War Emergency Edition

Manual On Uniform Traffic Control Devices for Streets and Highways

American Association of
State Highway Officials

Institute of Traffic Engineers

National Conference on Street
and Highway Safety

WASHINGTON, D. C.
November 1942

Prepared with
advice and assistance
of the
War Department
and
Office of Civilian Defense

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WAR EMERGENCY EDITION

MANUAL ON

UNIFORM TRAFFIC CONTROL DEVICES

Introduction

By concurrent action the American Association of State Highway Officials, the Institute of Traffic Engineers and the National Conference on Street and Highway Safety in May 1942 appointed a Joint Committee of twenty-one members, seven representatives from each group, and charged the Committee with the responsibility of revising the *Manual on Uniform Traffic Control Devices*, originally issued in 1935 and last revised in 1939.

At its first meeting the Committee, recognizing the abnormal conditions imposed by the war effort, as particularly evidenced by the shortage of critical materials and the expanding requirements of the blackout and dimout, unanimously agreed to direct its energies to the preparation of a manual of emergency standards adapted to existing and foreseeable wartime conditions. To insure that the standards proposed would in all cases be consistent with the policies of agencies charged with the prosecution of the war and the organization of civilian defense, and to take full advantage of the experience of these agencies, the Committee membership was expanded, for the purpose of the preparation of the emergency standards, to include representatives of the War Department and the Office of Civilian Defense, and close liaison relations were established with the War Production Board.

Scarcity and even the complete lack of certain important material and equipment resulting from the demand of the war production program have been felt in all quarters. Adherence to generally accepted standards in many types of installations has become increasingly difficult. At the same time the migration of war workers and the influx of members of the armed forces into unfamiliar areas make even more urgent the preservation of recognized standards in control devices. Determination of what standards are of greatest importance in wartime traffic control and how they can best be maintained with limited or available substitute material define the first major function of the Committee.

Blackouts and dimouts present new and extremely critical conditions. These have already been encountered in coastal areas, and no section of the country is exempt from the possibility of their occurrence. Especially during winter nights, when traffic peaks occur in hours of darkness, an area unprepared for emergency conditions may, in the event of sudden blackout, experience either complete stoppage of traffic movement or conditions chaotic beyond description. Here is presented what is potentially the gravest problem ever faced by our civilian traffic officials. The military or civilian defense authorities are responsible for determination of limits of illumination that should be permitted under any particular condition of war emergency. For the protection of vital war establishments and for the safety of the population, these authorities must, as circumstances dictate, require the imposition of these restrictions. The military authorities are also responsible for providing mobility of the armed forces and their supplies during these restrictions in illumination. They have, by extensive research, devised vehicle lights that are safely within the maximum allowable limits for illumination and at the same time permit reasonable facility of movement of military and other essential vehicles.

Blackout specifications prepared by the War Department, which may be imposed by military authorities during specified periods and in specified areas, provide that only those vehicles equipped with approved blackout lights should move. The vehicles eligible for such equipment will be determined by the Office of Civilian Defense, in line with allocations of critical materials by the War Production Board. Until a sufficient number of approved lights become available for eligible vehicles, temporary modifications of the lighting requirements, at least for emergency vehicles, will probably be made. Traffic devices specified herein are affected to the extent that expedients depart from the approved intensity and beam pattern.

Until an area is declared a military theater of operations, control of nonmilitary traffic in blackouts will remain the responsibility of the civil officials. The difficulty of such control is increased by the fact that civilian vehicles will be operated largely by persons less familiar with blackout conditions than military personnel.

The other major function of the Committee is to serve as a liaison agency between the military and civil authorities, to bring to the civilian officials the benefit of the Army's and the Committee's independently conducted researches in the form of standard safety aids and control devices that will most effectively provide for the movement of authorized civilian traffic under emergency conditions.

In the interest of all possible conservation of materials, this *War Emergency Edition* avoids in the main changes in standards other than those actually necessary for the prosecution of the war. The Committee recognizes that numerous changes will be desirable when peace is restored, and a thorough revision of the standard manual is planned in anticipation of that time. The specifications herein set forth, except those dictated by blackout or dimout limitations or defense transportation requirements, are not retroactive as to existing traffic control devices, those transferred to new locations or those drawn from existing stocks.

The *War Emergency Edition* has two main divisions —I, covering standards applicable to normal conditions, i. e., wartime conditions when neither blackouts nor dimouts are in effect; and II, special standards required to meet blackout conditions. The Committee expects to prepare a third division covering standards to meet dimout requirements. Inasmuch as these requirements have not as yet been determined by the War Department, Division III will necessarily be deferred and issued as a supplement to the *War Emergency Edition.*

The existing supply of the *Manual on Uniform Traffic Control Devices* as revised in 1939 is nearly exhausted. Furthermore, it would be undesirable to have to refer constantly to two separate publications to discover which governs in any particular instance. The *War Emergency Edition,* therefore, though condensed, has been designed to be complete in itself so far as standards are concerned. There is, however, much useful explanatory and illustrative material in the older manual that is still of value. Therefore, to facilitate comparison and make it easy to refer to the more detailed discussions found in the older manual, Division I of the emergency edition retains the section numbers of the earlier volume throughout, omitting a few considered as not applicable to emergency conditions. It also retains the subdivision into Parts I, II, III and IV relating respectively to signs,

markings, signals and islands and the further subdivision into legal authority, application, design, location, installation, operation and maintenance. While this necessitates looking under various headings for full information regarding, for example, the STOP sign, it avoids the large amount of repetition necessary if each sign or other traffic control device is fully dealt with in one place.

Division II, dealing only with blackout traffic control devices, is much shorter than Division I, and does not retain comparable section numbers.

Definitions

The following words and phrases when used in this Manual shall be understood to have the meanings respectively ascribed to them:

Relating to HIGHWAYS and TRAFFIC

Street or Highway. The entire width between property lines of every way or place of whatever nature when any part thereof is open to the use of the public, as a matter of right, for purposes of vehicular traffic.

Roadway. That portion of a street or highway improved, designed or ordinarily used for vehicular travel.

Traffic. Pedestrians, ridden or herded animals, vehicles, street cars and other conveyances either singly or together while using any highway for the purposes of travel.

Traffic Control Devices. All signs, signals, markings and devices placed or erected by authority of a public body or official having jurisdiction, for the purpose of regulating, warning or guiding traffic.

Relating to SIGNS

Traffic Sign. A device mounted on a fixed or portable support whereby notice is given in the form of words or symbols, officially erected for the purpose of regulating, warning or guiding traffic. (SIGN is not interpreted to include road delineation markers or other reflecting devices not conveying a specific message but serving only as a general warning. See MARKINGS.)

Regulatory Sign. A sign used to indicate the required method of traffic movement or use of the public highway.

Warning Sign. A sign used to designate conditions which are actually or potentially hazardous to highway users.

Guide Sign. A sign used to direct or inform traffic.

Stop Sign. A regulatory sign indicating that traffic shall stop before proceeding.

Slow-Type Sign. A warning sign indicating that traffic should reduce speed for safety.

Caution-Type Sign. A warning sign indicating that traffic should proceed with caution in anticipation of a potential hazard which may require a reduction of speed for safety.

Route Marker. A guide sign indicating the proper route to a desired destination.

Relating to MARKINGS

Traffic Markings. All devices, lines, patterns, words or colors embedded in the surface, applied upon or attached to the pavement, curbing or adjacent objects, officially placed for the purpose of regulating, warning or guiding traffic.

Limit Line. A line to indicate the point behind which vehicles must stop in compliance with a STOP sign, traffic control signal, officer's stop indication or pedestrian right of way.

Center Line. The marked medial line of a roadway.

Lane Markings. Lines marking the lateral limits of traffic lanes.

Insert. A pavement marking accomplished by setting into or attaching to the pavement a material (other than paint) of contrasting color, practically flush with the surface.

Word Markings. Word messages to vehicle operators marked on the pavement.

Road Delineation Marker. Any reflecting device mounted at the side of the roadway to indicate, when used in a series, the alignment of the roadway. The same reflecting device may be used to indicate a localized hazard.

Relating to SIGNALS

Traffic Signal. A device other than a sign, using light which flashes or otherwise changes, or having moving parts, by which traffic is warned or is directed to take some specific action.

Traffic Control Signal. A signal, operated manually, electrically or mechanically, by which traffic is alternately commanded to stop and permitted to proceed.

Stop Signal. A flashing signal having the same function as a STOP sign.

Caution Signal. A flashing signal having the same function as a warning sign.

Signal Head. Housing containing one or more signal faces which may be designated accordingly as one-way, two-way, three-way, four-way or multi-way.

Signal Face. That part of a signal head capable of controlling traffic in a single direction, arranged with lights in either a vertical or horizontal row.

Signal Support. The physical means whereby a signal head is installed in a particular location.

Signal Installation. All of the equipment and materials involved in the signal control of traffic at one intersection.

Cycle. The number of seconds necessary in any signal installation to provide one complete sequence for all of the intervals required to start and stop each movement of traffic at the intersection.

Interval. That part of the cycle in seconds during which the traffic indication of any particular signal face does not change.

Manual Control. Operation of a traffic control signal by hand.

Automatic Control. Operation of a traffic control signal by a mechanism.

Combined Control. Operation of a traffic control signal by hand or by mechanism as desired.

Fixed Time Control. A type of automatic control in which consecutive cycles are equal and are made up of constant intervals.

Traffic-Actuated Control. A type of automatic control which is actuated, and in some cases limited, by impulses from individual vehicles or pedestrians, or both.

(a) *Full Traffic-Actuated Control.* Control in which all of the intervals are initiated or modified by impulses from traffic.

(b) *Semi-Actuated Control.* Control in which only some of the intervals are initiated or modified by impulses from traffic.

Independent Control. Operation of a traffic control signal installation not in coordination with any other signal.

Coordinated Control. Operation of two or more traffic control signal installations with definite interrelation.

Master Controller. A controller designed to supervise the operation of, and maintain a definite time relationship among, all interconnected controllers in a signal system.

Signal System. Two or more signal installations operating in coordination.

Offset. The number of seconds that the green indication appears at a given signal after a certain instant used as a time reference base.

Out-of-Step. That condition of a traffic control signal installation belonging to a signal system when its operation does not possess the intended relationship to the system.

Re-Coordination. Restoration of the intended interrelationship of operation of signals in a signal system.

Simultaneous System. A signal system in which all signals always give the same indication to a given street at the same time.

Alternate System. A signal system in which alternate signals, or groups of signals, give opposite indications to a given street at the same time.

Progressive System. A signal system in which the various signal faces controlling a given street give "GO" indications in accordance with a timing schedule to permit (as nearly as possible) continuous operation of groups of vehicles along the street at a planned rate of speed, which may vary in different parts of the system.

Flexible Progressive System. A signal system in which the intervals at any signal may be independently adjusted to the traffic requirements at the intersection, and in which the "GO" indications at separate signals may be started independently at the instant which will give the maximum efficiency.

Synchronous Motor. An automatic control mechanism which maintains a strictly constant time cycle.

Relating to ISLANDS

Loading Island. A safety zone especially provided at a regular street car or bus stop for the protection of passengers.

Pedestrian Refuge Island. A safety zone in a crosswalk.

Traffic Island. Any restricted area in a roadway which provides for the separation and directing of traffic streams.

Divisional Island. A traffic island so located longitudinally in a roadway as to separate traffic streams flowing in the same or opposite directions.

Channelizing Island. A traffic island located in or near a widely extended roadway area to prevent the promiscuous movement of traffic through the area and to restrict it to definite channels.

Rotary Island. A traffic island located in an intersection to eliminate direct crossing of vehicle paths by producing one-way counterclockwise vehicular flow around the island.

DIVISION I--NORMAL CONDITIONS

PART I--SIGNS

Introduction

Adequate traffic signs, properly located, are an important means of safeguarding and expediting traffic. The war emergency has in no way reduced this importance, though the emphasis has shifted to the needs of production and defense.

Extensive tests have clearly demonstrated that standard highway signs, at normally prescribed locations and heights, even if reflectorized, are of practically no value under the restricted illumination permitted by blackout regulations. On the other hand, the need for signs during blackouts is limited, and can best be met by other means than a general relocation of existing signs. Signs for blackout use therefore constitute an almost wholly independent problem, which is dealt with in Division II of this Manual. It is expected that dimout signs will require similar special treatment in a subsequent Division to be prepared when necessary data become available.

The standards here set forth are applicable to normal conditions of illumination. They are affected by the following considerations arising out of the emergency:

(a) Materials for the manufacture of signs are restricted and in many cases not available. Steel and other metals, chrome yellow paint, reflecting buttons, and even lumber, must be used sparingly or yield to substitutes.

(b) Special traffic movements, actual or potential, require special signing of selected routes.

To conserve materials, particular attention should be given to making the most effective use of signs. They should be installed only where control, warning or guidance is necessary for public safety or the efficient movement of essential traffic, as determined by facts and field studies. Changes in traffic characteristics may call for a reappraisal of local sign requirements. Some existing signs can be moved to other locations where new or greater need has developed. Wartime reductions in traffic speeds and volumes may relieve the

necessity for many sign installations "for the duration." Many informational signs, especially those designating geographical or cultural features, are interesting but hardly warranted under present circumstances.

Substitutions of non-critical materials in sign manufacture appear to be possible without too serious a relaxation of existing standards. Certain earth pigments will provide a substandard but acceptable substitute for lead chromate in the yellow paint prescribed for STOP, SLOW and CAUTION signs. Reflectorized coatings, available under several trade names, can be used on signs in place of elements requiring critical materials. Wood and numerous types of weather-resistant composition board have replaced critical metals satisfactorily, if not always economically. The salvage and re-use of old metal signs has assumed new importance. Even embossed signs can be flattened and refinished in new designs.

In many strategic areas civil and military authorities are cooperating in the planning of special emergency routes. These routes are of two general types: (1) mapped and marked routes that constitute an alternate system of highways, primarily for the use of civilian traffic if the major highways are taken over for military movements or are made unusable by enemy action, and (2) evacuation or other temporary routes planned in advance but posted only in the event of an actual emergency. For the first type a permanent marker is recommended, of the design shown in Figure 147.1. This design has already been adopted by a large group of northeastern States.

For the emergency marking of temporary routes a less formal type of marker is permissible. Colored arrows, to be used with occasional special destination signs are being made ready in some areas. The arrows should be used liberally, especially at intersections where there is possibility of confusion.

The marking of military routes is not ordinarily a responsibility of the civilian authorities.

Classification

Signs for traffic control are classified into three major functional groups which can be further classified as follows:

A. REGULATORY

1. Stop
2. Speed
3. Movement
   - (a) Turning
   - (b) Signals
   - (c) One-way
   - (d) Alignment
   - (e) Exclusion
   - (f) Pedestrian
4. Stopping and standing
5. Parking
   - (a) Prohibition
   - (b) Restriction
6. Miscellaneous

B. WARNING

1. Slow
2. Caution
3. Railroad advance
4. Railroad crossing

C. GUIDE

1. Route marker
   - (a) Route
   - (b) Route turn
   - (c) Direction arrow
   - (d) Junction
   - (e) Detour
2. Destination
3. Location
   - (a) Cities and towns
   - (b) Rivers and streams
   - (c) Mountains
   - (d) Historical sites
4. Information

Small reflecting units at the roadside have been widely used during recent years. These may be used to mark culverts and other hazards, or, in series, to indicate the alignment of the road. In the latter application they are known as "delineators." Although, like signs, they are mounted on posts and convey a warning to the driver, they are much more closely related to obstruction markings or guide lines. They are accordingly treated in this Manual as markings, in Part II.

Uniformity

Even moderate highway speeds, necessary for the conservation of tires and gasoline, require signs which

can be seen at long distances and understood almost instantly. The complexity of many modern intersections increases this need. Standardization of shapes, colors, design, application and location of signs is therefore essential.

Article I--Legal Authority

Section 101--Legal Authority

Traffic signs shall be placed only by the authority of a public body or official having jurisdiction for the purpose of regulating, warning or guiding traffic. No traffic sign or its support shall bear any commercial advertising.

Article II--Application

Section 102--Conditions Warranting Signs

Traffic signs shall be used only under conditions where regulation, warning or guidance are necessary to provide public safety or convenience or to facilitate the movement of essential traffic.

Section 103--Uniformity of Application

Traffic signs shall be applied uniformly. Identical conditions shall always have the same application of signs, no matter where the particular conditions occur. Each sign shall be displayed for one definite and specific purpose only.

Section 104--Degree of Emphasis

Where conditions require increased emphasis, it shall be attained by one or more of the following methods:

(a) Dimensions increased (proportionately) above the specified minimum standard.
(b) Sign supports marked with standard colors for better daylight visibility.
(c) Reflectorization or illumination for better night visibility.
(d) Use of an advance warning sign, as where a curve or other obstruction in the approach hides the sign.

Section 105--Regulatory Signs

Regulatory signs, disregard of which constitutes a misdemeanor, are essential to indicate the applicability of legal requirements that would not otherwise be apparent. Great care must be exercised so that they are erected wherever needed to fulfill this purpose, but unnecessary mandates should be avoided.

Section 106--STOP Signs

A STOP sign shall be used only under the following conditions and then only where it is necessary that vehicles be required to stop before proceeding:

(a) Where restricted view or accident record indicates the need.
(b) Intersection of two main highways.
(c) Intersection of a secondary with a main highway.
(d) Railroad grade crossing where a stop is required by law.
(e) Approach to a drawbridge where a stop is required by law.

STOP signs should be used only where warning signs would be inadequate. Use at less dangerous points fosters disregard of all STOP signs. Isolated STOP signs, as in (a) above, should not be installed unless based on visibility, speed and accident studies.

Section 107--Other Regulatory Signs

Other regulatory signs shall be erected only as specific promulgations of legal operating requirements.

Section 108--Speed Signs

Where signs are erected to indicate changes in speed limits, they shall normally show merely the limit applying to the zone to be entered.

Since a 35-mile speed limit has been established by order of the Office of Defense Transportation, SPEED LIMIT 35 should be used in place of the END SPEED ZONE sign formerly prescribed for highways without a set speed limit.

