in which the operation of each signal is determined by the traffic requirements of the intersection and which in addition provides for the continuous movement of traffic.

## SELECTION OF METHOD OF OPERATION

Where the traffic conditions require the installation of traffic control signals at a number of neighboring intersections along a main thoroughfare or on a number of adjacent streets, so that each signal will affect the traffic flow at the others, it is essential to select some control system. To aid in such selection the outstanding features of those now commonly used are here described *in the order of preference.*

### FLEXIBLE PROGRESSIVE SYSTEM

The flexible progressive system is the best for the coordination of signals along a single street and is the only one that is well adapted to the control of signals on a number of adjacent streets that form a district. Its only limitation is that the complete cycle of changes must be of the same duration for all the intersections controlled. It has the following advantages:

(1) It permits the continuous movement of traffic at approximately a predetermined speed on both through and cross streets.

(2) It makes possible the adjustment of the timing of each signal to the variations in the flow of traffic at the particular intersection controlled by that signal.

(3) It discourages speeding, because it forces the driver of a vehicle to make frequent stops if he exceeds the speed determined for the system.

(4) It permits modification of the timing throughout a considerable area to adjust it to the differences in the movement of traffic at different hours of the day.

#### LIMITED PROGRESSIVE SYSTEM

The limited progressive system is an adaptation of the synchronized system obtained by so changing the wiring of alternate signals or groups of signals that each signal or group as seen from the same direction shows the color having the meaning opposite to that conveyed by the adjacent signal or group. Under the conditions for which this system is satisfactory it has the following advantages:

(1) It permits the continuous movement of traffic on a single street at approximately a predetermined speed, subject to the limitations stated in paragraph (c) below.

(2) It discourages speeding, because a vehicle is forced to make frequent stops if it exceeds the speed for which the system is arranged.

It has the following disadvantages:

(1) It is not well adapted to a street having blocks of unequal length.

(2) It requires equal time intervals for through traffic and for cross traffic, so that too much time is devoted to cross traffic on a street where there is a greater volume of through traffic.

(3) If the signals are grouped it reduces the capacity of the street between points where the color changes, because only the vehicles that enter the first intersection of a group during the first part of the green interval can move continuously.

#### SYNCHRONIZED SYSTEM

The synchronized system is simple, but it has the following disadvantages:

(1) It necessitates the stopping of all traffic simultaneously in one direction, so that the continuous movement of vehicles is impossible and the overall speed and the average speed are low.

(2) On streets traversed by electric railways, it increases the peak power load, because of the simultaneous starting of many street cars.

(3) It encourages speeding in order to pass as many intersections as possible before a change of signals.

(4) The timing is based on the flow of traffic at the most congested intersection, and as the timing at all intersections must be the same, the traffic at the other intersections is unnecessarily delayed.

#### Independent Signal

The independent signal is used at isolated intersections as a safeguard to intersecting lines of vehicular traffic where the traffic is heavy on each

line. Independent signals can often be used effectively, at intervals of several blocks, as interruptive devices to break the flow of traffic on a heavily traveled thoroughfare, such as a "through traffic street" in order to enable pedestrians and vehicular traffic on side streets to cross in safety. (See Rec. 64.)

### USE OF COLORS

The general practice in traffic control systems in the United States and that recommended in the Model Municipal Traffic Ordinance is to use three colors, but in some cities only two colors are used.

#### RECOMMENDATION 54.—*Three-Color System.*

(a) If a three-color system is used the colors shall be displayed in the order *red, green, yellow.*

The display of yellow after red is *not recommended* because it is likely to be interpreted by the waiting driver as an invitation to start before the green appears. Therefore, the red should be shown until the change is made to green and the yellow should be displayed after the green. In recent installations in some cities yellow is displayed before the end of the green so that the two colors show simultaneously. Experimentation is also being carried on with yellow overlapping with and continuing after green.

#### RECOMMENDATION 55.—*Meaning of Colors in Three-Color System.*

In a three-color system the colors shall be interpreted respectively as follows:

(a) Red means Stop before entering the intersection and remain standing until green is shown.

(b) Green means permission to Go, subject to the safety of others or to the specific directions of a police officer.

(c) Yellow after green means stop before entering the intersection unless when yellow first appears the vehicle is so close to the intersection that it cannot be stopped with safety.

(d) Yellow shall not be used in traffic control systems to govern the turning of vehicles or the movement of pedestrians.

At some intersections where pedestrian movement in all directions is heavy at times, especially if combined with complicated vehicular turns, it has been found necessary to set aside a time interval for exclusive pedestrian use of the intersection. As stated, the use of yellow alone in such a case is *not recommended* because it would conflict with the standard significance of that color. A special color, such as purple, or a combination of yellow with red showing in all directions can be used to indicate exclusive pedestrian movement.

#### RECOMMENDATION 56.—*Two-Color System.*

(a) If a two-color system is used, the colors shall be red and green, and the red shall be displayed simultaneously in all directions for the change period.

It is *not recommended* that the change period be indicated by a dark interval, during which no lights are shown.



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It is *not recommended* that the change period be indicated by a dark interval, during which no lights are shown.

RECOMMENDATION 57.—*Meaning of Colors in Two-Color System.*

In a two-color system the colors shall be interpreted as follows:

(a) Red means Stop before entering the intersection and remain standing until green is shown unless when the red appears the vehicle is so close to the intersection that it cannot be stopped with safety.

(b) Green means permission to Go, subject to the safety of others or to the specific directions of a police officer.

The determination whether or not a vehicle can be safely stopped before entering an intersection after the appearance of a stop signal should be based upon normal braking distances as defined in the National Code on Brakes and Brake Testing.

RECOMMENDATION 58.—*Removal of Confusing Colored Lights.*

All lights of such a color and location as to be confused with traffic control signals should be removed.

RECOMMENDATION 59.—*Right and Left Turns.*

(a) A turn either to the right or the left should be prohibited while the red is shown and permitted only while the green is shown.

(b) There may be reasons for making exceptions to this rule in certain places, but such exceptions should be avoided if possible. In such places, an auxiliary green arrow should be displayed pointing in the direction in which traffic is permitted to turn.

RECOMMENDATION 60.—*Signal Specifications.*

(a) The visible diameter of a signal lens shall be 8 inches.

(b) The illuminating lamp shall be of not less than 60-watt capacity.

(c) The optical system shall be so designed that each lens shall be illuminated independently of any other lens.

(d) The lens, reflector, and visor shall be of such design as to minimize the effect of all phantom light and to render the signal light plainly visible for a distance of 300 feet under all conditions.

(e) The relative position of the colors shall be:

(a) Vertical: Top, red; middle, yellow, if used; bottom, green.

(b) Horizontal: Left, red; middle, yellow, if used; right, green.

RECOMMENDATION 61.—*Location of Signals.*

(a) All traffic control signals shall be so placed that the lights are plainly visible to the drivers of the traffic to be regulated.

(b) The type and location of lights shall be as follows, *named in the order of preference*:

1. Four-way signal on post or bracket on each corner.
2. Three, two, or one-way signal on post or bracket on each far corner.
3. Three-way or two-way signal on post or bracket on each near corner.
4. Four-way signal suspended over center of intersection.

5. Four-way signal on post on safety island.
6. Four-way or two-way signal on brackets on diagonal corners.

Four-way signals at each corner are placed first in order of preference because they give traffic a maximum of information as to what is required, without introducing any obstruction. At least one signal light is always readily seen by the vehicle operator. The pedestrian on either crosswalk also directly faces a signal light.