Where for enforcement purposes new State legislation is deemed necessary, advisory WAR SPEED 35 signs may be used in the interim. If adequate publicity is given to the 35-mile limit as a war measure, the need for speed signs along the highway may be greatly reduced.

Section 109--Movement Signs

109a. *Turning* signs shall be used at all intersections, whether or not controlled, where left, right and/or "U" turns are prohibited.

109b. *Traffic signal* regulatory signs are often desirable in conjunction with signals to indicate the speed for which signals are timed, for special directions, and for other purposes.

109c. *One-way* signs shall be erected at every intersection where one-way traffic is in force on one or more highways and traffic could otherwise enter in the wrong direction. They may also be necessary at channelized intersections, and on divided roadways where traffic entering from minor highways must turn to the right.

109d. *Alignment* signs may be used where it is necessary to keep traffic to certain lanes, either to facilitate the movement of through and turning traffic or to prevent overtaking and passing at hazardous points.

A NO PASSING sign should be used at the approach to a hillcrest, curve or other hazard on an important 2-lane or 3-lane highway where there is not a clear view ahead a sufficient distance to permit overtaking and passing in safety, and there should also be placed an END NO PASSING ZONE sign indicating the point beyond which the prohibition does not apply.

109e. *Exclusion* signs shall be used where it is necessary, for military reasons or otherwise, to exclude all vehicular traffic, or certain stated kinds of traffic, from the roadway.

109f. *Pedestrian* signs should be used to guide or regulate pedestrian movements.

Section 109.1--*Stopping* and *Standing* Signs

There are some points where it is desirable, at least during certain periods of the day, to prohibit even the momentary stopping of any vehicle except when necessitated by conflicting traffic or traffic-control requirements. There are other points where such momentary stopping is permissible to allow a person to alight from or enter the vehicle, but where longer waiting, even with the driver at the wheel, is objectionable. No Stopping and No Standing signs are prescribed to cover these situations.

Section 110--*Parking* Signs

110a. *Parking prohibition* signs shall be used to indicate areas where parking is prohibited at all times. They shall also be used to indicate areas where parking is prohibited part of the time or to certain classes of vehicles, and shall indicate the nature and limits of the prohibition.

For the prevention of possible sabotage, stopping, standing and parking should be prohibited near bridges, viaducts and tunnels, and, where requested by proper authority, in the vicinity of vital plants or facilities.

110b. *Parking restriction* signs shall be used to indicate areas and limits where parking is restricted, and shall state the restriction.

Section 111--Warning Signs

Warning signs shall be used only to indicate physical or operating hazards.

Section 112--Slow-Type Signs

A slow-type sign should be used only for the following conditions where permanent physical hazards always require a reduction in speed for safety:

(a) Turns having radii of less than 200 feet.
(b) Curves having radii of 200 feet or more where conditions require a reduction in speed.
(c) Reverse curves.
(d) Successions of curves with or without short tangents.

(e) Hills having downgrades of 6 percent or more.
(f) Dips.
(g) Narrow bridges or roadways.
(h) Other points of limited clearance.
(i) Drawbridges.
(j) Safety zones or similar obstructions.
(k) Intersections which do not warrant a STOP sign but are sufficiently hazardous to require a reduction in speed.
(l) Street-car crossings and turns.
(m) Advance warnings of obscured STOP signs.
(n) Stated speed locations.

CURVE signs should be used only where a reduction of speed is required for safety because of degree of curvature, visibility, width of pavement, banking or similar conditions.

A REVERSE CURVE sign should be used only to indicate two curves in opposite directions separated by little or no tangent. In case of a double reverse curve or a number of distributed curves close together, a WINDING ROAD sign should be used.

A HILL sign should be used in advance of downgrades exceeding 6 percent, and at grades exceeding 10 percent a stated speed sign should be used. The following warrants are suggested:

On a 6-percent grade, more than 2,000 feet long
7-percent grade, more than 1,000 feet long
8-percent grade, more than 750 feet long
10-percent grade, more than 500 feet long
15-percent grade, more than 200 feet long
Over 15 percent grade, any length.

The sign should be used where the percent or length of grade is less than above indicated if the grade is also on a sharp curve.

NARROW signs should be used to indicate the beginning of a reduction in width of pavement on any highway, where reduced clearance between vehicles constitutes a hazard.

A SAFETY ZONE sign should be used at the approach end of every safety zone, and should indicate by arrows whether traffic is permitted to pass only to the right of the zone, or may also pass to the left.

Appropriate slow-type signs should be placed in advance of tunnels, low bridges, viaducts and similar fixed structures which have limited road widths or limited overhead clearance. In addition, information signs should state the amount of clearance or width.

A slow-type sign should also be used in advance of a STOP sign not visible a sufficient distance ahead.

Section 113--Caution-Type Signs

A caution-type sign should be used only for the following conditions where there is a potential operating hazard, requiring vehicles to proceed with caution:

(a) Highway intersections.
(b) Advance warning of traffic-control signals.
(c) Road construction or repairs.
(d) Other temporary road conditions.
(e) Military establishments and war production plants.
(f) Pedestrian zones.
(g) Animal crossings.

Section 114--Choice of Intersection Signs

The intersection sign with the least restricting effect and inconvenience that will serve the purpose at each intersection should be used.

The following is the normal order of installation:

(a) Caution-type sign, indicating the presence of an intersection.
(b) Slow-type sign, indicating a computed approach speed.*
(c) STOP sign.

Section 115--Railroad Advance Warning Signs

A railroad advance warning sign shall be placed on each approach to every railroad grade crossing except that of a minor siding or spur.

A minor siding or spur is one infrequently used, where a member of the train crew guards the crossing

* For methods of computing safe approach speed, see "Public Safety Memo No. 73," National Safety Council, "Normal Safe Approach Speeds at Intersections," American Automobile Association, and "Policy on Intersections at Grade," American Association of State Highway Officials. These several methods are discussed in pages 192-197 of the "Traffic Engineering Handbook," published by the Institute of Traffic Engineers and the National Conservation Bureau.

during its use. Regulatory officials should recognize that many sidings and spurs normally little used are at present carrying substantial traffic and should be protected by advance warning and crossing signs.

Section 116--Railroad Crossing Signs

A RAILROAD CROSSING sign shall be placed on each side of the tracks at every railroad grade crossing except that of a minor siding or spur.

Both of these signs are necessary, regardless of further protection by signals, gates or flagmen.

Section 117--Guide Signs

Guide signs should be used at intersections where it is important to furnish the traveler with directional and locational information.

During the emergency these signs should be kept to a minimum to conserve materials.

Section 118--Route Markers

Route markers shall be used only to indicate:

(a) U S, State, county and city routes.
(b) Special war transport routes and routes serving war production plants.
(c) War emergency routes, including special civilian and evacuation routes.

Route markers should be placed at all intersections on a marked route where traffic would be likely to lose the route, such as:

(a) At all important intersections.
(b) At all intersections where the route turns.
(c) At all irregular intersections, such as a Y, a T, or where the roadways meet at irregular angles.
(d) At all intersections where the type of surface changes.
(e) In cities on straight streets at intersections a few blocks apart.

Route markers should also be placed along the highway at random intervals as necessary to prevent uncertainty between intersections.

Section 119--Route Markers at Intersections

A turn in a route at an intersection shall be indicated by (1) a route marker with the letter "R" or the letter "L" in advance of the intersection, (2) a route marker with confirmatory arrow at the intersection, and (3) a confirmatory route marker beyond the turn.

When some routes proceed straight through an intersection while others turn, confirmatory route markers for all of the routes going straight through shall be placed conspicuously on the far side of the intersection.

Except in the case of the confirmatory marker, each route marker at an intersection shall have its own directional marker. Where this is a letter it shall be immediately below the route marker. Where it is a turn or straight-through arrow, it shall be immediately below or a part of the route marker. Straight-through shall be indicated by a vertical arrow pointed upward.

The marking of special emergency routes on short notice may be simplified by a liberal use of directional arrows, both as advance and as confirmatory markers.

Section 120--Route Junction Markers

When a marked route is crossed or joined by another route, the junction may be indicated on each route as it approaches the intersection by an auxiliary junction sign over or in combination with a marker indicating the other route.

Section 121--Overlapping Routes

When one highway serves for two or more routes which go straight through the intersection, the route markers for all shall be placed on the same post.

Section 122--Route Markers on Auxiliary Routes

Route markers shall be used on route detours and on alternate, bypass and temporary routes in the same manner as on regular routes, except that each marker shall have mounted above it an auxiliary sign indicating the type of auxiliary route.

A special detour route marker consisting of an arrow carrying the word DETOUR may be used in place of the combination of route marker and auxiliary detour sign.

A large supply of detour signs should be kept available in areas where highways are liable to damage from enemy action.

Section 123--Destination Signs

Destination signs may be placed at intersections and other points where it is important to inform traffic of the direction and distance to various destinations.

During the war emergency such signs should be used sparingly to conserve materials. Principal dependence is to be placed on route markers.

Section 124--Location Signs

Location signs showing names of places, geographic features and the like are to be regarded as generally nonessential during the emergency.

Section 125--Information Signs

Information signs, usually for the primary benefit of the tourist, are also nonessential, with the following exceptions:

125a. *Limited Clearance.* In addition to a warning sign at a point of limited clearance, an information sign shall be placed indicating the amount of clearance.

125e. *Air Raid Emergency Facilities.* The location of air-raid shelters, first-aid stations and similar emergency facilities may be indicated by suitable highway signs.

Article III--Design

The general plan of this system of signs is based on the principle that each functional group shall have a distinctive significance indicated by shape and color combination. It is only by reducing the hundreds of necessarily different signs to functional groups that they can be made intelligible to motorists traveling at high speeds under complex conditions. Reduced wartime speeds do not warrant relaxation in essential uniformity of design.

Supplementing the details of design specified in the succeeding sections and the illustrations appende

to this Manual, detailed drawings are available through the U. S. Public Roads Administration.

Section 126--Shape and Color

All signs shall be of the shape and color indicated in the table below. They shall have a narrow border, ordinarily of the same color as the message, just inside the edge. For 24-inch signs this border shall be of $\frac{3}{8}$-inch width, set in $\frac{3}{8}$ inch from the edge, and for other signs approximately in proportion. It is recommended that square corners be rounded on a radius of $1\frac{1}{2}$ inches.

TYPE	SHAPE	COLOR	
		BACKGROUND	MESSAGE
Regulatory			
Stop	Octagon	Yellow	Black
Speed	Vertical rectangle	White[1]	Black
Movement			
Turning	Vertical rectangle	White	Black
Signals	Vertical rectangle	White	Black
One-way	Arrow[2]	White	Black
Alignment	Vertical rectangle	White	Black
Exclusion	Vertical rectangle	White	Black
Pedestrian	Vertical rectangle	White	Black
Stopping and standing	Vertical rectangle	White	Red
Parking			
Prohibition	Vertical rectangle	White	Red
Restriction	Vertical rectangle	White	Green
Miscellaneous	Vertical rectangle	White	Black
Warning			
Slow	Diamond[3]	Yellow	Black
Caution	Square	Yellow	Black
Railroad advance	Circle	Yellow	Black
Railroad crossing	Cross-buck	White	Black
Guide			
Route marker			
U S	Shield	White	Black
State, county or city	Special		
War emergency route[4]	Square	White	Black
Auxiliary signs	Horizontal rectangle	White	Black
Destination	Horizontal rectangle	White	Black
Location	Horizontal rectangle	White	Black
Information	Horizontal rectangle	White	Black

1. In reflectorized coatings "white" shall be understood to embrace materials having a substantially white appearance by day and reflecting white light by night.

2. Alternate, horizontal rectangle with arrow on it (see section 142).

3. Square with one diagonal vertical.

4. See Section 147.1.

The standard chrome yellow normally used for the yellow signs listed above may not be available during the war emergency. Rather than abandon yellow altogether, the Joint Committee favors substitution of the best yellow shade available in a non-critical pigment. If yellow cannot be obtained, white may be used.

In some reflectorized signs, particularly the STOP sign, it is permissible to use a panel of contrasting color to make the main message more legible.

Section 127--Materials

Wartime shortages demand that signs be made of whatever suitable material can be obtained. Wood and numerous types of weather-resistant plywood and composition board have been used with success in place of the usual steel. Temporary emergency signs may be made of heavy cardboard, preferably reinforced by light wooden strips. (See appendix II.)

Section 128--Dimensions

All signs shall have the minimum dimensions shown in subsequent sections covering detailed designs. Where conditions require greater visibility necessitating a larger sign, the sign, including symbol or message, shall be enlarged proportionately in all its dimensions.

Where available dies or other manufacturing considerations prevent exactly proportionate enlargement of letters or figures, the nearest size in a standard alphabet should be used.

Section 129--Message - Wording

Where wording is used, the text shall be adequate to convey to the driver a clear concept of the message, using the fewest possible words.

The wording and arrangement for each type of sign shall be as specified in subsequent sections.

The main message shall be given preference over the secondary message as to location and size of lettering.

Section 130--Letters and Figures

Letters and figures shall be of the rounded style and of standard proportions, in accordance with the alphabets[1] available through the U. S. Public Roads Administration.

Tests have shown that rounded letters and figures are more easily legible than the block letters hitherto standardized. The rounded style offers no difficulty in sign manufacturing processes not involving the use of dies. To conserve materials, changeover from dies having block letter designs should not be made during the war emergency.

Section 131--Message - Symbols

The appropriate symbol shall take the place of a word message on turn, curve, railroad advance warning and caution-type intersection signs and shall supplement the word message on destination signs. Where the rectangular one-way sign is used, it also shall carry a symbolic arrow.

Section 132--Legal Authority

When specified by law or regulation, legal authority for a sign shall be expressed in suitable wording at the bottom inside the border in letters not more than ½ inch in height.

Section 133--Illumination or Reflectorization

All stop, slow-type and railroad advance warning signs shall be illuminated or reflectorized so as to be visible at night from all distances up to 350 feet. All illuminated signs shall be extinguishable on short notice or be otherwise conformable to War Department blackout or dimout specifications.

The symbols and/or main messages of stop, slow-type and speed-limit signs, and both the cross and letters "RR" of railroad advance warning signs, shall be illuminated or reflectorized.

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1. Rounded alphabets are being developed by the Public Roads Administration, but are not all available at the time of issue of this Manual. Inasmuch as the new series are not exactly equivalent to the old in width, it may be necessary in some instances to use different series from those indicated in section 140 and subsequent detail-design sections.

Adequate illumination is generally to be preferred to reflectorization, where cost is not a controlling element. No method of illumination or reflectorization should be employed that will materially reduce daylight legibility.

Section 134--Method of Illumination

Illumination may be by means of:

(a) A light, within or behind the sign, illuminating the main message, whether symbol or word. The light may be flashing or steady.

(b) An attached or independently mounted floodlight focused on the face of the sign.

Illumination of signs shall be white, except that flashing red self-illumination may be used in the lettering on STOP signs.

Section 134.1--Method of Reflectorization

Either the message or background of a sign may be reflectorized. Reflectorization of symbols or messages shall be white. If the background is reflectorized it shall be white or yellow in accordance with the color scheme outlined in section 126.

To improve legibility through greater contrast, a panel of a color to contrast with that of the message may be used.

Section 135--Combination Sign and Signal

Whenever signals in the form of flashing beacon lights are used in combination with standard signs as part of the design, the color of the flashing light shall conform with the code of color meanings specified in Section 362.

Section 137--Sign Posts and Their Foundations

Sign posts and their foundations shall be so constructed as to hold the sign rigidly in a proper and permanent position and prevent it from swaying in the wind.

During the emergency wood posts, preferably treated, may be substituted for the more usual metal posts. As a further means of conserving materials, signs may be attached to utility poles or other existing supports

where these are available at the proper locations. Utility poles should be used only with the permission of the controlling company. Signs constitute a hazard for pole-climbing workmen that can be justified only by the emergency need for economizing in materials.

Section 139--Attachment of Signs

If rust-proof metal is not available for attaching signs to their supports, suitable paint or other protection should be used to prevent the development of rust stains that may impair legibility.

Section 140--Detailed Design of STOP Sign

The design and specifications of the standard STOP sign shall be as follows:

(a) Shape - Octagon, with two sides vertical.
(b) Colors - Yellow background, black letters and border. White illumination or reflectorization (or flashing red self-illumination) of word "stop," or reflectorized background. Contrasting horizontal panel, 8 inches high, optional.
(c) Minimum dimensions - 24 by 24 inches.
(d) Main message - *Stop*, located in center.
(e) Secondary message - *Through Traffic*, *Road End*, *Rail Road*, or *Draw Bridge*, located above and below word "stop."
(f) Letters - "STOP" in 6-inch letters, Series E; secondary message in 3-inch letters, Series B.