Signals on the far corners alone are preferable to those on the near corners alone because the latter cannot readily be seen by the driver stopped alongside them. Far-corner signals are sometimes obscured, however, by cross traffic. If they are not to show in all four directions as many directions as possible are desirable.

Signals suspended over the center of the intersection must be high to avoid interference with high vehicles, and therefore cannot be seen by operators in certain types of vehicles when stopped at the entrance to the intersection. The cable suspension is unsightly, difficult to maintain and may interfere seriously with fire-fighting equipment.

The use of four-way signals on posts on safety islands is limited in application to streets wide enough and with sufficient pedestrian and vehicle traffic to warrant such islands. The use of post signals in the centers of intersections is *not recommended*, because they form unnecessary and dangerous obstructions.

Signal lights on brackets on two diagonally opposite corners are the least desirable of the approved forms because the signal is on the right for one driver and the left for the other, because the lights must be high to clear vehicles and because the bracket must be long and cumbersome to carry the signal far enough outward to show on two streets.

Only one type of location should be used in each city. It would be most advantageous if neighboring municipalities used the same type. It is suggested that appropriate information as to the type of location, the character of the signal system, and the like, be included on signs posted at the principal highway entrances of each municipality.

#### RECOMMENDATION 62.—*Main Thoroughfare Traffic Control.*

(a) Where traffic is controlled continuously for a considerable distance each intersection of a main thoroughfare with a cross street shall be protected.

The practice of using a few widely separated traffic control signals on a main thoroughfare to control all intersections on that thoroughfare is exceedingly dangerous and is *not recommended*.

The type of signal to be installed at each intersection on a main thoroughfare must depend upon the volume of traffic carried by the cross streets. Where signals are installed on given main thoroughfares the following recommendations shall apply.

#### RECOMMENDATION 63.—*Main Thoroughfare and Heavy-Traffic Cross Street.*

Each intersection of the main thoroughfare and heavy-traffic cross street shall be protected by a traffic control signal.

RECOMMENDATION 64.—*Main Thoroughfare and Light-Traffic Cross Street.*

Each intersection of the main thoroughfare and light-traffic cross street shall be protected by a sign lettered "STOP Through Traffic." (See Rec. 11.)

A "STOP Through Traffic" sign is used at the intersection of a main thoroughfare with a light-traffic cross street because a main thoroughfare can carry a greater volume of traffic and can carry it at a higher speed if the movement of the traffic is impeded only at cross streets on which the traffic is heavy. On main thoroughfares where the traffic is heavy, traffic control signals preferably should be installed at certain intersections, even where there is no considerable cross traffic, in order to break the traffic streams into platoons that will afford pedestrians and vehicles an opportunity to cross. Such signals should be arranged in a flexible progressive system, provided that the signalled intersections are close enough to permit vehicle drivers in general to take advantage of the progressive timing arrangement.

RECOMMENDATION 65.—*Height of Signals.*

(a) All traffic control signals shall be placed at such height as to be plainly visible to drivers in approaching traffic at a distance of 100 feet from the intersection.

(b) The bottom of the housing shall be 7 to 10 feet above the pavement if it is inside the curb line and at least 14 feet above if it is supported on brackets or cables over the roadway.

### EMERGENCY CONTROL

In any coordinated system supplemental arrangements may be provided for breaking the system into small units for emergency operation, such as runs of fire apparatus.

### CYCLE LENGTHS

The length of the cycle should be determined by a careful consideration of all the factors involved in the regulation, such as volume of through and cross traffic, turning movements, distances between intersections, average speed obtainable at different hours, classes of vehicles, street-car schedules, street-car speeds and loading times, number of lanes available, requirements of pedestrians, and any irregularity in the shape of the intersection. In general, short cycles are more effective than long ones, and proper timing on short cycles encourages the observance of the regulations by pedestrians.

RECOMMENDATION 66.—*Timing of Cycles.*

(a) A cycle length of 40 to 80 seconds should be used for the control of ordinary traffic.

(b) Changes in cycle lengths for rush hours may be advisable. Consequently timers (or controllers) should have flexibility of adjustment through a wide variation of cycle lengths.

(c) Traffic control signals should not be operated at times when the volume of traffic is too light to justify their operation. They should be so arranged that when they are not in operation that fact will be clearly indicated, preferably by a flashing yellow light on the signal.

## OTHER SIGNALS

### RECOMMENDATION 67.—*Train Approach Signals.*

Two well recognized types of signals are now used to indicate the approach of a train at a grade crossing. They are equally visible, and either may be used, namely:

- (a) A signal that swings a target and a red light across the highway.
- (b) A signal that flashes alternately two red lights, which are in a horizontal line 30 inches apart.

Regular street traffic control signals are sometimes used at railroad crossings particularly within city limits. Their use is enforceable under city ordinances but they should be used instead of the foregoing standard signal only if operated manually, or by combined automatic and manual control under supervision. If not operated continuously the standard train approach signal should be used when the traffic control signal is not in operation.

### RECOMMENDATION 68.—*Beacon Signals.*

Beacon signals shall conform to the following specifications:

- (a) Flashing red means stop and proceed when safe.
- (b) Flashing yellow means proceed with caution.
- (c) Beacon supports in the roadway shall be illuminated.

Beacon signals have been used extensively and for many purposes in regulating traffic. They should be used to mark permanent street obstructions, such as safety zones, bridge structures, posts, and abutments, and also to mark danger points, such as the end of a street, either at a dead-end or at a cross street, the beacon to be placed on the curb of the cross street opposite the center of the terminating street. They may also be used in connection with stop and cautionary signs. The location of beacon signals at points where they will obstruct traffic is not recommended. (See Section on Signs.)

### RECOMMENDATION 69.—*Lighting of Traffic Officers.*

Traffic officers stationed in roadways shall be illuminated at night, by flood lights if necessary, in the interest of safety.

### Section 3—Street Traffic Markings

The use of markings on obstructions in streets is absolutely necessary. Markings on pavements and curbs are of great assistance to a driver, because they do not divert his attention from the control of the vehicle. Their use, however, is subject to very definite limitations. In wet weather they can not be clearly seen, especially at night; and in those parts of the country where snow falls they may often be entirely covered by the snow. Markings on pavements are quickly worn off by traffic and must be renewed often, at considerable expense. Markings should be so placed that they may be seen easily, and the observance of the message which they convey should be rigidly enforced.

#### RECOMMENDATION 70.—*Types and Purposes of Markings.*

The following are approved kinds of markings:

- (a) Lines on pavement.
- (b) Colors on curbing.
- (c) Words on pavement or curbing.
- (d) Cross-hatching or checkerboard squares on obstructions.

#### RECOMMENDATION 71.—*Pavement Lines.*

The following are approved uses of lines on pavements:

- (a) Center line of a street.
- (b) Center line on a curve having a radius less than 600 feet.
- (c) Center line at and approaching hill crests.
- (d) Traffic lanes on streets wide enough for three or more lanes.
- (e) Traffic lanes for turning at street intersections.
- (f) Stop line at entrance to through traffic street.
- (g) Street-car clearance limits at turning points.
- (h) Boundaries of pedestrian crosswalks.
- (i) Parking-space limits.
- (j) Stalls for parking other than parallel.
- (k) Directional lines.

Lines to mark center lines of streets are desirable where there is considerable traffic in each direction. Additional lines marking traffic lanes are desirable in streets wide enough and with sufficient traffic to carry two or more well defined streams of traffic in one or both directions. On signalled streets, even where continuous longitudinal lines are not justified, lines extending from 50 to 75 feet each way from each signalled intersection are desirable to aid in holding stopped traffic to the right side of the street.