Section 141--Detailed Design of Other Regulatory Signs

The design and specifications of other regulatory signs (Figs. 141a-c) except the ONE-WAY sign shall be as follows:

(a) Shape - Rectangular, with longer dimension vertical.
(b) Color - White background, black letters and border, except on parking, stopping and standing signs; red letters and border for prohibited parking, stopping and standing; green letters and border for limited parking.
(c) Message and dimensions - One of the messages in the following table, with corresponding minimum dimensions of letters and sign as indicated:

Message	*Minimum Dimensions Letters Inches*	*Series*	*Sign Inches*
	Speed Regulations		
Speed Limit 35	4 or 8	C or D	18 by 24
War Speed 35	4 or 8	C or D	18 by 24
End Mile Speed	4	C	18 by 24
	Turning Regulations		
No Turns	4 or 4	D or B	12 by 18
No Right Turn	4 or 3	C or B	12 by 18
No Left Turn	4 or 3	D or D	12 by 18
No "U" Turn	4 or 3	D or D	12 by 18
	Signal Regulations		
Signals Set for M.P.H.	3 or 2	D or B	12 by 18
Watch Traffic Signals	3	B	12 by 18
Limit Line	4	C	12 by 18
	Alignment Regulations		
No Passing	5	B	18 by 24
End No Passing Zone	3	C	18 by 24
Keep Right - Pass in Center Only	3	B	18 by 24
Keep in Single Line	4	B	18 by 24
Form Lines	5 or 4	C or C	18 by 24
Double Arrow (for "Pass Right or Left")			18 by 24
	Exclusion Regulations		
One Way. Do Not Enter	4	B	18 by 24
Vehicles Excluded	4	B	18 by 24
Motor Vehicles Excluded	4	B	18 by 24
Commercial Vehicles Excluded	3	B	18 by 24
Trucks Over Tons Excluded	3	B	18 by 24
Tractors with Lugs Prohibited	3	B	18 by 24
No Thoroughfare	4 or 3	D or A	18 by 24

Message	Minimum Dimensions Letters Inches	Letters Series	Sign Inches
Pedestrian Regulations			
Cross on Green Light Only	3	B	12 by 18
	2	C	
	1½	C	
Cross on Walk Signal Only	3	B	12 by 18
	2	C	
	1½	C	
Cross at Crosswalks	3	C	12 by 18
	2	C	
No Pedestrian Crossing	3	D	12 by 18
	2	C	
	2	B	
Walk on Left Facing Traffic	3	C	18 by 24
Stopping and Standing Prohibitions			
No Stopping	3	D	12 by 18
	2	B	
No Standing	3	D	12 by 18
	2	B	
Parking Prohibitions			
No Parking at Any Time	3	D	12 by 18
	2	C	
No Parking This Side	3	D	12 by 18
	2	C	
No Parking Here to Corner	3	D	12 by 18
	2	C	
No Parking Street Car Stop	3	D	12 by 18
	2	C	
No Parking Safety Zone	3	D	12 by 18
	2	C	
No Parking Theater Exit	3	D	12 by 18
	2	C	
No Parking Passenger Zone	3	D	12 by 18
	2	C	
	2	B	
No Parking Loading Zone	3	D	12 by 18
	2	C	
No Parking Bus Stop	3	D	12 by 18
	2	C	

Message	Minimum Dimensions Letters Inches	Letters Series	Sign Inches
Parking Restrictions			
Parking Hour	{3 2}	{D C}	12 by 18
Parking Diagonal	2	B	12 by 18
Parking Parallel	2	B	12 by 18
Parking on Pavement Only	{2 2}	{C B}	12 by 18
Live Parking Only	{3 2}	{D C}	12 by 18
Miscellaneous Regulations			
No Dumping Allowed	{3 2}	{D C}	12 by 18
Load Limit Tons per Axle	2	C	12 by 18

Special conditions may necessitate other messages than those above. If so, they should be brief and simple.

Section 142--Detailed Design of ONE-WAY Sign

The design and specifications of the standard ONE-WAY sign (Fig. 142) shall be as follows:

(a) Shape - Arrow (alternate, rectangle with arrow on it).
(b) Color - White arrow, black letters, black background if rectangle is used. White illumination or reflectorisation of letters, or reflectorized arrow.
(c) Minimum dimensions - 36 inches long by 12 inches high.
(d) Letters - 3½ inches, Series C, centered on shaft of arrow.
(e) Message - *One-way*.

The sign shall be so attached as to prevent turning to give wrong direction.

Section 143--Detailed Design of Slow-Type Sign

The design and specifications of the standard slow-type sign (Figs. 143a,b) shall be as follows:

(a) Shape - Diamond (square with diagonal vertical).
(b) Colors - Yellow background with black letters and border. White illumination or reflectorization of symbol or message, or reflectorized background.
(c) Message and dimensions - One of the messages in the following table with corresponding minimum dimensions of letters and sign as indicated:

Message	*Minimum Dimensions* *Letters* *Inches*	*Series*	*Sign* *Inches*
Arrow bent to right (symbol for right turn)			24 by 24
Arrow bent to left (symbol for left turn)			24 by 24
Symbol for T intersection			24 by 24
Arrow curved to right (symbol for right curve)			24 by 24
Arrow curved to left (symbol for left curve)			24 by 24
Reverse curve (symbol)			24 by 24
Winding road	4	D	24 by 24
Hill	8	E	24 by 24
Dip	6	F	24 by 24
	4	E	
	2	F	
Narrow Bridge	4	C	24 by 24
One-Lane Bridge	4	C	24 by 24
Narrow Road	4	C	24 by 24
Draw Bridge	4	C	24 by 24
Low Bridge	4	C	24 by 24
Underpass	5	B	24 by 24
Pavement Ends	4	C	24 by 24
Safety Zone (with arrow)	3	D	24 by 24
Car Line	4	D	24 by 24
Tunnel	6	C	24 by 24
Viaduct	5	C	24 by 24
Stop Sign Ahead	4	B	24 by 24
Slow to Miles	4	D	24 by 24
	3	C	

Section 144--Detailed Design of Caution-Type Sign

The design and specifications of the standard caution-type sign (Figs. 144a-d) shall be as follows:

(a) Shape - Square with two sides vertical.

(b) Colors - Yellow background with black letters and border. For signs requiring night visibility, white illumination or reflectorization of symbol or message, or reflectorized background.

(c) Message and dimensions - One of the messages in the following table, with corresponding minimum dimensions of letters and sign as indicated:

Message	Minimum Dimensions Letters Inches	Letters Series	Sign Inches
Diagram of Intersection			24 by 24
Traffic Signals Ahead	4	C	24 by 24
Men Working	4	C	24 by 24
Road Work	4	D	24 by 24
Detour Ahead	4	C	24 by 24
Road Closed	4	C	24 by 24
Fresh Oil	5	C	24 by 24
Fresh Tar	5	C	24 by 24
Loose Stone	5	C	24 by 24
Loose Gravel	5	B	24 by 24
Rough Road	5	C	24 by 24
Slippery When Wet	5	B	24 by 24
Rough Shoulder	5	B	24 by 24
Soft Shoulders	5	A	24 by 24
School	6	B	24 by 24
Playground	4	B	24 by 24
Church	6	B	24 by 24
Hospital	4	C	24 by 24
Quiet Zone	5	C	24 by 24
Crosswalk	5	C	24 by 24
Cattle Guard - 300 Feet	4 3½ 2	D C D	24 by 24
Bridle Path	4	D	24 by 24

Diagrams of intersections should indicate with reasonable accuracy the angles of the highways forming the intersection, reading upward with the highway of approach vertical on the sign. It is helpful to differentiate by weight of line between important and lesser highways.

Section 145--Detailed Design of Railroad Advance Warning Sign

The design and specifications of the standard railroad advance warning sign (Fig. 145) shall be as foll

(a) Shape - Circle.
(b) Colors - Yellow background with black symbol, letters and border (white background in States so requiring by law). White illumination or reflectorization of symbol or message, or reflectorized background.
(c) Minimum dimensions - 30 inches in diameter.
(d) Letters - 6-inch, Series E.
(e) Message - Diagonal cross in 2½-inch lines, and letter "R" in each side quadrant.

Section 146--Detailed Design of RAILROAD CROSSING Sign

The RAILROAD CROSSING sign shall be of the crossbuck type and shall conform to the design and specifications adopted by the Association of American Railroads.

Section 147--Detailed Design of U S Route Marker

The design and specifications of the standard U S route marker (Fig. 147) shall be as follows:

(a) Shape - Shield.
(b) Color - White background with black letters and border. White illumination or reflectorization of numerals, or reflectorized background.
(c) Minimum dimensions - 16½ by 16 inches.
(d) Letters - 2-inch, variable width as required.
(e) Numerals - 5-inch, variable width.

Section 147.1--Detailed Design of Emergency Route Markers

For the temporary marking of emergency routes on short notice colored arrows and special destination signs are suggested. For the more permanent marking of an alternate system of highways the following design specifications, already adopted by a substantial group of eastern States, are recommended as a basis for standardization (Fig. 147.1):

(a) Shape - Square.
(b) Color - White background with black letters and border. White illumination or reflectorization of message, or reflectorized background.
(c) Minimum dimensions - 18 by 18 inches.
(d) Numerals - 6-inch, Series D.
(e) Letters - "Civil", 4-inch, Series C; name, 1½-inch, variable width as required.

Colored markers may be used to indicate different types of temporary emergency routes. It should be noted, however, that such routes may have to be used under black-out conditions, in which case reflectorization is necessary for visibility, and color differences will be recognizable only to a limited degree.

Section 148--Detailed Design of Auxiliary Signs for Use with Route Markers

The design and specifications of standard auxiliary signs (Figs. 148a-d) for use with U S route markers shall be as follows:

148a--*Directional Letter* "R" or "L" (to indicate in advance of an intersection that the route deviates to the right or left).

(a) Shape - Shield similar to route marker.
(b) Color - White background with black letter and border. White illumination or reflectorization of letter or reflectorized background.
(c) Minimum dimensions - 9 by $8\frac{1}{2}$ inches.
(d) Letter - 5-inch, Series E.

148b--*Directional Arrow* (to indicate at an intersection that the route deviates to the right or left).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black arrow and border. White illumination or reflectorization of arrow, or reflectorized background.
(c) Minimum dimensions - 15 by 8 inches.

148c--JUNCTION sign (to give advance indication of points where other routes meet or cross the one marked).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black letters and border. White illumination or reflectorization of letters, or reflectorized background.
(c) Minimum dimensions - 20 by 8 inches.
(d) Letters - 4-inch, Series B.

148d--DETOUR sign (to be used in conjunction with route markers to indicate a route temporarily used as a detour).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black letters and border.

(c) Minimum dimensions - 20 by 8 inches.
(d) Letters - 4-inch, Series C.

148e--ALTERNATE ROUTE sign (to be used in conjunction with route markers to indicate alternate route).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black letters and border.
(c) Minimum dimensions - 20 by 8 inches.
(d) Letters - 4-inch, Series A.

148f--BYPASS ROUTE sign (to be used in conjunction with route markers to indicate bypass around congested urban area).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black letters and border.
(c) Minimum dimensions - 20 by 8 inches.
(d) Letters - 4-inch, Series B.

148h--TEMPORARY ROUTE sign (to be used on road not intended as a permanent part of the route).

(a) Shape - Horizontal rectangle.
(b) Color - White background with black letters and border.
(c) Minimum dimensions - 20 by 8 inches.
(d) Letters - 4-inch, Series A.

Section 149--Detailed Design of Main Destination Sign

The design and specifications of the standard main destination sign shall be as follows:

(a) Shape - Rectangle with longer dimension horizontal.
(b) Color - White background with black letters and border. White illumination or reflectorization of letters and symbols, or reflectorized background.
(c) Dimensions - At least 15 inches high and long enough to accommodate names and arrows.
(d) Letters - Minimum, 6-inch, Series B.
(e) Symbols - Direction arrow opposite each name. (A vertical arrow means straight ahead.)

Section 150--Detailed Design of Secondary Destination Sign

The design and specifications for the standard secondary destination sign shall be as follows:

(a) Shape - Rectangular slat with longer dimension horizontal.
(b) Color - White background with black letters and numerals.
(c) Dimensions - 36 by 6 inches.
(d) Letters - 4-inch, Series B.
(e) Symbols - One end and opposite corners painted black to indicate head and tail of a direction arrow.

If the specified length is too short to accommodate the desired place name, the slat may be lengthened, but all slats displayed on the same post shall be of the same length. In no case shall the letters and numerals be less than 4 inches high.

Section 151--Detailed Design of Location and Information Sign

The design and specifications of the standard location and information sign shall be as follows:

(a) Shape - Rectangle with longer dimension horizontal.
(b) Color - White background with black letters and border.
(c) Minimum dimensions - 18 by 12 inches.
(d) Letters - 4-inch or larger.

Article IV--Location and Installation

The location and installation of traffic signs has become increasingly difficult with increasing speeds and traffic density. The war has temporarily and locally checked this trend, but has also brought new problems for solution.

Design for long-distance visibility is of little value if the sign is poorly located. On wide highways a sign on the road shoulder is often obscured by other traffic, or is outside effective headlamp illumination. Signs should be so placed as to indicate clearly where the message is applicable, and, in the case of caution signs, to give sufficient advance warning for appropriate response.

Overhead suspension is to be discouraged because it requires the use of cable and other critical materials.

At certain complex intersections on multi-laned highways, however, overhead signs may be an effective and economical alternative to confusing or expensive systems of roadside signs.

The method of installation is secondary to the place of installation. During the emergency, material can be saved by mounting signs temporarily on utility poles (see section 137) and other supports already present, provided that such supports are in approximately the correct location.

Section 152--STOP Signs

STOP signs at highway intersections shall be located at the crosswalk or limit line or, in the absence of a crosswalk, not more than 30 feet from the intersected roadway.

STOP signs at railroad grade crossings shall be located 15 to 50 feet from the nearest track.

STOP signs at draw bridges shall be located exactly where it is desired that vehicles stop.

If a STOP sign cannot be placed exactly where vehicles are expected to stop, a limit line should be installed at the stopping point. If curves or grades in the highway reduce visibility, an advance warning sign reading "Stop Sign Ahead" should be used.

Section 153--ONE-WAY Signs

ONE-WAY signs shall be placed on both corners of the outlet of a one-way street or highway, as well as at mid-block entrances thereto, as from alleys and filling stations.

When a two-way street is changed to a one-way movement, the exit shall be protected with a ONE-WAY -- DO NOT ENTER sign located on the right-hand corner or in the parking lane adjacent to the point.

Section 154--Parking, Stopping and Standing Signs

Parking, stopping and standing signs shall be placed at the first and last point where the legal requirement is effective.

They should be placed at intervals of about 100 feet where the requirement applies continuously for a considerable distance. (To conserve materials, this distance may be increased to as much as 250 feet during the emergency.)

Section 155--Other Regulatory Signs

Other regulatory signs shall be located where a legal requirement is to be made effective.

Section 156--Railroad Advance Warning Signs

Railroad advance warning signs shall be located normally about 350 feet from the railroad crossing in rural areas, but not more than 450 feet or less than 200 feet; a minimum of 100 feet in municipalities.

The distance will depend on local conditions, particularly prevailing speeds, and should be sufficient to permit a vehicle to stop short of the crossing if necessary.

Section 157--RAILROAD CROSSING Signs

RAILROAD CROSSING signs shall be located 15 feet from the nearest rail of the nearest track.

Section 158--Slow-Type and Caution-Type Signs

Slow-type and caution-type signs shall be located at a distance in advance of the hazard equal to a safe braking distance for vehicles at speeds commonly used by drivers approaching such a point, but in no case less than 100 feet.

Section 159--Route Markers

Route markers at an intersection shall be placed on the far right corner of the intersection.

Route markers set beyond an intersection to "pull" traffic through shall be located not more than 100 feet from the intersection, and in plain view from the approach side of it.

Advance route markers should be placed a sufficient distance in advance of the intersection to give ample warning to motorists approaching at reasonable speed

and should be in advance of any special lane marking approaching the intersection.

Section 160--Destination Signs

Destination signs on major routes at or in advance of intersections shall be substantially at right angles to the direction of travel which they are primarily intended to serve.

Section 161--Proximity of Signs

Normally, two signs for different purposes should not be placed closer together than 100 feet, if it can reasonably be avoided. During the emergency, especially in view of reduced speeds, a disregard of this rule is justified as a means of saving materials. Route markers and warning signs therefore may conveniently be mounted on the same post.

Section 162--Position in Relation to Roadway

Signs other than temporary signs in the roadway shall be placed on the right side of the roadway and approximately at right angles to it. They shall not be located on the insides of curves, in sags in the profile or behind objects which would obstruct their view.

At traffic circles, or other points where there is a sharp change in alignment, signs or markers on the far side of the roadway, directly ahead of the driver, may be justified. Signs on traffic islands also constitute an exception to the general rule.

Overhead signs should, so far as practicable, be centered above the traffic lane or lanes to which they apply.

Section 163--Lateral Distance from Pavement or Roadway

Where a raised curb exists, signs should be set so that no part of the sign shall be less than twelve inches back of the curb line.

On improved highways where no curb exists, signs should be erected at the outside edge of the graded shoulder, not to exceed ten feet from the edge of the surfacing.

Section 164--Height

On rural highways, where vehicles do not park in front of the sign within the required visibility, the center of the sign should be 3½ feet above the crown of the pavement. This also applies to signs on fixed obstructions in the roadway.

In business or residential areas, or wherever a raised curb exists, the center of the sign should be 8 feet above the pavement.

Overhead signs shall be placed high enough to clear safely vehicles of maximum legal height.

Article V--Maintenance

Poor maintenance detracts from the authority of signs. During the war emergency a special effort will have to be made if essential signs are to be kept in serviceable condition. Substitute materials may be expected to fail sooner than preferred materials. Certain replacements will not be obtainable. Unessential signs should be removed altogether, rather than be allowed to fall into a disreputable condition. The following are minimum standards of maintenance.

Section 165--Continuous Maintenance

All traffic signs shall be kept in good order and clearly legible at all times. Signs damaged or destroyed shall be replaced within 24 hours.

Section 166--Schedules for Cleaning and Repainting

Signs shall be cleaned and inspected for repainting at least once a year.

Section 167--Prompt Removal of Obsolete Signs

Signs no longer applicable shall be removed immediately.

PART II--MARKINGS

Introduction

Pavement, curb and object markings constitute an important segment of traffic control devices. Although they have very definite limitations, pavement markings are preferable to signs for certain conditions and they transmit warnings or other information to the driver without diverting his attention from the roadway. The only factor necessitating a change in standards during the war emergency for normal driving conditions is that certain paints, particularly yellow paint, contain materials that are or may become critical. However, since pavement markings are essential for blackout and dimout conditions and the changes necessary to make them most effective for these conditions also increase their effectiveness during normal driving conditions, standards that are necessary during blackouts and can be obtained with little or no increase in cost have been included in this Division. By following this procedure, the revisions or additional markings required in case the blackout or dimout condition arises will be reduced to a minimum.

Classification

While there is considerable similarity in function and application of markings on pavements and curbs, they have little in common with the marking of objects as warnings of hazards. Consequently these two major classifications of markings will be treated in separate groups, thus:

A – Regulatory and guidance markings on pavements and curbs
B – Warning markings on objects of hazard (including curbs when they are hazards)

Standardization

Most markings are individually simple as compared with signs, but they cannot be as completely standardized because of variety of type and application.

The characteristics that have been standardized and should be followed when markings are used are location, colors and design or pattern of marking, including width of lines and dimensions of certain designs.

A--REGULATORY AND GUIDANCE MARKINGS

Article A-I--Legal Authority

Section 201--Legal Authority

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

Article A-II--Application and Location

Section 202--Lines on Pavements

Lines are marked on pavements for regulatory purposes as follows:

(a) Center of roadway
(b) Traffic lanes
(c) No passing zones in conjunction with center lines and traffic lane markings
(d) Turning limits and street-car clearances at turns
(e) Boundaries of pedestrian crosswalks
(f) Limit or stop lines at through highways and signalled intersections
(g) Approach to an obstacle or reduced roadway width
(h) Boundaries of safety zones
(i) Parking limits and stalls
(j) Change from two-way to one-way street
(k) Approaches to railroad crossings and highway intersections
(l) Pavement edges

Arrows are marked on pavements for directional purposes to indicate the center of a route to be followed. Words are used to indicate lanes for various turning movements at intersections.

Section 203--Center Lines

Center-line markings are desirable under all conditions on hard surfaced roads having an even number of lanes and shall in every case be placed on the following pavements:

(a) On two-lane pavements carrying average annual volumes in excess of 2,000 vehicles per day.
(b) On two-lane pavements narrower than 20 feet carrying average annual volumes in excess of 1,000 vehicles per day.
(c) On two-lane pavements narrower than 18 feet carrying average annual volumes in excess of 500 vehicles per day.

Center-line markings shall be placed on all two-lane pavements carrying average annual volumes in excess of 300 vehicles per day at the following locations:

(a) On the approaches to the crest of a hill where the clear view ahead is less than 500 feet.
(b) On and 100 feet in advance of and beyond any curve having a radius of less than 600 feet or where the clear view ahead is less than 500 feet.
(c) On the approach to a traffic control signal or arterial highway for a distance of not less than 100 feet from the limit or stop line, and as much more as may be necessary to cover the distance within which vehicles are commonly aligned.

Center-line markings should also be placed at locations where the accident record indicates the need for a center line and on hard surfaced roads in areas where the entire roadway is likely to be obscured frequently, as by fog.

The center of four-, six-, and eight-lane undivided roadways shall be marked with two barrier lines as described in Section 226.

In some instances on 4-lane sections where parking is restricted during certain hours to provide two lanes of moving traffic in each direction, but where crossing the center line is permissible during other hours, a single solid center line should be used. Lane lines should then be broken to distinguish them from the center line.

Section 204--Lane Markings

Lane markings on the pavement shall be used:

(a) On all highways with an odd number of traffic lanes where the center lane is not of a contrasting color.
(b) At important intersections, pedestrian crossings and dangerous locations.
(c) On curves where the roadways are wide enough to accommodate four or more traffic lanes.
(d) At congested locations where the roadway will accommodate more traffic lanes than are normally used when there are no lane lines. These include:

1. Locations between safety zones and sidewalk curbs.
2. Other locations where the normal lane width is decreased.
3. Approaches to widened intersections.

Longitudinal lines used to form lanes should normally be so spaced across the roadway as to allow not less than 10 feet of width for each lane of moving traffic and not less than 7 feet for vehicles parked parallel to the curb. In certain restricted areas, as in (d) above, it may be necessary to reduce these widths somewhat.

It is very important to distinguish the lane lines from the center-line marking on multiple-lane roads.

Section 204.1--No-Passing and Barrier Markings

On two-lane highways marked with a center line in zones where overtaking and passing is dangerous and unlawful there shall be marked alongside the center line, on the side from which crossing the line is prohibited, a barrier line as described in Section 226. (See Figure 204.1a.)

On three-lane highways and on other highways marked with an odd number of traffic lanes, a combination of lane-line and barrier-line markings as described in Section 226 shall be used:

(a) To prevent the use of the center lane where the clear view ahead is insufficient for safe passing. (See Figure 204.1b.)
(b) To discontinue the center lane:

1. At railroad grade crossings and signalized intersections.
2. Where the normal pavement width is decreased, as at narrow bridges, or where parking prevents the full use of all lanes for moving traffic. (Pavement markings similar to those shown in Figure 213a should be used for these conditions.)

No-passing zones for two- and three-lane highways shall be determined and indicated separately for traffic in each direction. The marking shall restrict traffic in each direction to the right lane within the limits of the no-passing zone, but shall permit passing when the road opens up to view.

The no-passing zone for the purpose of marking two- and three-lane highways should vary with the speed of traffic on the particular highway. However, in view of the restricted speeds during the emergency, marking no-passing zones only where the sight distance is less than 500 feet will generally be satisfactory.

Where the distance from the end of one no-passing zone to the beginning of the next is less than 300 feet, the no-passing line should be continuous to connect the two zones.

Lane markings should not be depended upon solely to prevent overtaking and passing in hazardous areas, but such areas should be marked by *No Passing* signs as indicated in Section 109d.

At steep grades on routes carrying a large percentage of slow-roving trucks an added lane is sometimes provided on two-lane roads for trucks ascending the grade. Such added truck lane shall be of a contrasting color or marked to distinguish it from the other lanes, and appropriate signs shall be used.

During the emergency it may be necessary to eliminate additional construction and increase the capacity of three-lane highways near war industries where there are high hourly traffic volumes, including a high percentage of heavily loaded trucks, by permitting uphill traffic on steep grades to use two lanes.

Marking a three-lane highway to permit traffic going uphill to use two lanes shall be made in accordance with Figure 204.1c and only when the following conditions exist:

(a) The grade is in excess of 5 percent for at least 1,000 feet or 3 percent for 2,000 feet.
(b) The sight distance is less than 500 feet at one or more points on the grade.

When two long grades have a common crest both may be marked for uphill traffic to use two lanes except at the crest, where use of the center lane must be prohibited for at least one direction.

Section 205--Street-Car Clearance Limits

Curved lines should be marked on the pavement to indicate the limits and clearance of the overhang on turning street cars.

Section 206--Crosswalks

Crosswalks shall be marked at all intersections where there is material conflict between vehicular and pedestrian movement. Where special emphasis is desired it shall be obtained by limit lines as described in Section 207.

Marked crosswalks shall also be provided at other appropriate points where there is substantial pedestrian movement, as at long loading islands, where pedestrians are permitted to cross between intersections, and where pedestrians could not otherwise determine the proper crossing.

Section 207--Limit Lines

Limit lines shall be used where it is important to indicate the point behind which vehicles are required to stop in compliance with a *Stop* sign, traffic control signal, officer's stop indication or pedestrian right-of-way.

A limit line, designed in accordance with Section 228, may either be placed in advance of a crosswalk or it may coincide with the nearer crosswalk line and extend across all approach lanes.

The word "*Stop*" shall never be marked on a pavement or any other surface where a stop is not always required.

Section 208--Approach to an Obstruction

Lines shall be marked on the pavement to give warning of the approach to an obstruction in the roadway. (See Part IV-Islands.)

At the approach to intersections with dangerous obstructions and at traffic circles, arrows should be placed on the pavement at a slight angle to give an advance warning to drivers of the direction they must turn to avoid the obstruction.

Section 209--Boundaries of Safety Zones

The pavement area restricted for use as a safety zone shall be marked by lines and buttons in cases where no raised platform has been installed. Their use should however be supplementary to the installation of adequate end and side protection of the zone in accordance with the standards presented in Part IV (see Sections 409 and 410).

The use of lines, buttons or lines and buttons without other protection to designate a so-called safety zone is *dangerous* and *is not recommended.*

Section 210--Pavement Markings for Parking Space Limits

In addition to discouraging encroachment on fire hydrant zones, bus stops, taxicab stands, loading zones, approaches to corners and clearance spaces for islands, pavement markings for parking-space limits are effective in outlining the edges of the paved surfaces and preventing collisions with parked vehicles during blackouts. In cases where angle parking is permitted, the marking of lines to indicate the limits of stalls reduces the waste space.

Section 211--Route Directions

Special directional markings consisting of a series of arrows or arrows and route numbers in the center of the lane can sometimes be used to route traffic as a supplement to present markers or where directions could not be indicated by any other means.

Section 212--Approach to Railroad Crossing

Pavement markings as described in Section 233 shall be used at all paved approaches to railroad crossings except minor sidings or spurs or in urban areas when other protection is afforded.

Section 213--Pavement Edges

Line markings on the pavement may be located along the sides of the roadway, especially on bridges, to indicate the limit of safe approach to the edge of the pavement. They are also of benefit at night on dark-colored surfaces. When used they shall supplement rather than replace the center and lane lines.

Pavement edge lines, although helpful, are not a sufficient warning at points where the pavement width changes to a lesser number of lanes. Diagonal guide lines, a guardrail or reflectorized guide posts, as shown by Figures 213a, b, and c, shall be used where feasible.

213.1--Road Delineation Markers

Although their use has been rather limited up to the present time, road delineation markers are effective aids for night driving when placed either continuously along the roadway or only for short sections at

hazardous locations. They are more effective than pavement edge lines, which may be confused with lane- or center-line markings. Another important feature in certain areas is that they are visible when there is snow on the ground.

Delineators shall be used:

(a) Along all rural highways where it is not possible to place a center line as required by Section 203;
(b) On and 500 feet in advance of all curves sharper than 12 degrees where a center line is required by Section 203, even though there is a center-line marking; and
(c) As required by Section 213; where there is a change from a wider to a narrower pavement width.

Section 214--Word Markings

Word markings on the pavement shall not be used for mandatory messages without supporting signs.

Word markings on wide pavements to indicate lanes for various turning movements at wide intersections are effective only when limited to two or three words.

Section 215--Button Markings

Buttons that project several inches above the pavement, whether illuminated or not, shall not be used at any point where they can interfere with traffic.

Buttons may be used to mark non-traffic areas in a wide pavement but must be supplemented by line markings on the pavement.

Section 216--Curb Markings

Curb markings may be used to indicate areas along the curb where parking is restricted or prohibited. When used they shall conform to curb markings for blackout conditions and shall supplement rather than replace signs.

ARTICLE A-III--DESIGN

Section 217--Lines on Pavements

Lines may be marked on pavements by:

(a) Construction joints in the pavement, filled with material of contrasting color, except as provided in Section 218.
(b) Construction of the pavement with adjacent strips of different materials showing variation of surface.
(c) Paint or other material of contrasting color applied to the surface alone or in combination with glass beads or other materials to increase the visibility of the line.
(d) Inserts set into or attached to the body of the pavement.

Section 218-- Construction Joints

Construction joints shall not be accepted as adequate pavement line markings unless filled with a material of a different color than the pavement and then not for the following conditions:

(a) Transverse pavement markings.
(b) Center-line markings on 4-, 6- or 8-lane roads.
(c) Center- or lane-line markings at important intersections.
(d) Center-line markings at points where a no-passing or barrier line is used.
(e) Center-line markings on 2-lane roads carrying traffic volumes that exceed to any great extent the lower limits indicated by Section 203.
(f) Center- and lane-line markings at congested locations or where accident records indicate the need of a more visible marking.

At locations where the alignment of the road has been changed and there are construction joints at an angle with the roadway, all center and lane lines must be painted to eliminate the possibility of traffic using the construction joints as pavement markings.

Section 219--Contrasting Pavement Materials

Many roadways wider than required for two traffic lanes are built with a single lane of concrete pavement on each side of the roadway and macadam or other material between. The surface of this medial area has a different color and surface texture from the concrete and serves very effectively to hold the opposing streams of traffic apart so that the center is used only for passing. Whenever the contrasting colors do not indicate the proper lane widths, such as where surfaces have been widened, painted lane lines should be provided in cases where they would otherwise be unnecessary.

Lane surfaces of contrasting colors shall not be accepted as providing adequate lane- or center-line markings at intersections, pedestrian crossings or dangerous locations.

Section 220--Paint and Similar Materials With and Without Glass Beads

Painting is a satisfactory method of indicating all mandatory pavement markings.

A continuous improvement in paints and equipment and methods of application have resulted in a very marked increase in the use of pavement markings. Trucks are in use that are capable of placing a center line and the required barrier lines on a highway while operating at the rate of 10 miles per hour. Hand equipment can be used to place intersection and special markings at a reasonable cost.

A rather recent development is the use of glass beads to increase the reflecting qualities of a painted line. While the beads have little or no effect in the daytime, the visibility of lines at night using either blackout or normal headlights is greatly increased when the beads are properly applied. Although the initial cost of the line is considerably higher when glass beads are used, some agencies have found that the increased life, especially at heavily traveled locations, more than compensates for the difference in cost.

Section 221--Inserts

Inserts such as a narrow strip of colored concrete, rectangular blocks or disks set into the pavement to give the appearance of a line are not recommended for emergency markings or where there is a likelihood that roadway conditions will be altered.

221a--*Rectangular* inserts when used shall be of a permanent color different from that of the pavement, and shall be set so that their upper surfaces are flush with the level of the pavement. They shall be set end to end to form a continuous line, or they may be separated by spaces not greater than the length of a single insert so that the appearance will be that of a broken line.

221b--*Round* inserts when used shall show a bright surface contrasting with that of the pavement under the action of traffic, shall be not less than 4 inches in diameter and shall be spaced not more than 16 inches apart center to center on transverse lines or more than 36 inches apart center to center on longitudinal lines. (They may be set as much closer together as desired.) They shall have a rounded surface so that a smooth contour will be presented to the wheels of vehicles, and they shall not project more than ½ inch above the level of the pavement. They shall be permanently fixed in place by anchor bolts or some similar effective device.

Section 222--Widths of Lines on Pavements

Lines marked on pavements shall be not less than 4 inches wide except that longitudinal lines may be 3 inches wide when glass beads are used in combination with the paint.

Ordinarily longitudinal lines should be not more than 6 inches wide and transverse lines not more than 24 inches wide. Studies have shown that for blackout conditions 4-inch transverse lines with 4-inch perpendicular lines 3 feet long spaced 2 feet center to center on the side of approaching traffic to give a "Comb" effect are more visible and effective than solid lines 2 feet wide. It is therefore recommended that this design with perpendicular lines up to five feet long be used during the emergency in place of wide transverse lines where it is desired to obtain special emphasis and provide for blackout conditions. (See Figure 2

Section 223-- Lengths of Longitudinal Broken Lines

The length of longitudinal broken lines and the intervening spaces shall be within the following limits:

Center lines and lane markings, lines at least 15 feet, spaces not more than 25 feet.
Street-car clearance lines, 2- to 4-foot lines and spaces.
Traffic guide lines, 4- to 10-foot lines and spaces.

Broken lines are used in place of solid lines either as a means of reducing the amount of paint used or to distinguish center lines from barrier lines and lane lines from center lines. The results of studies indicate that when the same quantity of paint is used per mile of highway for two longitudinal broken lines within the above limits, the one with the shorter spaces is the more effective, especially during blackouts.

An arrowhead shall be placed on each section of a traffic guide line.

Section 224--Words on Pavements

The letters on pavements should be greatly elongated in the direction of traffic movement because of the small angle at which approaching drivers view the letters. If more than one word is used, the separating space should be about twice the height of the letters and the first word of a series should be placed so as to be reached first by the traffic.

Section 225--Colors for Lines or Words on Pavements

White, yellow and black are the colors commonly used to show the strongest contrast with the pavements. Black paint has been used mainly for center or lane markings on concrete pavements where the joints are filled with a black elastic material. White paint, however, is rapidly replacing black paint for this purpose. At night, especially with the blackout headlight, black lines cannot be seen as well as white lines even on pavements with relatively light colored surfaces.

Black paint shall not be used in any case for markings at approaches to intersections or railroad crossings or for words, arrows or transverse lines.

The use of yellow paint shall be reserved for barrier line markings and curb markings where parking is restricted except during blackouts.

The chromium in yellow paint may become a critical material during the emergency. Yellow paints satisfactory for pavement marking can be obtained, however, by substituting earth pigments for the major portion of the chromium ordinarily used. This procedure is recommended rather than changing to white paint for barrier lines. However, where white paint has been used for barrier lines its use should be continued for the duration of the emergency.

Section 226--Barrier Lines and Markings to Prohibit Overtaking and Passing at Hazardous Points

Auxiliary markings to indicate zones on 2-lane highways where overtaking and passing is prohibited and to confine traffic traveling in one direction on a 3-lane highway to one lane shall be by means of barrier lines in addition to center or lane lines. A center line may be omitted when a double barrier line is used to prohibit traffic from crossing the center of a 4-, 6- or 8-line highway. All barrier markings shall be solid lines either white or preferably yellow, as wide as the center or lane lines when of a different color and 2 inches wider than the center or lane lines when of the same color. When dashed lines are used for the center line, solid barrier lines of the same color and width are permitted. Barrier lines shall be applied as shown by Figures 204.1 (a, b and c) and 213 (a, b and c).

Section 227--Crosswalks

Both boundaries of a marked crosswalk shall be indicated by white-line markings across the entire roadway. Such lines shall be at least 4 inches wide at urban intersections and at least 12 inches wide at rural locations or where there is no intersection. Special emphasis, if required, shall be obtained by a limit-line design as described in Section 228.

Section 228--Limit Lines

Limit lines, if used, shall be at least 16 inches wide and extend across all approach lanes, except that when special emphasis is desired for both normal and blackout driving conditions, the comb design as described in Section 222 shall be used (see Figures 222 and 228).

Section 229--Approach to an Obstruction

Pavement markings to give warning of approach to an obstruction shall be as follows:

(a) At high-speed or rural locations, three lines, consisting of two white lines starting 6 inches outside of each corner of the approach end of the obstruction and converging at a point distant at least 20 times the offset distance and not less than 100 feet, from which point a single white line shall be extended 100 feet farther from the obstruction, and a single barrier line for approaching traffic (see Figure 229). The area between the two white lines should be striped as shown by Figure 229.

(b) At low-speed or urban locations, two lines, consisting of the one white line starting at the right of the obstruction and the barrier line as described in (a).

Section 230--Pavement Markings for Parking Regulations

Pavement markings to indicate parking regulations, when used, shall be as follows:

(a) Where parallel parking is prohibited during certain periods, a series of lines approximately 7 feet long perpendicular to the curb spaced at least 20 feet apart. Where parking is permitted at all times, an additional continuous line approximately 7 feet from and parallel to the curb.