Center lines should be used to hold traffic to its proper side on curves of less than 600-foot radius, and also on hill crests where the view ahead is insufficient to permit overtaking and passing in safety. Lines on hill crests should extend down the hills far enough to discourage attempting to pass when it cannot be accomplished before traffic approaching over the hill top might block the way.

The marking of crosswalk boundaries is one of the most important uses of pavement lines, and should be used extensively wherever there is considerable pedestrian movement. Such lines encourage pedestrians to obey traffic signals and indicate to motorists where they may look for pedestrians and where they must stop when facing "Stop" signs or signals. Such crosswalks are particularly essential at irregular intersections where otherwise neither the pedestrian nor the motorist can determine the proper place for the pedestrian to cross.

Traffic lanes for turning at street intersections are desirable to expedite safe turning movements, and the marking of street-car clearance limits serves a similar purpose.

The marking of parking space limits tends to prevent dangerous encroachment on fire hydrant zones, intersection areas, and the like. The marking of parking stalls for angle parking enables all operators to park at the same angle with a minimum of waste space.

Special directional lines can sometimes be used effectively to route traffic in a manner that could not easily be indicated by any other means. A directional line shall be short and shall have an arrow head on one end to indicate direction.

#### RECOMMENDATION 72.—*Curb Markings.*

Curb markings are used principally to show the regulations applying to vehicles stopping or standing next to the curb. They are most effective if different colors are used to distinguish different regulations.

The colors given below shall be used for the purposes shown:

Prohibited parking.....	Red
Loading zone (passengers and material).....	Yellow
Passenger zone (loading and unloading of passengers only).....	White
Limited time parking.....	Green

#### RECOMMENDATION 73.—*Wording on Pavement or Curb.*

(a) A message on a pavement or a curb shall be brief and clear.

If it is not, the driver of a vehicle will not have time to read or to comprehend it. Although such messages are effective under certain conditions, they should be used sparingly.

#### RECOMMENDATION 74.—*Round Inserts.*

(a) A round insert shall be made of aluminum, non-rusting steel, monel metal, brass, or other material that will show a bright contrasting surface under the action of traffic.

(b) The diameter of the insert shall be not less than 4 inches.

(c) Inserts shall be spaced about 12 inches on transverse lines and about 18 inches on longitudinal lines.

(d) The insert shall be attached to the pavement by anchor bolts or a similar device.

(e) It shall not project above the level of the pavement more than half an inch.

(f) It shall have a rounded surface so that it will present a smooth contour to the wheels of vehicles.

RECOMMENDATION 75.—*Rectangular Inserts.*

(a) A rectangular insert that is made of brick, stone, rubber, metal, or other material shall be of a permanent color different from that of the pavement.

(b) The inserts shall be set to form lines, either continuous or broken.

(c) They shall be embedded in the pavement so that their upper surfaces are flush with the level of the pavement.

RECOMMENDATION 76.—*Paint.*

(a) A painted line shall be not less than 4 inches wide.

(b) A line painted on a bituminous pavement shall be white or yellow; one painted on concrete shall be black or white.

(c) A painted line shall be frequently renewed in order to insure its plain visibility at all times.

RECOMMENDATION 77.—*Canvas.*

(a) Canvas markings shall be attached to the pavement with cement so firmly that the lines will remain true under all conditions of use and in all kinds of weather.

(b) Their color shall be white or yellow.

RECOMMENDATION 78.—*Mushroom Buttons.*

(a) Large mushroom buttons that project several inches above the pavement shall not be used at any point where they may interfere with traffic.

If a mushroom button projects several inches above the pavement it forms a hazard even if it is illuminated. Such buttons may be satisfactorily used to mark non-traffic spaces in a wide pavement.

RECOMMENDATION 79.—*Flexible Sign Inserts.*

A flexible sign insert may be used as an alternative marker for words painted on the surface of the roadway. Such a marker shall be made of rubber or similar flexible material that will stand upright under normal conditions but that will bend flat on the pavement when it is hit by the wheels of a vehicle, so that it will neither offer resistance to the free passage of the vehicle nor damage it or the marker. Such a marker shall be not larger than 8 inches in height and 30 inches in length and shall have yellow letters on a black background. The base of the marker shall be inserted in the pavement in such a way that it may be readily removed either for replacement or, in winter, to avoid its destruction by snow ploughs.

RECOMMENDATION 80.—*Obstructions.*

(a) If an obstruction must remain in the roadway it shall be clearly marked either by alternate black and white lines, 3 to 6 inches wide,



sloping at an angle of 45 degrees, or by black and white checkerboard squares, each 6 to 12 inches on a side.

(b) Additional protection from an obstruction shall be provided by the use of a flashing yellow beacon light and/or by the use of a yellow reflecting sign, set 3 feet above the pavement, that will be illuminated by the headlights of approaching vehicles.

**RECOMMENDATION 81.—*Railroad Crossing Gates.***

(a) Gates protecting railroad grade crossings shall be marked with alternate stripes of black and white, of 12 inch minimum width, placed at an angle of 45 degrees with the horizontal, when the gates stand across the highway, and sloping downward toward the center of the highway.

(b) Both sides of the gates shall be painted alike.

The foregoing standards for crossing gates have been adopted by the American Railway Association.

## Section 4.—Safety Zones

Safety zones are used principally at street car loading points in heavy traffic streets. A less frequent use is in cross walks at or near the centers of wide streets, to afford protection to pedestrians when they are unable to proceed safely across the entire street without stopping.

Safety zones of the former class, if of the approved type, are a great protection to car riders, affording them opportunity to enter and leave street cars in safety. Furthermore, when used on streets carrying any considerable number of street cars and wide enough to afford adequate space for vehicle traffic alongside them, they greatly expedite that traffic, enabling it to continue in motion while the street car is loading, whereas without such protection for the car rider the most approved traffic regulations require the vehicle traffic to stop and remain standing until the passengers reach a place of safety.

### RECOMMENDATION 82.—*Positions of Safety Zones.*

(a) A safety zone shall be established at every street-car stop where the traffic is heavy and where at least one adequate traffic lane is available between the safety zone and the street curb.

(b) A safety zone shall be established at every crosswalk on a wide street or at any hazardous intersection.

### RECOMMENDATION 83.—*Types of Safety Zones.*

Of the several types of safety zones the following are recommended *in the order of preference*:

(a) A raised platform of concrete or wood, adequately protected against collision at the end approached by the traffic.

(b) A marked space without platform, adequately protected at the end and along the sides.

A third type of safety zone consists of a space on the pavement without a platform, marked at the ends and along the side by portable signs and permanent marks. The signs are mounted either on heavy pedestals or on posts set in sockets in the pavement. This type *is not recommended for general use*. It may be used on streets where congestion of pedestrians occurs only at certain times of the day and where at other times, especially at night, it is expedient to give the use of the entire roadway to vehicles by removing the portable signs.

In some communities a safety zone is indicated by merely marking a space by lines on the pavement. This type of so-called safety zone is dangerous and *is not recommended*.

### RECOMMENDATION 84.—*Traffic Lane.*

(a) A traffic lane not less than 9 feet 6 inches wide shall be provided between the edge of the safety zone and the curb.

(b) The traffic lane shall be kept clear by prohibiting stopping, standing, and parking along the curb throughout the length of the zone and for a distance of not less than 20 feet beyond each end.

RECOMMENDATION 85.—*Raised Safety Zones.*

(a) All raised safety zones shall be not less than 5 nor more than 7 inches high on the side toward the curb.

(b) Safety zones other than those provided for street-car stops shall be not less than 3 feet wide and 6 feet long.