(b) Where angle parking is permitted, a series of lines spaced approximately 9 feet apart, measured at right angles to such lines, and located at the established angle with the curb to form parking stalls. Angle parking stalls should not be marked unless there is an area at least 15 feet wide parallel to the curb that is not needed to form traffic lanes 10 feet wide.

Section 231--Curb Markings for Parking Prohibitions

Curb markings where parking is prohibited at all times, when used, shall be alternate black and white vertical stripes not less than 6 inches or more than 12 inches wide on both the top and face of the curb.

Curb markings to designate parking prohibition during certain rush periods, parking being permitted at other hours and during air raids, shall be yellow, or bright red in case yellow paint cannot be obtained.

Where curb markings are used to indicate parking prohibitions, their effectiveness has been increased by a line running perpendicular from the curb approximately 7 feet into the roadway at each end of the curb marking.

Section 232--Route Directions

Where a line of arrows is marked on the pavement to indicate a route direction, such line shall be located in the center of the lane of traffic that is to follow the designated course (see Figure 232).

Direction arrows shall be marked on the approaches to a loading island when vehicular traffic is permitted to pass only to the right of the island.

Section 233--Approach to Railroad Crossings

Pavement markings to indicate railroad grade crossings shall be made according to the design shown by Figure 233.

Section 234--Pavement Edges

Pavement-edge lines, when used, shall be substantially wider than any other longitudinal lines at that point.

Where a guide-line marking is used near the edge of a pavement at a transition from a wider to a narrower pavement, the length of the edge line shall be at least 20 times the offset distance and shall supplement rather than replace the reflectorized guideposts or guardrail required wherever feasible (see Figures 213 a, b and c).

Section 234.1--Road Delineation Markers

When bidirectional delineators are used on both sides of a road, those on one side shall be directly opposite the ones on the other side.

When used only at sharp curves, all markers shall be bidirectional and placed on the outside of the curves on 2-lane roads and both sides on roads wider than 2 lanes.

All delineators shall be mounted at a uniform height from the crown of the road surface and at a uniform distance from the traveled portion of the roadway. For normal night driving the preferable height is 42 inches. For blackout driving a lower mounting is necessary (see Division II).

The spacing between delineators shall be uniform, preferably not more than 100 feet, when used on tangent sections and sufficiently close on curves to assure that at least three units are visible at all times. When the spacing is decreased at curves, the change in spacing shall be accomplished by a gradual transition in the spacings.

In some cases where a uniform spacing cannot be maintained due to particular conditions, such as at a crossroad, it has been found desirable to omit one unit rather than vary the spacing. The arrangement of bidirectional markers on the outside of a sharp curve only is preferred to an arrangement on both sides, since it minimizes confusion as to the direction and extent of the curve. The inside markers are relatively ineffec-

tive at sharp curves on 2-lane roads and offer little justification for their expense, except possibly at locations such as those subject to frequent heavy fogs.

Such markers used in series shall be white.

Single units to indicate hazards, such as ends of culverts, may be white or red. If red they should be of such design and shape as not to be mistaken for automobile tail lights.

Article A-IV--Maintenance

Section 235--Continuous Maintenance

During the war emergency all necessary traffic markings shall be kept in good order and clearly visible at all times.

B--WARNING MARKINGS ON HAZARDOUS OBJECTS

Article B-I--Legal Authority

Markings on objects as a warning of their hazardous location are subject to the same jurisdictional restrictions as are those on pavements and curbs for the regulation and direction of traffic.

Article B-II--Application and Location

The application and location of markings on obstacles should be such that they will be visible to all approaching traffic during blackouts when only the standard blackout lamps are in use.

Section 236--Object Markings

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

Typical obstructions of this character are bridge supports, monuments, traffic islands, beacon or signal supports, loading islands, "Road Closed" barriers, railroad and drawbridge gates, end posts of narrow bridges, underpass piers and abutments, culvert headwalls, guardrails, sign posts, poles, trees and rocks.

Frequently obstructions have been placed in roadways under the mistaken belief that they would serve as aids to the control of traffic. Such installations include signal pedestals in the centers of intersections, sign or signal posts in the center of the roadway at railroad crossings, and mushroom buttons in active traffic areas. These should invariably be removed for safety. Only such immovable obstructions as bridge supports and necessary islands may be permitted to remain. The construction within intersections of small channelizing islands with curbs that are not for pedestrian protection should be discouraged during the war emergency. In their place, markings on the surface of the pavement that will not be an obstruction to emergency vehicles during blackouts should be used.

Section 237--Curb Markings on Obstructions

Curb markings shall be placed on all curbs around obstructions, including islands in the line of traffic flow. At T- and offset intersections, on important thoroughfares, curb markings in the line of approaching traffic are desirable for normal driving conditions and necessary when blackout conditions exist.

Article B-III--Design

Section 238--Markings on Obstructions

Obstructions in the roadway, including curbs in the line of traffic, shall be marked with not less than five alternate black and white stripes visible to approaching traffic at a safe stopping distance. The stripes shall slope downward in the direction of travel of the observing traffic, at an angle of 45 degrees with the horizontal, except on curbs, where the stripes may be vertical. The markings shall be painted on the object itself or on an independent surface mounted directly in front of the object.

Markings should be extended as close to the pavement surface as possible. For reflecting or illuminating requirements see Section 242.

Section 239- Markings on Adjacent Objects

Guardrails, trees, rocks and other objects adjacent to the roadway when painted white are effective in facilitating night driving.

Section 240--Dimensions of Stripes on Objects

Stripe markings on objects shall be of uniform width, not less than 4 inches or more than 12 inches.

A curb at the end of an island or the post supporting a sign would not require stripes of more than the 4-inch minimum width, while a large surface, such as the abutment wall flanking an underpass, might warrant marking stripes 8, 10 or even 12 inches wide, depending upon its area. The wider stripes are easier and less expensive to mark.

Section 242--Illumination and Reflecting Elements

Wherever an obstruction exists in the direct line of traffic flow in a roadway, white-paint markings thereon shall be reflectorized with glass beads or other reflecting material so as to make them clearly visible to approaching traffic with both blackout and normal headlamps.

As a supplementary measure of precaution, it is also advisable to mount on the obstruction an appropriate sign with reflecting elements. Materials for new flood-lighting installations will probably not be available during the war emergency. During blackouts the illumination used for normal driving conditions must be extinguished or greatly reduced in intensity. It is therefore recommended that wherever possible the surfaces be reflectorized rather than illuminated. Reflectorization involves a minimum of critical materials and can also be accomplished in a manner that will be effective during blackout conditions.

Section 243--Approach to Obstructions

In addition to the markings on the face of an obstruction in the roadway, warning of approach to the hazard shall be given by line markings on the pavement as stated in Section 229.

Article B-IV--Maintenance

It is as important to keep markings on obstacles clearly visible as in the case of pavement and curb markings, but since they are not subject to traffic wear, they do not need to be renewed so frequently. The instruction contained in Section 235 should be observed.

PART III - SIGNALS

Introduction

Highway traffic signals include all power-operated devices using light, by which traffic is warned or is directed to take some specific action. Thus they are distinguished from illuminated or reflecting signs.

Traffic signal equipment will be increasingly difficult to obtain because the materials which normally go into its manufacture are needed for other vital uses in connection with the war effort. This means that signal installations will be limited and full advantage will have to be taken of all equipment now on hand. If equipment is urgently needed and cannot be obtained by transfer from other locations or other available sources, application may be made to the War Production Board for priority rating to assist in the purchase of new equipment. Appendix I is intended as a guide in the event it becomes necessary to resort to the purchase of new equipment.

Classification

Signals are classified as follows:

A. TRAFFIC CONTROL (Stop and Go)

1. Fixed time
   - (a) Independent
   - (b) Simultaneous
   - (c) Alternate system
   - (d) Progressive system
2. Traffic actuated
3. Manually operated semaphores[1]

B. FLASHING

1. Caution
2. STOP
3. Train - approach

The basic functions and design of the two principal groups of signals are quite different, and for convenience are treated separately.

Standardization

All types of signals can be substantially standardized as to design, location and operation, and it is of

1. Manually operated semaphores must be recognized as traffic control signals. As those in present use are fairly uniform and readily understood, however, and their use is diminishing, they will not be further treated in this Manual.

primary importance that there be national standardization of such features as affect the public participation in traffic movement. During the war, emergency standards, substitute materials and restricted light output are required. Such standards and requirements are herein presented.

Train-approach signals are of great importance at railroad crossings. Their design and operation have been standardized by the Association of American Railroads, and the outstanding features of these standards are recorded herein.

Value of Signals

Signals, particularly traffic control signals, involve considerable public expense and the use of critical war material, and alter the natural flow of traffic. Hence they should never be installed except on the basis of factual studies of traffic conditions, and relation to the war effort.

On such basis, traffic control signals have the following advantages, particularly during the war emergency:

(a) They provide for orderly movement of traffic at busy intersections and at entrances to war production plants and military establishments.

(b) They represent an economy over manual control and relieve police officers for the protection of vital areas and for other war emergency duties.

(c) They reduce certain types of accidents at intersections.

(d) Along an artery they can be coordinated under favorable conditions to provide for continuous (or nearly continuous) movement at a definite speed, thus conserving rubber and gasoline.

(e) They can be used to interrupt heavy traffic at intervals to permit other traffic, pedestrian or vehicular, to cross.

Unfortunately, the effectiveness of properly utilized traffic control signals has led to others being installed somewhat indiscriminately. This practice definitely hinders the war effort by causing unnecessary delay to military and civilian traffic. In addition, because of the difficulty of obtaining traffic control devices, the practice wastes equipment which should be used at warranted locations.

A - TRAFFIC CONTROL SIGNALS

There are two main classifications of traffic control signals:

(a) Fixed-time signals, which are operated by mechanism on a predetermined time schedule that may, however, be varied in certain ways.
(b) Traffic-actuated signals, which are actuated by approaching vehicular or pedestrian traffic by means of mechanical or electrical devices.

Article A-I--Legal Authority

Signal indications would be nonenforceable if placed by other than public authority, and unofficial signals should be legally prohibited. Authority is usually given to a certain public body or official over the design, installation and operation of signals. Such broad control when properly used involves numerous advantages and is heartily recommended.

Article A-II--Application

Experience has demonstrated that traffic control signals should be installed only when certain conditions exist. There should be an economic or war-effort justification for the installation and operation of every signal. Such justification is based upon the value of:

(a) Reduction in time losses due to unnecessary periods of waiting.
(b) Reduction in tire wear and gasoline consumption due to sudden and unnecessary stops.
(c) Prevention or reduction of accidents.

A greater importance is attached to these values during the war because of the vital need for expediting the movement of war workers and materials, including truck and mass carrier traffic, conserving war transportation facilities and reducing the loss of man-hours in war industries.

In view of the changing traffic conditions caused by the present emergency, a survey should be made to determine, (a) those signalized locations which no longer meet the warrants set forth in this Manual, and (b) those intersections which now are vitally in need of

signalization and satisfy the warrants. The scarcity of new traffic signal equipment makes it imperative that equipment found to be unnecessary by such a survey be transferred to the warranted locations so far as is practicable.

The amount of traffic approaching a signalized intersection varies from minute to minute. Not only does the total volume vary, but the percentage of the cycle necessary for the opposing GO intervals also varies. Within reasonable limits, the less traffic, the shorter the GO interval should be. Maximum efficiency in traffic control operation would require intervals of varying length dependent upon the time required for approaching traffic and variances in the percentage of the cycle allocated to the different entering highways. Fixed-time control will provide these changes only to a limited extent unless additional features are provided which vary the cycle length during different times of day.

The ideal condition would be for signal indications to change in exact accord with traffic demands from minute to minute. To approach this ideal more nearly, types of control equipment have been developed by which traffic desiring to use the intersection roadway actuates the control mechanism. The resulting method of control is known as traffic-actuated control.

The minimum "warrants" listed in Section 301 are intended to provide proper justification for traffic control signals.

Section 301--Conditions Warranting Installation of Traffic Control Signals

Traffic control signals shall be installed and operated only where and when one or more of the following warrants, as defined in Sections 302-308, exist:

(a) Minimum vehicular volume.
(b) Heavy left turn.
(c) Minimum pedestrian volume.
(d) Coordinated movement.
(e) Interruption of through highway traffic.
(f) Accident hazard.
(g) Combination of warrants: Other factors.

The various conditions to fulfill these warrants should be established by suitable counts and studies, under the direction of a competent traffic engineer. This is particularly important when any signal equipment is to be used, since the War Production Board requires a clear showing of need in connection with the war effort before assigning priority ratings. This is further discussed in Appendix I.

In general, the warrants given in Sections 302-308 are equally sound for fixed-time and traffic-actuated control. The latter is more effective at many intersections and may therefore be installed under somewhat lower volume conditions. It does not, however, provide speed control in progressive systems and should not be used as part of a speed-controlling coordinated system, unless specially designed for this purpose.

Section 302--Minimum Vehicular Volume Warrant for Traffic Control Signals

The minimum vehicular volume warranting the installation and operation of a traffic control signal is as follows for the usual intersection:

(a) Total vehicular volume entering the intersection from all directions must average at least 1,000 vehicles per hour for 8 hours in an average day, and

(b) Total vehicular volume entering the intersection from the minor street or streets must average at least 250 vehicles per hour for 8 hours in an average day, and must be a sufficient percentage of the total from all directions to require the GO indication for at least 25 percent of the time.

Where the cross traffic is less than 250 vehicles per hour, alternating of control indications, involving financial outlay and delays to the major street traffic, is not justified. Where it exceeds this amount but does not reach the percentage minimum indicated in paragraph (b) above, traffic-actuated signals are likely to be more effective.

When the total vehicular volume entering an intersection having traffic control signals falls below 500 vehicles per hour for a period of four or more consecutive hours, the signals shall be operated as flashing caution or stop signals, or a combination thereof.

An actual count of vehicles is essential to determine the total vehicular flow through an intersection. In general, such counts may satisfactorily be recorded by 15-minute periods, although it is desirable to know of fluctuations during 5-minute periods in the busiest traffic hour. It is suggested that the count classify the vehicles by types and by whether they go straight through, turn right or turn left. The count should be of sufficient duration to establish whether or not a traffic control signal is warranted, and if so, during what hours it should be operated as a "stop and go" signal.

Section 303--Heavy Left Turn Warrant for Traffic Control Signals

The minimum left-turning volume and volumes of other traffic warranting traffic control signal installation and operation are as follows:

(a) Total vehicular volume entering the intersection from all directions must average at least 1,000 vehicles per hour for 8 hours in an average day, and

(b) Vehicular volume making a left turn from one or more directions must involve at least an average of 300 vehicles per hour during the heaviest traffic hour and cross through an opposing stream of at least equal volume.

In such cases, a separate interval is normally given to one of the conflicting movements.

Section 304--Minimum Pedestrian Volume Warrant for Traffic Control Signals

The minimum pedestrian and vehicular volumes warranting traffic control signal installation and operation are as follows:

(a) Pedestrian volume crossing the major street must average at least 300 persons per hour for at least 6 hours per day, and

(b) Vehicular traffic entering the intersection from the major street must average at least 750 vehicles per hour for the same 6 hours.

When for four or more consecutive hours the vehicular traffic drops below 375 vehicles per hour on the major street, or the pedestrian volume crossing the major street drops below 150 persons per hour, the signal shall be operated as a flashing caution or stop signal or a combination thereof.

Provision for safe and efficient crossing of roadways at intersections by pedestrians deserves a great deal of attention, particularly at this time. Nearly two-thirds of all persons killed in traffic accidents in cities are pedestrians. Intersections which meet this warrant justify control where cross vehicular traffic is too light to warrant a signal solely on a vehicular basis.

In addition, certain special non-intersection locations may warrant the installation and operation of a traffic control signal for the benefit of pedestrians where heavy volumes of pedestrians must cross roadways at irregular intervals. Such locations are often found in the vicinity of war offices and industrial plants. Where very heavy volumes of pedestrian movement exist, pedestrian overpasses or underpasses should be considered, since they furnish the only positive protection.

Studies of pedestrian and vehicular movements are essential to determine whether pedestrian conditions justify the installation and operation of a traffic control signal. The method and forms for vehicular traffic counts have been described in Section 302. The pedestrian study should determine by 15-minute intervals the number of pedestrians crossing each roadway in each direction separately. Persons going to or from a street car across one or more moving traffic lanes should be counted. Pedestrian counts should cover at least those hours when it is believed that pedestrian volume crossing the major street may warrant traffic control operation.

Section 305--Coordinated Movement Warrant for Traffic Control Signals

A traffic control signal which would not be justified under any of the preceding warrants may be warranted as a part of a coordinated signal system if a majority of the signalized intersections composing the system comply with one or more of them, and if the proposed signal installation is necessary to maintain compact group movement or desired group speed.

Coordinated control, in which GO intervals at succeeding intersections are interrelated, involves effective regulation of speed and maintenance of proper grouping of vehicles. For such a purpose traffic signals may be justified where they would not otherwise be warranted. By keeping the vehicles in a coordinated system in compact groups and effectively regulating their speed,

less delay and greater convenience and safety are accorded both vehicles and pedestrians entering the coordinated roadway at intervening unsignalized intersections.

Section 306--Interruption-of-Through-Highway-Traffic Warrant for Traffic Control Signals

A traffic control signal which would not be justified under the preceding warrants may be warranted at an intersection on a through highway where the vehicular volume and speed are such that pedestrians and vehicles on the cross street frequently cannot find safe and convenient opportunities to enter or cross the through highway after reasonable waiting periods.

Under present conditions, many streets and highways heretofore little used have become access routes from homes to concentrations of industry closely connected with the war effort. In cases where these access routes intersect through highways, consideration should be given to the need for interruption of the through highway movement by a traffic control signal. The principle of this warrant may, in some instances, be applied to a major thoroughfare which is not a through highway.

Section 307--Accident Hazard Warrant for Traffic Control Signals

A traffic control signal which would not be justified under any of the preceding warrants may be warranted when five or more accidents of types susceptible of correction by a traffic control signal have occurred within a 12-month period, each accident involving personal injury or property damage to an apparent extent of $50 or more.

A traffic control signal when obeyed can be expected to eliminate or reduce materially the number and seriousness of the following types of accidents:

(a) Those involving collisions between vehicles on intersecting streets which will move on separate GO intervals.
(b) Those involving pedestrians and vehicles which will move during different GO intervals - PROVIDED PEDESTRIANS OBEY THE SIGNALS.
(c) Those between straight-moving and left-turning vehicles where these are to move on separate GO intervals.
(d) Those involving excessive speed in cases where coordination will restrict speed to a reasonable rate.

On the other hand, traffic control signals cannot be expected to reduce the following types of accidents:

(a) Rear-end collisions, which often increase after signalization.
(b) Collisions between vehicles proceeding in the same or opposite directions, one of which makes a turn across the path of the other.
(c) Accidents involving pedestrians and turning vehicles, both moving on the same GO interval.
(d) Other types of pedestrian accidents, IF PEDESTRIANS DO NOT OBEY THE SIGNALS.

If none of the warrants except the hazard warrant is fulfilled, the initial presumption should be against signalization. It is preferable to institute (with proper education and enforcement) other remedial measures which inconvenience traffic less and take fewer vital war materials, such as caution, slow, stated speed and STOP signs or signals; laning or otherwise organizing traffic movements; safety zones and traffic islands.

Section 308--Combination of Warrants for Traffic Control Signals - Other Factors

Signals may occasionally be justified where no one warrant is satisfied but two or more are nearly satisfied, particularly if there are present other important factors, such as:

(a) Predominance of military vehicles or other vehicles closely associated with the war effort.
(b) A sudden change from rural conditions, where relatively high speeds are safe, to urban conditions.
(c) Extreme width of roadway which pedestrians must cross.
(d) Predominance of especially handicapped pedestrians, such as small children, or blind, aged or crippled adults, who need to cross the roadway.
(e) Points where large numbers of pedestrians must cross a fast-moving stream of vehicles.
(f) An intersection on or at the bottom of a long or steep grade.

These exceptional cases should be decided on the basis of thorough analysis of facts--never on the basis of petitions or complaints.

Section 309--Selection of Type of Fixed-Time Control Mechanism

Where any warrant described in Sections 302-308 is satisfied, it is necessary to select the type of control mechanism to be used. New controllers are still being manufactured using substitute materials, but they are extremely difficult to obtain because of the need for high preference ratings. This will limit the selection considerably and will require that existing controllers be rebuilt or adapted whenever possible to meet the conditions at the intersections where signals are needed.

The various types of control mechanisms are as follows:

(a) Nonsynchronous fixed-time controller for isolated intersections.
(b) Program type of fixed-time controller for isolated intersections.
(c) Synchronous type of fixed-time controller for isolated intersections.
(d) Synchronous and nonsynchronous type of controller with provision for coordination.
(e) Master controller.

Section 310--Nonsynchronous Fixed-Time Controller for Isolated Intersections

This type of controller is the least desirable. Controllers of this type already purchased should be shifted to relatively unimportant isolated intersections warranting signalization where:

(a) There is little likelihood that the signal installation will be coordinated with any other, and
(b) The fixed lengths of cycle and intervals will be tolerable during all hours of traffic control (STOP and GO) operation.

Section 311--Program Type of Fixed-Time Controller for Isolated Intersections

This type of controller provides for automatic changes in cycle length and in the proportions allotted to various GO intervals in accordance with a predetermined daily schedule. Such controllers may be used at isolated intersections where:

(a) There is little likelihood that the signal installation will be coordinated with any other;
(b) There are marked variations for considerable periods in traffic demands, as, for example, where the major traffic stream enters on different GO intervals in the morning and evening peak periods; and
(c) With this program in effect, delays are not unreasonable.

Section 312--Synchronous Type of Fixed-Time Controller for Isolated Intersections

This type of controller involves the use of a synchronous motor. The design should provide the various items of flexibility described in Section 336. Such controllers should be used at isolated intersections where:

(a) The installation is likely to be coordinated with one or more other signal installations, but where interconnection with a master controller is determined to be unjustified economically; and
(b) The fixed lengths of cycle and intervals will be tolerable during all hours of traffic control operation.

This type of controller is almost always preferable at intersections for which the nonsynchronous type is suitable.

Section 313--Controllers Providing for Coordination

Two types of control are available for coordination. One of these involves non-interconnected synchronous motors, the other a master controller interconnected to local controllers at each signal installation in the system. Section 375 discusses the various degrees of flexibility attainable by these two types, and the selection should be based upon:

(a) The volumes of traffic involved;
(b) Variances in traffic volume during the hours of intended STOP and GO control;
(c) Variances among GO interval needs on the highways involved; and
(d) An analysis of the differences of cost involved.

Synchronous motors are used both for controllers which are designed for supervisory control by master

controllers and for controllers which are not thus designed. The latter type may be used with success in coordinated systems where the maintenance of very precise coordination is not required or where there is little likelihood that heavy volume or other conditions will require the added flexibility of an interconnected system. If the artery to be signalized has very heavy traffic, it may be desirable to buy and install, temporarily without interconnection, synchronous controllers designed for supervisory control. Then when it becomes possible to obtain interconnecting cable, these controllers will permit a very flexible type of system to be operated.

Section 322--Full Traffic-Actuated Control

Full traffic-actuated control (and to a much lesser extent semi-actuated control) has the following advantages at independent or isolated signal installations:

(a) It reduces delays considerably. The more responsive equipment reduces it very nearly to a minimum. This reduction of delays expedites traffic and relieves congestion.

(b) Motorists and pedestrians are more likely to respect and obey the signals because traffic is dispatched with reduced delays.

(c) The safety element of continuous STOP and GO operation can be retained, since the unreasonable delays encountered at fixed-time signal installations during light traffic hours are largely eliminated. Such delays are the main reason for discontinuing STOP and GO operation of fixed-time signals.

(d) Traffic-actuated control minimizes the tendency of traffic to avoid signalized intersections. This results in more logical routing of traffic and fewer demands for signals.

Application of this method of control can be made at points where pedestrians cross a heavy traffic stream by providing push buttons for actuation by pedestrians.

Full traffic-actuated control is well adapted for any independent or isolated signal, and is especially effective at multiple intersections, at intersections with traffic requirements which vary considerably during different times of day, and where special conflicting movements should be handled separately, particularly if they vary in time requirements at different hours.

The heavier the traffic having varying time requirements, the greater will be the reduction in delays by use of traffic-actuated control.

Full traffic-actuated control is more responsive to traffic demands and is generally much more flexible than other mechanical control.

Section 323--Semi-Actuated Control

Semi-actuated control has certain appropriate applications. These include:

(a) School crossings or other locations where intermittent pedestrian crossings should be provided for by push-button actuation and resultant delays can be tolerated. Since no impulses are received from the vehicular traffic on the main thoroughfare, the first pedestrian demand received after this traffic has had at least a selected minimum GO interval will secure the pedestrian crossing indication.

Disadvantages of such installations are that, on the one hand, a single pedestrian can interrupt a compact group of vehicles on the main thoroughfare, after the selected minimum GO interval for the main thoroughfare has been used, while on the other hand if a pedestrian crossing interval has just been completed, it will be impossible for any number of pedestrians, no matter how little vehicular traffic is at the instant using the main thoroughfare, to secure another crossing interval until a complete GO interval of selected minimum length has passed for the main street vehicular traffic.

(b) Intersections on through highways or main arteries where speed control is not a factor, but where pedestrians and or vehicles on the cross street frequently cannot find safe and convenient opportunities to enter or cross the through highway after reasonable waiting periods. Semi-actuated control with both push-button and side-street vehicle-actuating devices is especially adapted under this warrant where cross street demands are generally light, infrequent and irregular.

The concentration of pedestrians in the vicinity of war production plants and military establishments will frequently justify this method of control.

(c) Intersections where there is light traffic on the cross street and where a fixed-time cycle cannot be kept short and the intervals proportioned fairly.

Section 324--Special Pedestrian Signals

Special pedestrian signals have two different applications:

(a) To provide a separate interval for pedestrian movement during which vehicular traffic proceeding in all directions is stopped.

(b) To provide an interval, within a GO interval for vehicular traffic, to tell the pedestrian when he may safely start to cross so as to complete the crossing before the traffic starts on the other street.

Section 325--Traffic Control Signals in Lieu of Train Approach Signals at Railroad Grade Crossings

Traffic control signals shall not be used as alternatives to train approach signals except where streets intersect at a railroad crossing. When used, both sides of the tracks shall be adequately protected by traffic signal faces.

Such signals where used shall prohibit any movements that could conflict with rail traffic. Arrows may be used to permit those movements that are safe, if any, during the passage of a train over the crossing.

Section 389 on train approach signals sets forth the desirability at certain grade crossings of manually controlled signals or automatic signals that will take some account of the speed of the approaching train. The same principle applies to traffic control signals at railroad grade crossings.

Section 326--Traffic Control Signals Near Railroad Grade Crossings

Except under the conditions set forth in Section 325, traffic control signals should not be installed at a street or highway intersection within 150 feet of a railroad grade crossing.

Traffic control signals too close to railroad grade crossings are likely to be misinterpreted by certain drivers approaching from either direction as governing the periods when it is safe to cross the railroad tracks. If the grade crossing is also protected by standard train approach signals, there may be considerable confusion between the two types of signal apparatus so close together.

If exceptional conditions warrant such an installation, extreme care should be taken in the design and operation to avoid the possibility of forcing vehicular traffic to stop on the railroad tracks.

Article A-III--Design

Because of the present shortage of certain critical materials normally used in the manufacture of traffic signal equipment, it is obvious that substitute materials will have to be employed. The flexibility of traffic control equipment will undoubtedly be affected, but it is to be hoped that the relatively high degree of standardization attained after years of experience in the manufacture, operation and maintenance of signal equipment will be maintained.

Section 327--Number of Lenses per Signal Face

Each signal face shall have three lenses. It may have additional lenses as indicated herein.

The three-lens type of signal face is adopted as standard primarily because of the important functions of the yellow light which cannot be satisfactorily performed by a two-lens signal. During the emergency, the yellow light has added importance because it eliminates the sudden "tire-wasting" stops which occur so frequently at the two-lens signals. In those cases where three-lens signals have been converted to two-lens signals by masking or disconnecting the yellow lens, the yellow lens should again be put into operation, if materials are available. Flashing yellow is a valuable caution device when the signal is not on STOP and GO operation.

Special arrow indications are permissible for one or more of the following individual movements: Right turn, left turn, straight through.

The foregoing does not apply to special pedestrian signals.

Section 328--Color and Position of Lenses

The three prescribed lenses shall be of the following colors only and shall be arranged vertically in the signal face in the following positions:

Red - At the top
Yellow - Below the red
Green - Below the yellow

When special arrows are used they shall be green. They shall be either below the three prescribed lenses or to the right of them, and shall be in the following vertical order, beginning at the top: Straight-through arrow, right-turn arrow, left-turn arrow.

Uniformity in the position of lenses is of distinct value to all drivers, and of special importance to color-blind persons.

The colors red, yellow and green should conform to the Adjustable Face Traffic Control Signal Head Standards which appear in the Institute of Traffic Engineers' Technical Report No. 1. This has been approved as an American Standard (D 10.1-1942) by the American Standards Association.

Section 329--Shapes and Dimensions of Lenses

The three normal traffic control lenses referred to in Sections 327 and 328 shall be circular, with a visible diameter of not less than eight inches.

A green arrow lens shall show an arrow so designed that its shape will be distinctly visible at a distance of 200 feet. An arrow to indicate straight through movement shall be pointed vertically upward, and an arrow to indicate substantially a right-angle turn shall be horizontal.

In some cases where the turn is substantially different from a right angle the arrow may be pointed obliquely upward on a slope appropriate to the angle of the turn.

Figure 329 illustrates an effective arrow design. It is very important that approaching drivers recognise the green arrow shape at a sufficient distance to govern their actions accordingly. Many arrow lenses now in use fail to meet this requirement.

Section 330--Illumination of Lens

Each lens shall be illuminated independently of any other lens. Except in the case of green arrows,

the illumination shall be by a clear lamp of not less than 40-watt capacity, especially designed for traffic signals. Each green arrow lens shall be illuminated by a clear lamp of not less than 25-watt capacity.

There shall be no ribbing on any lens carrying an arrow.

Illuminated building or advertising signs that interfere with the effectiveness of traffic signals should be removed, relocated or otherwise treated so a clear signal indication will always be given to approaching traffic.

Section 331--Visibility of Lens

Each lens, reflector and visor shall be of such design as to render the lens, when illuminated, clearly visible to the traffic controlled by that signal face at all distances from 10 to 300 feet, under all light and atmospheric conditions except dense fog. The design shall be such as to prevent, to the maximum degree practicable, any signal face from being seen from a direction to which its indications do not apply.

Section 332--Lettering on Lenses

Except on special pedestrian signals, lettering shall not be used on signal lenses.

Section 332.1--Special Pedestrian Signals

Special pedestrian signals shall be of distinctive design and shall not use either singly or in combination the signal lenses that normally control vehicular movement. There shall be one indication when the pedestrian may start to cross and another when he must not.

Figure 332.1 illustrates one suggested design for walk indication.

Section 333--Auxiliary Illuminated Signs

Signal heads and auxiliary mounting equipment should be designed so that auxiliary signs can be attached and illuminated either above or below or on either side of any signal face.

Section 334--Operating Power for Controllers

The operating power for all controllers should be ample to provide accurate operation for outside temperatures between 35 degrees below zero and 120 degrees Fahrenheit, and for the lowest voltage which will be encountered.

Section 335--Immunity to Vibrations

Controller design should be such that its operation will be unaffected by vibrations or other jarring of the control box.

Section 336--Flexibility of Controllers

Fixed-time controllers of all types should be so designed that a timing schedule for any normal traffic conditions can be easily set up. It should be possible to fix any established setting firmly in place.

The flexibility of controllers for use at the normal intersection of two streets should make it possible:

(a) To set up at least six separate intervals or periods, even though only four intervals are to be used for the present.
(b) To vary the length of the total cycle between 30 and 120 seconds by steps not to exceed 5 seconds for cycle lengths between 30 and 90 seconds, and ten seconds for cycle lengths between 90 and 120 seconds.
(c) To vary the length of intervals or periods independently by small steps to cover virtually any set of timing requirements.

The longer cycle lengths mentioned in paragraph (b) above are sometimes necessary at complex intersections where three-way movements are required.

With respect to item (c), the following ranges are in use in some specifications:

(a) Green interval on main street, from 25 to 65 percent of the total cycle.
(b) Pedestrian clearance period after the green interval on the main street, from 0 to 25 percent of the total cycle.
(c) Yellow interval for movement on the main street, from 0 to 10 percent, and yellow interval for movement on the

cross street from 0 to 15 percent of the total cycle.

(d) Pedestrian clearance period after the green interval on the cross street, from 0 to 30 percent of the total cycle.

Section 337--Additional Flexibility for Controllers Used in Flexible Progressive Systems

Controllers used in flexible progressive systems should be so designed that at each intersection the green light on the main street can be made to appear at any desired instant during the cycle. This should be made possible by a simple and readily accessible device which can be fastened securely in any desired position, permitting change in the setting quickly, easily and by small steps.

Section 338--Automatic Maintenance of Coordination

In flexible progressive systems having a master controller and a cable connecting it to a controller at each signal installation in the system, the design should be such that once in each cycle there will be an automatic check as to whether any local controllers are "out of step," and any necessary re-coordination will, unless a local controller is in need of repair or adjustment, be accomplished within the next two cycles.

Section 339--Provision for Manual Operation

The provision of apparatus to permit manual operation of signal installations in flexible progressive systems is not in general recommended. At heavy intersections operating under independent control, manual operation of signals at certain times may be warranted by varying traffic requirements.

Experience has proved that if manual control is possible at intersections in flexible progressive systems, there is too great a tendency on the part of the police to operate certain intersections manually. This destroys coordination at those intersections, with disadvantages generally more important than the possible improvement in proportioning intervals achieved by manual control. The presumption should be against manual control until the inability of automatic control to meet the situation at the particular intersection is demonstrated.

Section 340--Weather Proofing

Control box housings shall be constructed and gasketed to prevent entrance of water and dust to the operating parts of the controller. All pipe connections shall be water tight and dust tight.

A "breathing hole" of approximately ⅛-inch diameter, located in the bottom of the outer housing, may be desirable to prevent excessive heat and as a precaution against condensation of moisture.

Section 341--Elimination of Radio Interference

Controllers should be designed, or supplemented by apparatus, to prevent an objectionable degree of radio interference.

Article A-IV--Location

Proper location of traffic control signals is a paramount factor if the meanings of the signal indications are to be clearly conveyed to the motorist. Faults to be avoided are:

(a) Installing traffic control signals along an artery several intersections apart, and expecting traffic, especially cross traffic, at intervening unsignalized intersections to be governed by such signals.

(b) Failing to provide at least one effective signal indication for each direction of travel, where a number of streets come together, at approximately, but not exactly, the same point.

(c) Failing to provide signals readily visible to pedestrians.

(d) Failing to provide signals readily visible from all traffic lanes in wide roadways.

If traffic control signals are warranted in a given area or intersection, the installation of a satisfactory type will be justified by the reduction in accident hazards and confusion. New signal equipment will be difficult to obtain, and in some cases a certain amount of improvisation will be necessary in order to provide adequate facilities.

Section 342--Signal Installation to Control Its Own Intersection Only

A signal installation shall control traffic only at the intersection where the installation is located.

The unfair and hazardous plan of depending on signals at a few intersections to control traffic at several intermediate intersections requires operation of the signals as a simultaneous system, which is usually inefficient. Drivers on unsignalized cross streets must often enter the crosswalk in order to see a signal on the artery. Strangers are likely to enter unsignalized intersections unknowingly, which is obviously very hazardous.

Section 343--Location of Signal Faces at the Intersection

Signal faces shall normally be located to give approaching vehicular traffic a control indication from the far right corner of the intersection (see Figures 343 and 343a).

New metal posts for mounting signals will probably not be available during the emergency. Two alternatives are possible. Wooden posts, preferably treated, may be substituted, or existing posts or poles may be used. If suitable existing posts or poles are found, they should be used even though this may involve near-side mounting.