(c) Those used for street car stops shall be 4 feet wide, shall have a clearance of 4 inches from the side of the street car, and shall be long enough to provide adequate access to car entrances for the number of cars ordinarily stopped at the zone at one time.

RECOMMENDATION 86.—*Protection of Safety Zones.*

(a) Safety zones of the approved types (See Rec. 83, a, b) shall be protected at the end the traffic approaches by substantial obstructions, either posts or abutments, extending approximately  $3\frac{1}{2}$  feet above the surface of the pavement.

(b) The posts shall be made of heavy timber, reinforced concrete, or iron filled with concrete.

(c) They shall be placed at the corners or around the end of the zone, forming a curve.

(d) Above this protection there shall be placed a flashing yellow beacon signal.

(e) A "safety zone" sign shall be mounted either on the posts or on the beacon support. (See Rec. 17.)

(f) Posts or other protective obstructions shall be marked in accordance with the specifications for markings.

(g) Both the obstructions protecting the safety zone and the zone itself shall be adequately and separately illuminated at night.

(h) At a safety zone having no platform to define its boundaries, the side of the zone next to the traffic lane shall be protected by posts 5 inches in diameter, spaced at intervals not exceeding 8 feet for the entire length of the zone.

## PART II

### Facts and Experience

The Committee, through the willing cooperation of approximately eighty local committees, obtained factual data and authoritative comment relating to traffic signs, signals, and markings in over one hundred cities. This material was carefully compiled and formed the basis of the recommendations contained in this report. The compilation contains tables showing the number of cities using each type of sign, signal, and marking. It also contains statements concerning many related matters, such as colors used, time intervals, safety zones, and the like.

It was deemed unnecessary to print this material. However, anyone directly interested may secure a copy of Part II, and a report on the volume of traffic which justifies the installation of a signal, in mimeographed form, by writing to American Engineering Council, 26 Jackson Place, Washington, D. C.

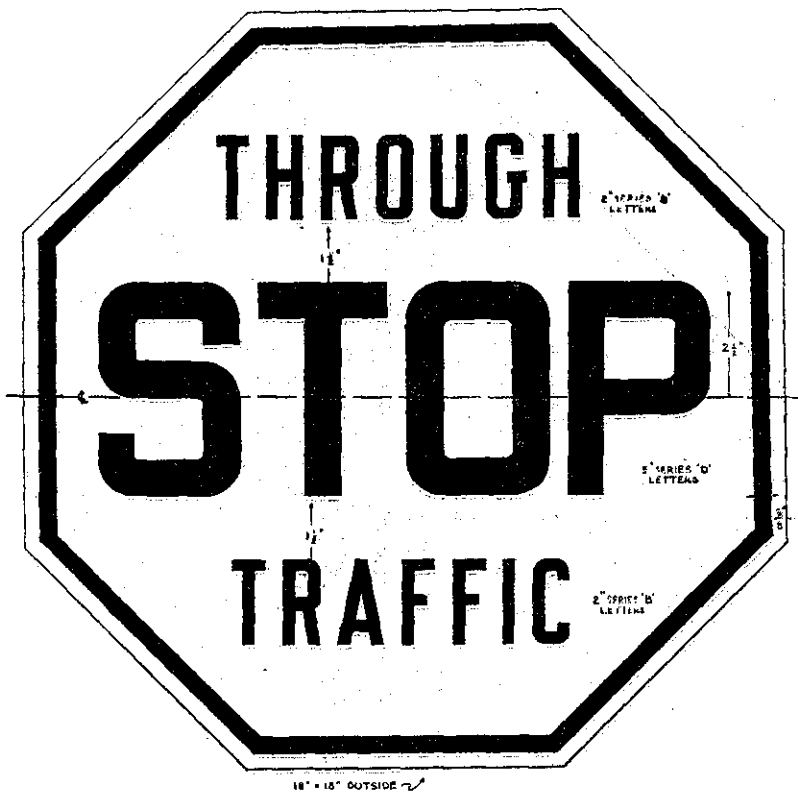


Figure 1: Stop Sign—Through Traffic Street  
 Letters and border, solid red  
 Background, federal yellow  
 (See Recommendations 10-15)

(Note: When a sign 24" by 24", as provided in Recommendation 10-a, is used the word "Stop" shall be in 6" Series E letters, and the message words in 3" Series B letters.)



Figure 2: Slow Sign—Safety Zone  
 Letters, arrow and border, solid black  
 Background, federal yellow  
 (See Recommendations 16-18)



**Figure 3: Slow Sign—Cross Street**  
Letters, border and cross, solid black  
Background, federal yellow  
*(See Recommendation 19)*



Figure 4: Slow Sign—Hill  
Letters and border, solid black  
Background, federal yellow  
(See Recommendation 20)



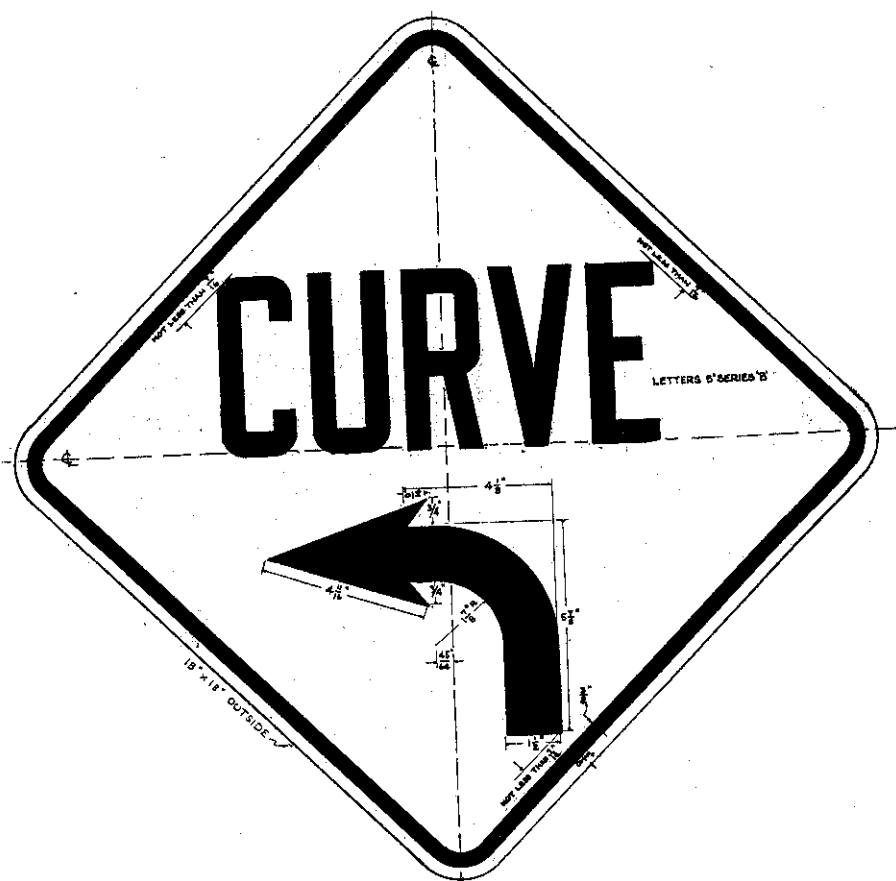


Figure 5: Slow Sign—Curve  
 Letters, symbols and border, solid black  
 Background, federal yellow  
 (See Recommendation 21)



Figure 6: Slow Sign—Traffic Turn  
 Letters, border and symbols, solid black  
 Background, federal yellow  
 (See Recommendation 22)