Pedestals in the roadway to carry signals are driving hazards and are not recommended. This is not intended, however, to preclude the use of signals on pedestals or posts on the medial strip of a divided roadway or on certain other types of traffic islands.

Section 344--Location in Relation to Curb and Property Lines

One signal face for each direction of approaching vehicles shall be located as near as practicable to the curb line of the street whose traffic it controls. It should be about three feet beyond the far crosswalk line of the intersecting street, or the point where a crosswalk would normally be located (see Figure 343).

In order to present to the driver a maximum of effectiveness, a post or pole bracket-mounted signal face should be kept close to the curb line. However, for the protection of the equipment from injury by passing vehicles, it is not desirable that any part of the signal head extend within 12 inches of the curb line.

A signal or its support should not obstruct the crosswalk, hence the supporting post should be erected about three feet outside of the crosswalk line as shown in Figure 343.

Section 345--Location in Relation to a Partially Improved Roadway

Where only part of the established roadway is improved for vehicle travel, the signal face shall be not more than 10 feet to the right of the improved area.

Mainly along rural highways cases arise where only a part of the roadway is improved for vehicle use. So long as the signal face is not more than 10 feet to the right of the edge of the improved portion, it should be satisfactorily visible, since approaching vehicles on city streets, with parking at the curb, are generally about 10 feet from a signal located at the curb. The average vehicle operator gives his major attention straight ahead, and an object more than 10 feet off to the side is not likely to receive proper attention.

This rule has important bearing on the type of mounting, for if the 10-foot distance permits the installation of a post, a low mounting height can be used and maintenance simplified. If, on the other hand, the unimproved portion of the roadway is so wide that a bracket-mounted signal face or center suspension must be used, costs are increased, mounting height must be greater and maintenance is more difficult.

Section 346--Number of Signal Faces per Corner

There shall be at least one signal face for the control of traffic on each street entering the intersection.

There shall be a signal face directly in front of each approved line of pedestrian crossing, if

(a) The number of pedestrians is appreciable, or
(b) The hazard to even a few pedestrians is considerable.

Any roadway having more than two moving lanes in each direction shall have an auxiliary signal face on the left-hand side of the highway, preferably on the far left corner of the intersection. This signal face is in addition to the normal far-right-corner face.

Each direction of vehicular traffic warrants a signal face virtually in front of it as it approaches and crosses the intersection. These conditions can be provided only by a separate signal face for each stream to be controlled.

At every intersection where there is considerable pedestrian movement it is important that there be a signal readily seen and understandable by the pedestrian on whichever side of the street and in whichever direction he is proceeding. Under some existing installations, he is required to depend upon a signal barely visible diagonally across the street, or upon a red signal visible against traffic on the street he desires to cross. In many instances no yellow signal is visible to him and he has no warning that the signals are about to change. With the increasing use of special turning arrows and the signalizing of one-way streets, there are points at busy intersections where he has no indication whatever as to when he should proceed.

Section 347--Auxiliary Signal Face Locations

Proper visibility and effectiveness require auxiliary signal faces in the following locations (see Figures 347a, 347b, and 347c).

347a--*Long Intersection*--Where the signal face is more than 100 feet from the limit line of the traffic which it controls, an auxiliary near side, right-hand signal face shall be provided.

347b--*Irregular Intersection*--When the physical shape of the intersection is such that the far-corner signal face is not in the direct view of approaching traffic, an auxiliary signal face shall be installed at a suitable location so as to give satisfactory visibility to approaching drivers.

347c--*Obstructed View*--Where physical conditions prevent a vehicle driver from having a continuous view of the signal face for a distance of 200 feet in advance of the limit line, an auxiliary signal location should be used at the intersection which will provide this visibility. If, however, physical conditions make it impossible to provide a signal face at the intersection which can be seen for 200 feet, a caution signal, or a sign effective at night reading "Traffic Signal Ahead," should be erected in a suitable position to warn approaching traffic.

Section 348--Height of Signal Faces

The bottom of the housing of a signal face shall be not less than 8 feet or more than 10 feet above the sidewalk or, if none, above the pavement grade of the center of the highway, except that where it is necessary to install a signal face under which vehicles must pass, the height to the bottom of the housing shall be a minimum of 14 feet 6 inches above the roadway surface.

Article A-V--Installation

This article embraces signal-head mountings and other design and construction features incidental to providing signals conforming to the requirements in Articles A-III and A-IV.

Section 349--Types of Mounting for Signal Head

Types of signal-head mountings include the following:

(a) Alongside the roadway
  (1) Posts
  (2) Short brackets attached to poles
(b) Over or in the roadway
  (1) Long brackets or mast arms attached to poles off the roadway
  (2) Cable suspension
  (3) Posts or pedestals on islands

Group (a) has advantages, including simplicity of design, ease of access and maintenance, and better conformity as to height to the needs of traffic. Of the two types in this group, post mountings are preferable. In view of the scarcity of materials, existing poles,

metal or wooden, should be used whenever possible for the signal mountings.

Mast-arm and cable suspension involve considerable lateral strain. Cable suspension interferes with fire fighting and requires overhead maintenance equipment. Both types involve considerable difficulties in cleaning and maintenance, besides placing the signals too high for best visibility to waiting traffic and to operators of vehicles close to the intersection. They are sometimes necessary at intersections to supplement post-mounted signals.

Section 350--Installation of Underground Conduit and Cable

It is generally desirable to use underground conduit and cable especially at urban intersections. In the present emergency, however, it will be extremely difficult to obtain such material and the alternative of using overhead wires for interconnections will often be necessary. The possibility of making use of underground conduit of public utilities, which may be entirely suitable at some locations, should be investigated.

Section 351--Selection of Cable

The cable is an important element in the successful and economical operation of a signal or a signal system. Copper and rubber are two of the most critical war materials, and extreme care is urged in the lay-out of signal wiring and intercommections, to use the least possible amount of cable. The salvage of cable at locations where signals are no longer warranted will, to some extent, supply that which is needed for war emergency installations. It will be necessary in some instances to substitute cable or cables of a lesser number of wires for the 10- or 12-conductor cable commonly used and dispense with the spare wires that are normally reserved for later special uses. To the extent that safe operating standards are not departed from, a certain amount of overload can also be tolerated. It is recommended that a responsible electrical engineer or similar authority be consulted when the use of a cable lighter than that customarily installed is contemplated.

351a. *Quality.* Experience has proved the desirability of using cable of high quality for all but purely temporary installations.

351b. *Color Code.* A standard color code should be adopted for traffic control cables. Such a code indicates the function to be performed by conductors with various colors and combinations of colors in their braid covering. The color code selected for any jurisdiction would naturally vary according to the features provided in the operation of the traffic control signal or signal system.

Section 352--Insulation

Adequate insulation shall be provided throughout the entire installation, conforming to Fire Underwriters' specifications.

Section-353--Cable Positions and Clearances

Positions for traffic control cables shall be such as not to interfere with utility structures and wires or with positions reserved for them. Suitable clearances agreed upon by all interested parties shall be provided in all such cases.

In most communities the utility companies and appropriate governmental agencies have agreed upon certain positions on poles and certain positions underground for various structures, conduits and wires. Much trouble can be avoided if those in charge of traffic signal installation will work out location standards with such other affected groups. Where a pole is used for several groups and types of cable it is important to maintain satisfactory clearances, both horizontal and vertical, to avoid electrical troubles.

Section 354--Messenger Wires

All overhead cable shall be supported with a suitable aerial messenger wire whenever there is a span of more than 30 feet.

The size and strength of messenger wire is dependent on the load to be carried. It is very likely that a lighter signal cable will have to be used during the emergency, and in this event an appropriate reduction in the size and strength of the messenger wire can be made.

Section 355--Rust-Proofed Hardware

Satisfactorily rust-proofed hardware should be used in all places open to the weather.

Section 356--Prevention of Explosives

Suitable steps shall be taken to prevent explosion where underground wiring is used.

Gases from underground conduits and structures are likely to enter the traffic signal conduit and accumulate in the control box. The making and breaking of contacts in the controller have ignited explosive mixtures of gases. One satisfactory method of preventing this hazard is to seal the conduit with hot wax just below the control box.

Section 357--Wiring and Fuses

All wiring in the signal installation, with adequate provision for fuses, shall be installed in accordance with the current standards and requirements of the Board of Fire Underwriters.

Section 358--Shielding of Signals

Each signal face shall, if possible, be so shielded by a visor or screen that an approaching driver can see only the signal face or faces intended for his observance.

Confusion results if signals are so located that operators see two signal faces giving different indications.

Section 359--Pointing of Signal Faces

Each signal face shall be so adjusted vertically and horizontally that its beams will be of maximum effectiveness to the approaching traffic for which it is intended.

For an average urban intersection where the normal speed of the approaching vehicle is 25 miles per hour, the point of maximum effectiveness would be at the height of a driver's eyes, about 6 feet to the right of the center line of the pavement and about 75 feet back from the limit line.

Frequently poles on which signal faces are installed are not exactly vertical. Brackets or other mounting fixtures should be so designed that it will be possible to adjust the signal face both vertically and horizontally through a considerable angle.

Article A-VI--Operation

The maximum effectiveness of traffic control signals occurs when they are operated in accordance with actual traffic requirements. The need for expediting the movement of war workers and materials on streets and highways and the traffic changes due to rationing make it imperative that existing programs of traffic signal operation be critically reviewed for possible modification and improvement. The operating standards contained herein provide for a reasonable efficiency in the operation of signals at warranted locations.

Section 360--Continuous Operation of Traffic Control Signals

Traffic control signals shall normally be operated either as STOP and GO devices, or:

(a) As a caution signal (flashing yellow) provided normal safe approach speeds on all approaches exceed 8 miles per hour.

(b) As a combination of caution signal (flashing yellow) and stop signal (flashing red), in which cases the caution signal shall show in all directions for which the normal safe approach speed exceeds 8 miles per hour and the stop signal shall show in all directions for which the normal safe approach speed is less than 8 miles per hour.

(c) In the case of a "Through Street," as a caution signal (flashing yellow) on the through street and as a stop signal (flashing red) on other approaches.

Signals requiring a showing of red only occasionally, as at drawbridges, fire stations, school crossings and other points, shall show steady green or a flashing yellow at all other times.

During seasonal shut-downs when it is not desirable to operate signals in any of the manners described above,

they should be turned, hooded or taken down so that operators will be under no misapprehension that a bulb may be burned out.

Methods of computing normal safe approach speeds have been developed by and are available from the American Automobile Association, the National Safety Council and the American Association of State Highway Officials. These are reproduced on pages 194-197 of the Traffic Engineering Handbook, published by the Institute of Traffic Engineers and the National Conservation Bureau.

Section 362--Meaning of Color, Arrow and Special Pedestrian Indications

Color, arrow and special pedestrian indications in traffic signals should have the meanings ascribed to them in this section and no other meanings.

Satisfactory results from traffic signal operation require a uniform understanding of their color combinations. Those herein set forth are in basic accord with the Uniform Vehicle Code (Act V, Sections 32 and 33), copies of which are available through the U. S. Public Roads Administration, Washington, D. C.

The meanings of the indications which should be thus prescribed by law are as follows:

362a--*Green*

1. Vehicular traffic facing the signal may proceed straight through or turn right or left unless a sign at such place prohibits either such turn. But vehicular traffic shall yield the right-of-way to other vehicles and to pedestrians lawfully within the intersection at the time such signal is exhibited.

2. Pedestrians facing the signal may proceed across the roadway within any marked or unmarked crosswalk.

362b--*Yellow*

1. Vehicular traffic facing the signal shall stop before entering the nearest crosswalk at the intersection, but if such stop cannot be made in safety, a vehicle may be driven cautiously through the intersection.

2. Pedestrians facing such signal are thereby advised that there is insufficient time to cross the roadway, and any pedestrian then starting to cross shall yield the right-of-way to all vehicles.

The yellow lens is required in standard signal apparatus for the reasons indicated in Section 327. Confusion has frequently arisen from the absence or misuse of this lens. When the length of the yellow vehicle clearance interval is correct, and the standard meaning above described is generally observed, necessary functions of warning and clearing the intersection are performed by this interval.

362c--*Red*

1. Vehicular traffic facing the signal shall stop before entering the nearest crosswalk at an intersection or at such other point as may be indicated by a clearly visible line and shall remain standing until green is shown alone.

2. No pedestrian facing such signal shall enter the roadway unless he can do so safely and without interfering with any vehicular traffic.

362d--*Red with Green Arrow*

1. Vehicular traffic facing such signal may cautiously enter the intersection only to make the movement indicated by such arrow but shall yield the right-of-way to pedestrians lawfully within a crosswalk and to other traffic lawfully using the intersection.

2. No pedestrian facing such signal shall enter the roadway unless he can do so safely and without interfering with any vehicular traffic.

The full utility of these special green arrow indications is dependent upon there being a lane exclusively available for the movement or movements so indicated. Such lanes should be clearly marked on the roadway surface at all times.

Wherever it is intended to permit traffic on a certain thoroughfare in a given interval to make certain movements and prohibit it from making others, the regular circular red lens facing that traffic shall be illuminated together with a separate green arrow for each permitted movement.

362e--*Flashing Red (Stop Signal)*

When a red lens is illuminated by rapid intermittent flashes, drivers of vehicles shall stop before entering the nearest crosswalk at an intersection or at a limit line when marked, and the right to proceed shall be subject to the rules applicable after making a stop at a *Stop* sign.

362f--*Flashing Yellow (Caution Signal)*

When a yellow lens is illuminated with rapid intermittent flashes, drivers of vehicles may proceed through the intersection or past such signal only with caution.

The use of steady yellow as a caution signal is not recommended.

362g--*Pedestrian Walk and Wait Signals*

Whenever special pedestrian control signals exhibiting the words *Walk* or *Wait* are in place, such signals shall indicate as follows:

(a) *Walk*--Pedestrians facing such signal may proceed across the roadway in the direction of the signal and shall be given the right-of-way by the drivers of all vehicles.

(b) *Wait*--No pedestrian shall start to cross the roadway in the direction of such signal, but any pedestrian who has partially completed his crossing on the walk signal shall proceed to a sidewalk or safety island while the wait signal is showing.

Section 363--Removal of Confusing Colored Lights

The Uniform Vehicle Code, Act V, Section 37, prohibits the display of any unauthorized sign, signal, marking or device which interferes with the effectiveness of any official traffic control device. The enactment of this provision is particularly important as applied to all lights of such a color and location as to be confused with traffic control signals. Any steps necessary to eliminate this serious hazard are warranted.

Section 364--Unexpected Conflicts During GO Intervals

No movement which may involve an unexpected crossing of pathways of moving traffic should be permitted during any GO interval, except under unusual conditions, when:

(a) The movement involves only slight hazard,
(b) Serious traffic delays are materially reduced by permitting the movement, and
(c) Traffic subjected to the unexpected conflict is effectively warned thereof.

When such conditions exist, warning may be given by an illuminated sign or under certain conditions by the use of a flashing yellow caution signal instead of a green GO signal. The foregoing applies not only to conflicts as between vehicles but also as between vehicles and pedestrians.

Section 365--Length of Cycle

The cycle shall be as short as will accommodate the necessary movements.

Considerable dissatisfaction with traffic control signals may be attributed to improper timing. Therefore, this subject warrants the thorough consideration of those who have charge of signal timing.

Short cycles encourage observance of the signals by pedestrians and vehicle drivers. For city conditions a cycle length of from 35 to 50 seconds is generally found to be satisfactory for the usual intersection. For rural intersections it may be desirable to use somewhat longer cycles, giving the extra time to the main highway. Signal timing should be established on the basis of study of traffic requirements by a competent traffic engineer.[1]

Section 366--Rotation of Intervals

Each interval provided for traffic movement should generally be given once and only once during each cycle; provided, however, that with traffic-actuated control by pedestrians or vehicles, intervals not regularly utilized may be initiated only when the demand exists.

1. The National Safety Council has published a report on this subject entitled "Timing Stop and Go Signals," Public Safety Memorandum No. 84. A memorandum on the subject is also available from the American Automobile Association. The subject is also treated in the Traffic Engineering Handbook published by the Institute of Traffic Engineers and the National Conservation Bureau.

extraordinary conditions may warrant the duplication or omission of an interval in any one cycle.

Nothing herein should be interpreted as preventing continuous movement of one line of traffic during several intervals where analysis shows this procedure to be desirable and safe.

Section 367--Fixed-Time Intervals Proportioned to Traffic Requirements

Cycles should be divided into intervals proportionate to the time required by the traffic which will enter the intersection during the signal intervals. Where the time requirements of the different movements vary widely in proportion during different times of the day, provision is sometimes made with an automatic time clock for changing the percentage of total cycle allowed for each interval to accord reasonably well with the traffic time requirements. Where the percentages of the total cycle required by different traffic movements do not vary materially during the day, the percentages allowed the different intervals should be those which most accurately accord with the requirements of the heaviest traffic hour.

Usually the volume of traffic per lane entering the intersection on a GO interval will not be equal from the two directions on the same street. The per-lane volume of traffic entering from the heavier direction, therefore, should determine the time required for the interval.

Section 368--Limitation of Number of Intervals and Special Indications per Cycle

No interval or special indication should be used in a signal cycle unless its desirability has been definitely established.

Section 369--Vehicle Clearance Interval

A yellow vehicle clearance interval shall be used following each green interval. In no case shall a yellow interval be displayed in conjunction with the change from red to green.

In general, the vehicle clearance interval should be not less than three seconds, or more than is reasonably necessary to clear the intersection of traffic. At intersections where speeds are 35 miles per hour or more the clearance interval should be at least five seconds.

The use of the yellow clearance interval as a period during which pedestrians are supposed to walk is disapproved. The functions of the yellow interval should be exclusively those of intersection clearance and of warning to approaching drivers.

Section 370--Coordination of Fixed-Time Traffic Control Signals

In general, all fixed-time traffic control signals within 1,200 feet of one another and controlling the same roadway should be operated in coordination.

Great inconvenience and delay result from the independent operation of closely adjacent signal installations operating on fixed-time control. Most of this delay can be eliminated by carefully planned coordination.