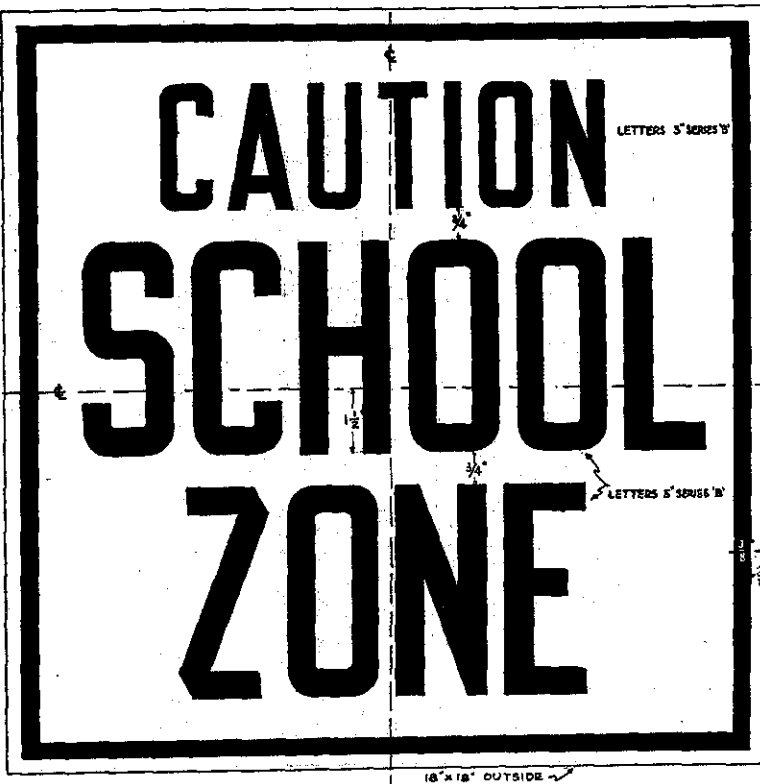
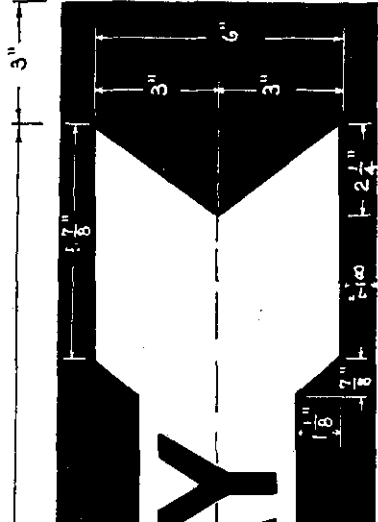


Figure 7: Caution Sign—School Zone  
 Letters and border, solid black  
 Background, federal yellow  
 (See Recommendations 24-27)



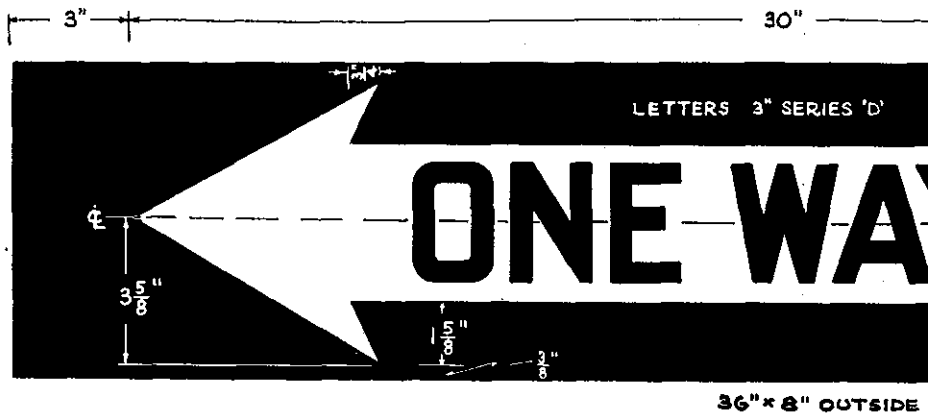


Figure 8: One Way and Detour Sign  
 Letters and background, solid black  
 Arrow, white  
 (See Recommendations 28-30)

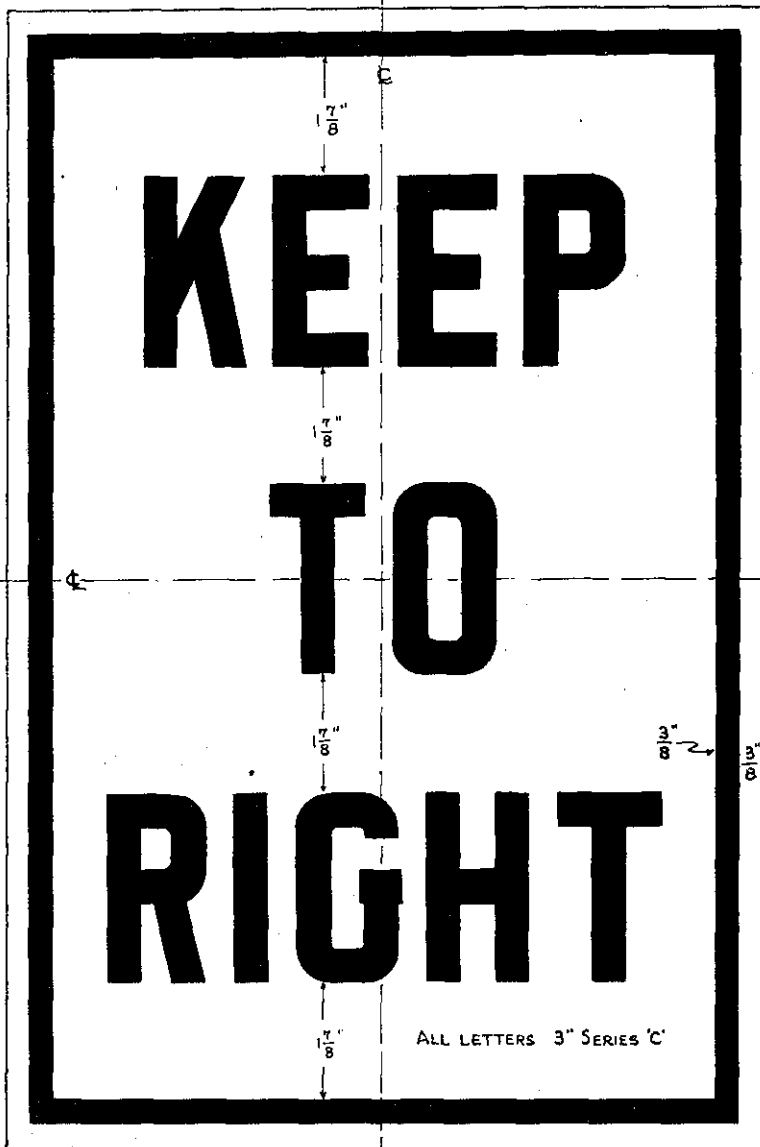


Figure 9.: Information Sign—Keep to Right  
 Letters and border, solid black  
 Background, white

(See Recommendations 31, 32, 34)



Figure 10: Information Sign—No Turn  
 Letters and border, solid black  
 Background, white

(See Recommendation 33)



Figure 11: Information Sign: Speed Limit — Miles  
 Letters, numerals and border, solid black  
 Background, white

(See Recommendation 36)

(Note: When a sign 30" by 24", as provided in Recommendation 36-a, is used the words "Speed Limit" shall be in 3½" Series E letters, the numerals shall be in 8" Series F letters, and the words "Miles" in 3" Series D letters.)



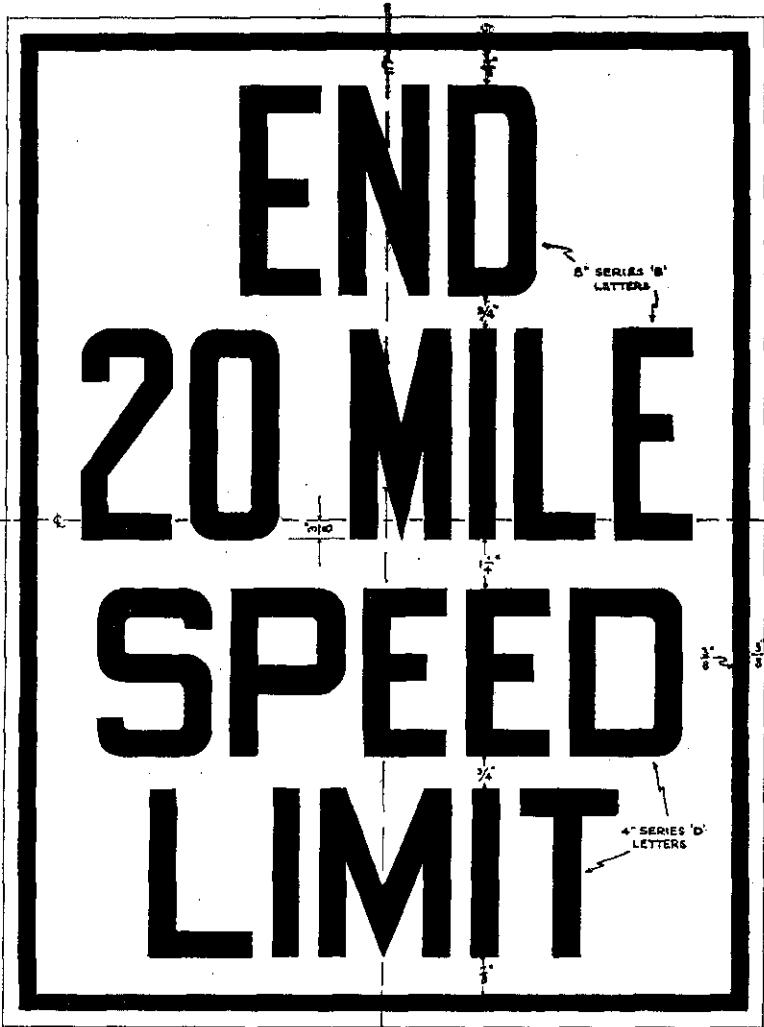
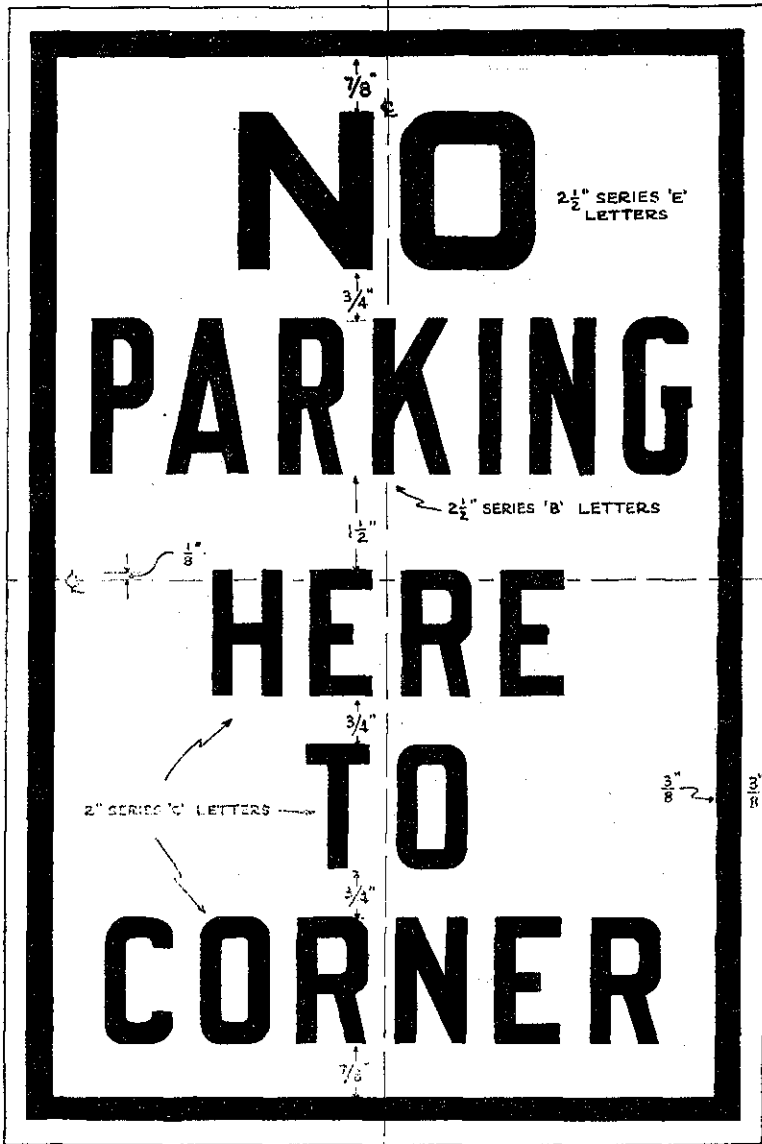


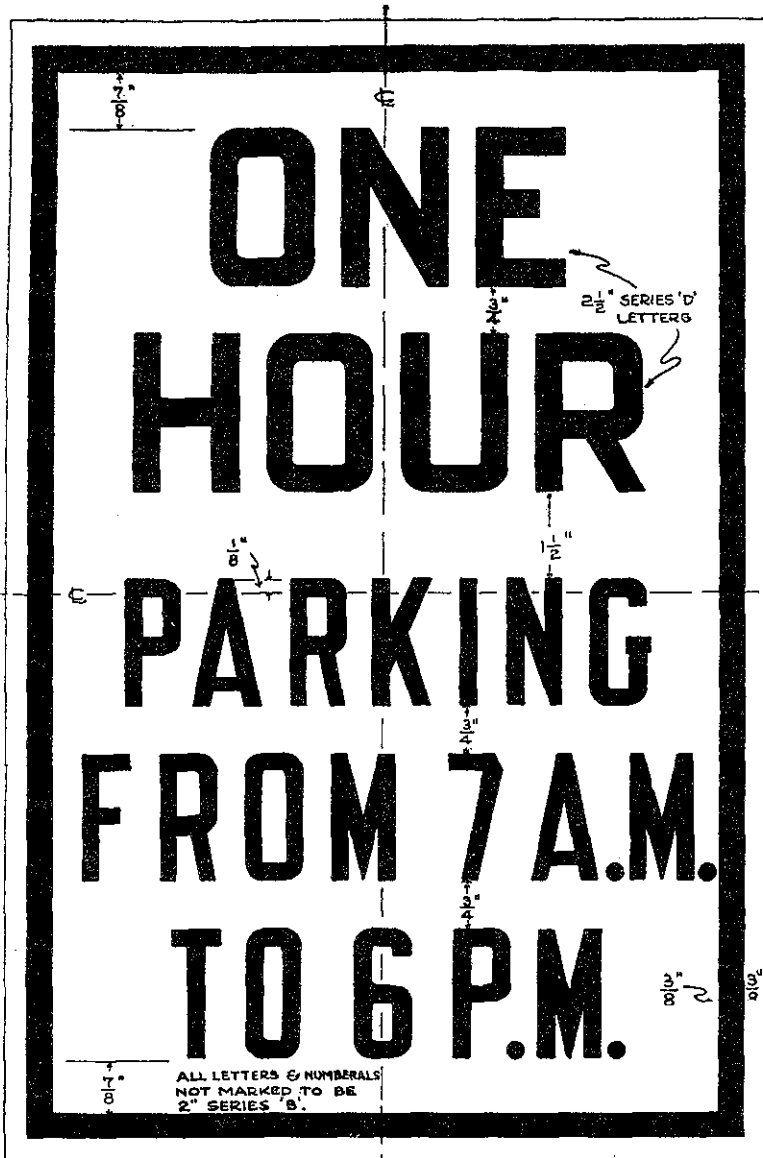
Figure 12: Information Sign: End of — Mile Speed Limit  
 Letters and border, solid black  
 Background, white

(See Recommendation 36)



12" x 13" OUTSIDE

Figure 13: Restriction Sign—No Parking  
 Letters and border, solid red  
 Background, white  
 (See Recommendations 39-45)



12" x 18" OUTSIDE

Figure 14: Restriction Sign—Limited Time Parking  
 Letters and border, green  
 Background, white

(See Recommendation 46)

## APPENDIX A

### SPECIFICATIONS FOR SIGN MATERIALS

#### INTRODUCTION

The Joint Board on Interstate Highways of the Bureau of Public Roads has proposed the following specifications for the material, fabrication, and finishing of road signs in wood, embossed metal, cast iron, cast steel, cast aluminum, or vitrified enamel, in accordance with the standard working drawings approved by the Association of State Highway Officials, and with these specifications.

#### MATERIALS

The materials to be used for the sign shall be designated by the purchaser and shall conform to the following specifications:

The wood shall be yellow poplar, redwood, white pine, yellow pine, fir, cypress, kiln dried, grading one face clear, other side free from wane, loose knots, or large pitch pockets, as may be designated and approved by the purchaser.

The sheet metal used for embossed signs or for the base of vitrified enamel signs shall conform to the following requirements, at the option of the purchaser.

(a) The total amount of carbon, phosphorus, sulphur, manganese, and silicon shall not exceed 0.7 per cent. If the total of these five elements equals or exceeds 0.2 per cent, the metal shall contain not less than 0.17 per cent of copper, and not more than 0.06 per cent of sulphur. If the total of these five elements is less than 0.2 per cent, the presence of copper is optional and sulphur shall not exceed 0.04 per cent.

(b) The metal shall be in commercial flat sheets.

The cast iron used shall conform to the American Society for Testing Materials Standard Specifications, Serial Designation A 47-24 or A 48-18 and subsequent amendments to date of contract, as may be indicated by the purchaser. Where adequate foundry control methods are enforced, special tests for physical properties of the separate heats used will not be required.

The cast steel used shall conform to the American Society for Testing Materials Standard Specifications, Serial Designation A 88-24 (semi-steel) and subsequent amendments to date of contract. Where adequate foundry control methods are enforced, special tests for physical properties of the separate heats used will not be required.

The cast aluminum used shall conform to the American Society for Testing Materials Standard Specification, Serial Designation B 26-21, Alloy E, and subsequent amendments to date of contract.

The paint used for metal signs, both for background and design colors, shall be of the enamel type, of a quality and character to permit baking, and shall produce a true color tone and a surface that is smooth, tough and without cracks or other blemishes. The yellow color tone, as indicated by reflected white light, shall show a dominant wave length of not less than 580 nor more than 588 millimicrons, a purity of not less than 80 per cent, and on integral reflection of pigment of not less than 35 per cent. A liquid color sample conforming to this specification will be furnished by the purchaser if demanded.

The enamel used for vitrifying shall either be a colored glass or shall have a glass base or carrier with pigment in suspension, so compounded that upon fusion it will produce glass of the required color.

The paint used on wooden signs, both for background and design colors, shall consist of pure linseed oil and of pigments of the best grade, together with pure gum turpentine and dryer. It shall produce a true color tone that will not change under exposure and a surface smooth, tough and without cracks or other blemishes. The yellow color tone as seen by reflected white light shall conform to the same standards that are specified for paint for metal signs.

#### FABRICATION

*Variation.*—All working drawings shall show finished signs, and die and pattern makers must make such allowances as may be required by the processes of manufacture. For wood signs the overall dimensions are nominal. For sheet metal the overall dimensions of finished signs may vary from the drawings by not more than one-sixteenth inch per foot for draw in embossing. For cast iron, cast steel and cast aluminum the overall dimensions of finished signs may vary from drawings not more than one-eighth inch per foot.

*Wooden Signs.*—Signs made of wood shall have tongue-and-groove glue joints parallel with the grain of the wood, the grain to run in the direction of the longer overall dimension of the finished sign; shall be thoroughly glued with a high-grade waterproof glue; and shall be reinforced with two battens securely fastened to each separate member of the sign. Sign boards and battens shall be of 1 inch stock, surfaced on all sides. Face of board when finished shall be a smooth plane surface.

*Sheet Metal Signs.*—Signs made of sheet metal shall be embossed or shall have a vitrified finish; and when embossed the details of the design shall be raised from the background of the design not less than 0.100 nor more than 0.125 of an inch. The finished embossing or vitrifying shall conform to the lines of the working drawings and shall be clear and even in outline and free from cracks or tears. The entire sign shall be free from wind, twist, or buckle, and the background shall be a substantially plane surface. Unless otherwise specified by the purchaser, all signs shall be of 18 gauge metal, U. S. Standard. If so specified, signs having a dimension of more than 22 inches lateral to the finished design shall be of 16 gauge metal, U. S. Standard.

*Cast Iron or Steel Signs.*—Signs of cast iron or steel shall be true to line and finish as specified under specifications for material. The background shall be not less than 0.160 of an inch in thickness, and the design shall be raised not less than 0.100 nor more than 0.125 of an inch. If the thickness of background is to be greater than the minimum specified above that fact shall be stated by the purchaser.

*Cast Aluminum.*—Signs of cast aluminum shall be true to line and gage and free from holes and coarse, pitted, or porous areas. The background shall be not less than 0.200 of an inch in thickness, and the design shall be raised not less than 0.100 nor more than 0.125 of an inch. If the thickness of the background is to be greater than the minimum specified above, that fact shall be stated by the purchaser.

#### FINISH

##### *Background Color*

- (a) Wooden signs shall have a primer coat, dipped, brushed or sprayed;

a second coat dipped, brushed or sprayed; and a finish coat, brushed or sprayed. Each coat shall be thoroughly dry before the next coat is applied. The finish coat, after drying, shall produce a semi-gloss finish and shall be free from brush marks, blisters, wrinkles or other blemishes.

(b) Embossed metal signs shall have one primer coat, dipped or sprayed, and at least one additional coat on the back and two additional coats on the face. The last coat shall be brushed or sprayed, and after the last background coat has been applied the sign shall be baked for not less than one and one-half hours at a temperature of 175°F. to 325°F., according to the requirements of the pigment and the carrier oils. The baking temperature and the rate of increase of temperature shall be so controlled as to produce a tough, flexible coating, not visibly darkened and entirely free from cracks, shrinkage, wrinkles, blisters, or other blemishes. Each background coat may be separately baked, but separate baking is not required.

(c) Vitrified enamel signs shall have a background finish consisting of a "slush," "grip," or "ground" coat, separately fused to the base metal. On this shall be applied the succeeding coats necessary to produce the design desired. All coats shall be so fused as to produce in the finished sign a single integral coat of enamel.

(d) Cast iron and steel signs shall have the background coat applied in the manner specified for embossed metal signs.

(e) Cast aluminum signs may be finished as bright castings without further treatment, or they may receive a coat of aluminum paint if the color code of the standard design specifies white. Baking will not be required for aluminum paint, but if the background color is applied with paint of the enamel type, the process used shall be that specified for embossed metal signs.

#### *Design Color*

(a) The design color on wooden signs shall be applied by hand or by process and shall dry to an even glossy black. The finished design shall be clear cut and sharp and the lines of all letters and details shall be true, regular and free from waviness, unevenness, furry edges or lines, and from all cracking, scaling, pitting, blistering, or blemish of any kind.

(b) The design color on embossed metal signs shall be applied by means of a roller or other suitable device until the equivalent of at least two wet coats has been applied. It shall then be baked in the manner required for the background color. The design color on vitrified enamel shall be applied as may be necessary to produce the desired colors and fused as required above. The finished design shall be clear cut and sharp, the lines of all letters and details shall be true, regular, and free from waviness, unevenness, furry edges or lines and from all cracking, scaling, pitting, blistering, or blemish of any kind.

(c) The design color on cast metal signs may be applied in the manner specified for embossed metal signs or may be built up with brushing or spraying lacquers that will bond thoroughly with the metal surface or the background coats.

## APPENDIX B

### UNITED STATES BUREAU OF STANDARDS SPECIFICATIONS FOR PAINT<sup>1</sup>

*General requirements.*—Mixed paint shall be well ground, shall not settle badly or cake in the containers, shall be readily broken up with a paddle to a smooth uniform paint of good brushing consistency, and shall dry within 18 hours to a full oil gloss without streaking, running, or sagging. Its hiding power shall be equal to that of a sample mutually agreed upon. The color shall conform to the specifications for metal signs. All these paints are good on wooden signs for three years before repainting and under favorable conditions will last even longer than this.

*White priming coat.*—The following is the formula for a gallon of white lead paint, which is sufficient to cover about 600 square feet.

#### *Formula for One Gallon of White Paint*

White lead in oil (B. S. Circular 84).....	lbs.	11
Raw linseed oil.....	pints	4
Turpentine .....	pints	1 2/3
Drier .....	pints	1/9

*White finishing coat.*—The following formulas are taken from Bureau of Standards Circular 215, to which reference is made for further particulars.

#### *Formula for Pigment of White Paint*

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Titanium pigment .....		50
Zinc oxide .....		40
Extending pigments .....	10	
Matter soluble in water.....	0.8	

The pigment shall contain no lead and no sulphur in the form of sulphide.

The titanium pigment shall contain 25 per cent titanium oxide, the remainder of it to be blanc fixe (precipitated barium sulphate).

#### *Formula for White Paint*

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Pigment .....	62	58
Liquid (containing at least 85 per cent linseed oil).....	42	38
Water .....	0.5	
Coarse particles and "skins" (total residue retained on No. 325 sieve) .....	1.2	

The weight per gallon shall not be less than 14 pounds. This paint will retain its whiteness longer than paint in which white lead is used for the finish coats.

<sup>1</sup> These specifications are intended to apply to paint used for street signs, and not for street markings.

*Black paint.*—The following formula is abstracted from Bureau of Standards Circular 94, to which reference is made for further particulars.

*Pigment for black paint.*—The pigment shall consist of carbon, lead oxide, insoluble mineral material, and, at the option of the manufacturer, oxide of iron. The pigment shall show on analysis not less than 20 per cent of carbon and not less than 5 per cent of lead oxide calculated as  $Pb_2O_3$ . The total of lead oxide, iron oxide, insoluble mineral material, and loss on ignition shall not be less than 90 per cent.

*Formula for Black Paint*

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Pigment .....	32	28
Liquid (containing at least 80 per cent linseed oil) .....	72	68
Water .....	0.5	
Coarse particles and "skins" (total residue retained on No. 325 screen) .....	1.5	

The weight per gallon shall not be less than 9 pounds.

*Yellow paint.*—The pigment shall be composed of chrome yellow (chemical precipitates of normal or basic lead chromates or mixtures of these with or without admixture of other insoluble compounds of lead), zinc oxide, and extending pigments.

*Formula for Pigment of Yellow Paint*

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Total lead weighed as $PbSO_4$ .....		50
Zinc oxide .....	40	
Extending pigments .....	Remainder	

*Formula for Yellow Paint*

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Pigment .....	50	45
Liquid (containing at least 90 per cent linseed oil) .....	55	50
Water .....	0.5	
Coarse particles and "skins" (total residue retained on No. 325 sieve) .....	2	
Iodine number of fatty acids prepared from paint, according to B. S. Circular 89 (Wijs method). 175.		

The pigment shall contain no sulphur in the form of sulphide.

*Green pigment.*—The pigment shall be a chrome green containing about 23 per cent of color (sum of lead chromate and insoluble Prussian blue), about 10 per cent of magnesium silicate, aluminum silicate, or similar siliceous material, and about 67 per cent of barium sulphate. It should be made by precipitating the color on the proper base rather than by mixing the individual materials. It must yield on analysis the percentages indicated below of the materials specified:



<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Color (total lead chromate and insoluble Prussian blue).		20
Lead compounds other than lead chromate (calculated as PbSO <sub>4</sub> ).....	5	
Material soluble in water, including Prussian blue.....	0.2	
Acid-soluble or water-soluble calcium in any form (calculated as CaO).....	0.5	
Material other than color and barium sulphate.....	15	

The remainder must be barium sulphate.

*Green paint.*—The liquid in the mixed paint shall contain not less than 90 per cent of pure raw linseed oil, the remainder to be combined drier and thinner. The thinner shall be turpentine, volatile mineral spirits, or a mixture thereof. The paint shall be well ground, shall not settle badly or cake in the container, shall be readily broken up with a paddle to a smooth, uniform paint of good brushing consistency, and shall dry within 18 hours to a full oil gloss, without streaking, running, or sagging. The weight per gallon shall be not less than 12 pounds. The paint shall consist of the following ingredients:

<i>Ingredients</i>	<i>Per cent</i>	
	<i>Maximum</i>	<i>Minimum</i>
Pigment .....	55	50
Liquid (containing at least 90 per cent linseed oil).....	50	45
Water .....	0.5	
Coarse particles and "skins" (total residue retained on No. 200 screen based on pigment).....	0.5	

*Red water-resisting enamel.*—The following specifications are abstracted from Bureau of Standards Circular, United States Government Standard Specifications, No. 66.

*General composition.*—Pure high-color strength toluidine red toner (meta-nitro-paratoluidine-azo-betanaphthol), free from any base or substratum, and the best water-resisting long oil spar varnish. The color and hiding power, if specified, shall be equal to those of a sample mutually agreed upon by buyer and seller. The enamel must conform to the following specifications:

Weight per gallon: Not less than 7½ pounds.

Pigment: Not less than 6 per cent by weight.

Coarse particles and skins (total residue retained on No. 325 sieve): Not more than 0.5 per cent.

Non-volatile matter: Not less than 60 per cent by weight.

Set to touch: In not less than 18 hours.

Dry hard and touch: In not more than 48 hours.

Working properties: Must have good brushing, flowing, covering and leveling properties and must not cake in container.

Water resistance: The dried film must withstand cold water for 18 hours and boiling water for 15 minutes without whitening, dulling or changing in color.

Toughness: The enamel must pass a 50 per cent Kauri reduction test of 24 degrees C. (75 degrees F.)

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