Section 371--Types of Coordination

The most useful classification of traffic control signal systems is based on their method of coordination. Since the primary purpose of this coordination is to organize and facilitate traffic flow, it is essential to indicate what vehicular traffic will do under the various systems. On this basis of classification there are three general types of coordination of fixed-time signals. These are defined and described in Sections 372-374 as (a) simultaneous system, (b) alternate system and (c) flexible progressive system.

Section 372--Simultaneous System

A simultaneous system is one in which all signals always give the same indication to a given highway at the same time. All intervals change at the same instant and like intervals are identical at all signal installations.

The simultaneous system is simple and requires but one controller. In customary operation, however, it has the following disadvantages:

(a) The simultaneous stopping of all traffic along the highway prevents continuous movement of vehicles and results in low over-all speed.
(b) Speeding is encouraged in order to pass as many controlled intersections as possible before a change of signals.
(c) Cycle length and interval proportioning must be based on the heaviest traffic requirements encountered. Since the timing at all intersections must be the same, considerable inefficiencies are introduced at most signal installations.
(d) The simultaneous starting of many street cars creates a sharp peak in power load.

Section 373--Alternate System

An alternate system is one in which adjacent signals or groups of signals show opposite indications to a given highway at the same time. All signals change their indications at the same time, but instead of all signal faces governing one highway changing from red to green, the first, third and fifth signal faces or groups thus change, while at the same time the second, fourth and sixth faces or groups change from green to red.

Under conditions for which this system is satisfactory, it has the following advantages:

(a) If each succeeding intersection has its signal indications alternated, and if blocks are approximately equal in length, continuous movement of groups of vehicles at approximately a predetermined speed is possible. If groups of intersections show the same signal indications, continuous movement is possible for the vehicles at the front of the group.
(b) Speeding is discouraged 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:

(a) It requires equal GO intervals for both main and cross street traffic, which is inefficient at most intersections.
(b) It is not well adapted to a street having blocks of unequal length.
(c) If the signals are alternated by groups, the flow capacity is materially reduced during heavy traffic, the latter part of the moving group being delayed between intersections when the color indication changes.

cross streets are equally spaced, grouping by two intersections reduces capacity about one-half, while grouping by three intersections reduces capacity to about one-third.

Changing a simultaneous system to an alternate system will usually increase the efficiency of traffic movement and may be regarded as a step toward progressive control.

Section 374--Flexible Progressive System

A flexible progressive system is one using a common cycle length throughout, in which the individual signal faces controlling traffic on a given highway show GO indications independently in accordance with a timing schedule designed to permit (as nearly as possible) continuous operation of undelayed groups of vehicles along the highway at a planned rate of speed, and in which the intervals at any signal installation may be independently adjusted to the traffic requirements at that intersection.

In general the flexible progressive system when efficiently designed and operated has the following advantages:

(a) Continuous movement under favorable conditions of full undelayed groups of traffic at approximately a predetermined speed is possible on both the main and cross streets in the system.

(b) Intervals at each intersection may be proportioned for maximum efficiency considering traffic requirements at that intersection.

(c) Speeding is discouraged because a vehicle must make frequent stops if it exceeds the speed determined for the system.

(d) Differences in block length can be handled better than with other fixed-time systems.

Section 375--Degree of Flexibility of Flexible Progressive System

There are many degrees of flexibility provided by systems bearing this name. The least expensive method of providing such a system is by the use of unconnected synchronous motors receiving energy from a common source or from electrically synchronized sources. The second

general method involves the use of a master controller which "supervises" secondary controllers, which may or may not be of the synchronous motor type, at each signalized intersection.

With the first method, a common cycle length and proper coordination between controllers will exist as long as no trouble occurs, but if one or more controllers get out of step, re-coordination must be established by adjusting with stop watches the lags of timers which are out of step.

With the second method, the master controller primarily insures that the secondary controllers keep in step. The introduction of numerous additional features of flexibility is also made possible. For example, most equipment of this type permits changing the length of the cycle for the system at different times of day. It is also possible to institute flashing operations from the central control board at any desired time of day. Some types of equipment provide for several different timing schedules, such as one to favor heavy inbound flow in the morning, another for average conditions, and a third to favor heavy outbound flow in the late afternoon, thus utilizing the street capacity to a greater extent.

Section 376--Conditions Affecting Efficiency of Signal System

Certain conditions seriously reduce the efficiency of signal systems, even of the most flexible progressive systems. Among these are:

(a) Very short street blocks, especially where reasonably high speeds are possible. (This particular condition does not affect the simultaneous system.)
(b) Narrow streets where parking and loading interfere with free movement.
(c) Traffic composed of units of widely differing speeds, such as street cars, buses, trucks, horse-drawn vehicles and passenger automobiles, especially on narrow streets.
(d) Certain types of complicated intersections, such as those requiring three GO intervals per cycle.
(e) Heavy volumes of vehicles turning into the artery, especially if the block into which they turn is short.

Nevertheless, some type of flexible progressive system generally secures the best results possible by

fixed-time control under such street and traffic handicaps as cannot be removed or relieved.

Section 377--Selection of Type of Coordination

The type of coordination chosen should be that which careful studies indicate will produce the best traffic results.

377a. *Flexible Progressive System.* In general, the flexible progressive system is best adapted to the efficient movement of traffic.

377b. *Alternate System.* The alternate system may prove satisfactory where blocks are of practically even length and where the equal GO intervals in all directions reasonably accord with traffic requirements at each major intersection. The lack of flexibility of this system not only restricts its utility but also prevents desirable readjustments to accord with changes in traffic conditions.

377c. *Simultaneous System.* Intersections not more than 300 feet apart often constitute a serious coordination problem. At normal traffic speeds the time required to move from one intersection to the next is so short that a very short cycle would be required for a flexible progressive or alternate system of control. If only two such intersections are to be coordinated, the best plan is generally to operate them as a simultaneous system, giving an ample GO interval on the main street for a major portion of the traffic to clear through both intersections. If two such close intersections are encountered in a larger group to be coordinated, the best plan is to select the flexible progressive system and to adjust the lags at both of the close intersections so as to interfere the least with the continuous movement of traffic. Frequently this will result in virtually simultaneous operation of these two signal installations. Except for this limited application and perhaps other rare exceptions, the use of the simultaneous system is not recommended.

Section 378--Speed for Progressive Systems

The speed or speeds for which a flexible progressive system is designed should accord reasonably with what speed tests show would be the speed of movement of

vehicles if cross traffic delays were eliminated. After drivers have become accustomed to a progressive system, it may be possible to increase the speed with safety.

Local authorities should be careful to avoid design speeds which will conflict with State laws governing speeds.

Section 379--Signs Indicating Timed Speed

Timed speed or best speed signs (see Part I, Section 141) should always be erected to guide drivers operating under an alternate or flexible progressive system. Such signs should be located close to the signal indication by which the driver is guided. They may be erected at every signalized intersection or, if the blocks are short, at every other intersection.

Article A-VII--Maintenance

Much of the authority of signals is dependent upon their compelling effectiveness. Proper maintenance is therefore of primary importance if they are to command the desired respect. If it is important that street lights be regularly and effectively maintained, how much more desirable is proper maintenance for traffic signals, which have so large an effect on traffic accidents. Good maintenance also increases the effective life of traffic equipment.

The standards set forth herein are intended to provide the essential features for an adequate maintenance program.

Section 381--Inspection and Bulb Replacement

Traffic signal installations should be systematically inspected for lamp outages and satisfactory operation. All burned out bulbs should be replaced.

Section 382--Cleaning

Signal lenses, reflectors and bulbs should be thoroughly cleaned at least once every six months. Lenses and reflectors should always be cleaned when bulbs are replaced, unless the last regular cleaning has been very recent.

The reduction in brilliancy of a signal indication resulting from even a moderate amount of dust and dirt is generally very much underestimated.

The frequency with which cleaning is required will vary according to the location of the signal. A signal located on a bridge over railroad tracks may require cleaning once a month.

Section 383--Maintenance of Controllers

Every controller shall be kept in effective operation in strict accordance with its predetermined timing schedule. For this purpose the following are minimum standards:

383a--*Lubrication*--Controllers shall be carefully lubricated in accordance with a lubrication chart furnished by the manufacturer at least as frequently as is specified by the manufacturer and more frequently if experience proves it necessary.

Different controllers require lubrication at widely different intervals. The more complex the control mechanism, the larger the number of moving parts, and the more work they do, the more exacting will be the lubrication requirements.

The manufacturer should furnish a simple lubrication chart showing clearly the points requiring lubrication and the kind or kinds of lubricant to be used. No other lubricant should be used unless its appropriateness has been established. If the desired lubricant is not available in the present emergency, the manufacturer should be consulted concerning a proper substitute.

383b. *Timing.* The correctness of timed operation of the controller should be carefully checked at least once each six months.

The checking as to timing can be done effectively in connection with cleaning, lubrication or overhauling. The length of each interval should be recorded for at least two complete cycles. These should then be checked against the timing schedule, which should be located in the control box housing.

A coordinated signal system should be checked as to timing by having an observer drive through the system twice a week.

The necessity for checking timing arises from the possibility of mechanical or electrical misadjustments or unauthorized changes in timing.

383c. *Overhauling.* Every controller should be removed from service and overhauled at least once every twelve months.

The overhauling should consist of a thorough cleaning, checking for correctness of operation, a careful inspection for worn parts or parts out of position, any necessary adjustments, replacement of necessary parts, and lubrication. The controller should then be placed on test in the shop for at least two days, during which period several observations should be made as to whether its operation is in strict accordance with the timing schedule, and otherwise satisfactory.

Section 384--Painting

Signal heads, brackets, poles, posts, control boxes, housings and conduits above ground should be repainted at least every two years, and as much oftener as may be necessary to prevent corrosion and to maintain the good appearance of the equipment.

Section 385--Record Keeping

Thorough maintenance records should be kept and analyzed at regular intervals to determine future policies as to equipment purchases and maintenance program.

Good maintenance records are valuable in a number of ways:

(a) Careful analysis will assist in determining whether or not the maintenance program in use is satisfactory.
(b) Analysis of costs will aid in deciding upon types of equipment to be purchased and improvements in maintenance methods.
(c) Maintenance records may be subpoenaed by courts in connection with accident cases.

Maintenance records should indicate the necessary time required and costs of cleaning, lubrication, retiming, overhauling, bulb replacement, painting, et cetera, for each signal installation and for each specific controller.

B--Flashing Signals

Group B embraces all traffic signals other than traffic control (STOP and GO) signals. These include STOP, caution and train-approach signals. With the exception of the train-approach wigwag signal all are flashing, and the latter is classed as flashing since it produces a similar effect.

Article B-I--Legal Authority

Flashing signals should be placed along the highway only by the properly constituted authorities having jurisdiction.

Article B-II--Application

Section 386--Conditions Warranting STOP and Caution Signals

Stop and caution signals shall be used as parts of a traffic control signal installation not continuously operated as STOP and GO signals, under the conditions set forth in Section 360.

STOP signals are also desirable instead of or in conjunction with STOP signs at especially hazardous intersections.

Caution signals should be used to mark permanent obstructions in the line of travel on the roadway, such as safety zones, posts, bridge structures and abutments. They may also be used to attract attention to slow-type signs marking exceptionally hazardous road conditions, such as the end of a road, a sharp turn or a steep grade, but they fail to impress unless confined to points of extreme danger.

Section 387--Conditions Warranting Train-Approach Signals

Train-approach signals shall be installed at railroad grade crossings to warn highway traffic of any approaching train where the volume of flow on either the railroad or the highway is considerable, or where physical obstructions to clear vision exist on the highway approaches.

Such signals shall be used for no other purpose.

Train-approach signals have been standardized in all particulars of application, design and location by the Association of American Railroads as shown in its Bulletin No. 3 on Railroad Highway Grade Crossing Protection (see Section 389).

Where signal equipment cannot be obtained for such installations during the present emergency two alternatives are possible:

(a) The crossing can be protected by a watchman or gates.
(b) The proper authority, if so empowered by law, can designate the crossing as a STOP crossing and STOP signs can be erected.

Article B-III--Design and Operation

Section 388--STOP and Caution Signals

Signal heads for STOP and Caution signals, while they may vary in minor details of shape and dimensions, shall include the following essentials:

(a) Each lens shall have a visible diameter of not less than 8 inches.
(b) The illiminating element, lens, reflector and visor shall be of such design as to render the lens, when illuminated, clearly visible to traffic facing the signal at all distances from 10 to 300 feet under all light and atmospheric conditions except dense fog.
(c) The light shall flash continuously at a rate not less than 50 or more than 70 times per minute. The illuminated period shall be at least as long as the dark period.
(d) The colors of the lenses shall be red for stop and yellow for caution.
(e) When a flashing signal is used in combination with a standard sign, it shall be incorporated in the design of the sign above the symbol or word message which the sign indicates. An alternative to this is flashing illumination of the symbol or word message itself.

Beacons showing steady lights are not recommended, because they lack attracting power and are likely to be confused with other lights.

Section 389--Train-Approach Signals

The Association of American Railroads has approved two types of signals to give warning to the user of a highway of the approach of a train at a railroad crossing:

(a) Flashing light type - with two red lights mounted horizontally and flashing alternately.
(b) Wigwag type - with a swinging target and red light.

The standards adopted by the Association of American Railroads also include the following requirements:

Train-approach signals shall be mounted on the same post that carries the standard railroad crossing sign and shall not be used at any other place or for any other purpose.

Signal indications shall begin not less than 20 seconds before the arrival of the fastest train operating over the crossing.

Acceptance of this provision is based on the emergency period, pending study and the development of a satisfactory circuit which will relate the start of the signal to the approach speed of each train.

The length of stroke of the swinging light in the wigwag type measured horizontally between extreme positions, and the distance between centers of lights in the flashing type, shall be 30 inches. The number of complete swings of the wigwag type and the number of flashes of each light in the flashing type shall be not less than 30 or more than 45 per minute.

Flashing Light Type--Each flashing light unit shall provide an indication having a beam candlepower of uniform intensity at any angle up to 10 degrees on either side of the axis, and the range at any point in the 20-degree angle under bright sunlight conditions with the sun at or near the zenith shall be not less than 1,500 feet when a 10-watt lamp rated at 1000 hours is burned at rated voltage. Lenses or roundels for the indication shall be $8\frac{3}{8}$ inches in diameter minimum, and shall be in accordance with Association of American Railroads Signal Section Specification 69.

Wigwag type--The signal light, when the disk is suspended vertically, shall have a range at night of 1,500 feet through a total angle of not less than 30 degrees when a 10-watt lamp rated at 1000 hours is burned at rated voltage.

Lenses or roundels shall be 5 inches in diameter minimum, and in accordance with Association of American Railroads Signal Section Specification 69.

Care should be taken to point train approach signals so that the beams will be of maximum effect to the approaching traffic which it is intended to control.

Article B-IV--Location

Section 390--Location with Respect to Roadway and Hazard

The purpose of a signal other than a traffic control signal should largely govern its location with respect to the roadway and the hazard warranting the signal. Following are the suitable locations:

STOP or caution signals	Same as STOP and slow-type signs or suspended over the center of an intersection.
Train-approach signals	At the right side of the roadway and at such a distance from the center line of the track that a vehicle in the approaching traffic lane will stop at least 15 feet from the center of the nearest track before passing the signal.

There should be a train-approach signal each side of the track or tracks, at the right side of the roadway. The location of train-approach signals in the center of the roadway is not recommended, even in wide roadways.

Section 391--Height of Signals

The height of signals in this group should be as follows:

(a) On obstructions, 4 feet above pavement.
(b) On safety zones, 4 feet and 12 feet above pavement.
(c) At the roadside, 8 feet above pavement.

(d) At railroad crossings, not less than 7 or more than 9 feet above pavement.
(e) Suspended over roadway, not less than 14½ feet.

Article B-V--Maintenance

Section 392--Standards for Maintenance

The same considerations govern the maintenance of flashing signals that apply to traffic control signals.

PART IV--ISLANDS

Introduction

Islands are constructed to expedite or facilitate the safe movement of vehicular and pedestrian traffic. Under the present war emergency the importance of their proper application and design to accomplish this purpose and at the same time be adequate for all degrees of permitted illumination is greatly increased.

Efforts in regard to islands should be directed during the present emergency primarily toward removing all small islands that serve no useful purpose, redesigning other islands to reduce their hazardous features, and increasing the visibility of pedestrian refuge and other necessary islands. The visibility should be increased by proper application of paint and effective reflecting materials rather than by illumination which requires critical material and must be turned out or reduced in intensity during blackout conditions.

As with pavement markings, most of the effective designs and markings for islands during blackout driving conditions are also effective for normal driving conditions.

Classification

Islands may be classified functionally and physically as follows:

A. SAFETY ZONES
   1. Loading islands
      (a) Permanent
      (b) Removable
      (c) Preliminary
   2. Pedestrian refuge islands

B. TRAFFIC ISLANDS
   1. Divisional
   2. Channelising
   3. Rotary

Safety zones include all areas in roadways set aside for persons on foot. Traffic islands include all areas created for the separation and directing of vehicular traffic. Although the basic functions and design of the two groups are quite different, and for convenience are treated separately, it is common for an island to serve both as a pedestrian safety zone and as a traffic island.

Standardization

Islands are not adapted to detailed standardization. This manual sets forth certain basic requirements that should be met in the design, construction and illumination of islands, certain minimum dimensions that should be observed, and certain defects of design that should be avoided.

A--SAFETY ZONES

Article A-I--Legal Authority

The only questions of legal authority involved in the establishment of islands are the authority to place them in roadways where they might obstruct vehicular traffic, and the authority to exclude that traffic from them.

A model of legal authority for the establishment of safety zones is presented in the Model Traffic Ordinances, Part II, Section 14, and authority for the exclusion of vehicular traffic from such zones is provided in Article XI, Section 101, of Act V, Uniform Vehicle Code.

Article A-II--Application

Of the conditions which should be considered in determining whether or not a safety zone is warranted, the following are of major importance:

(a) Accident frequency
(b) Density of vehicular traffic
(c) Density of pedestrian traffic
(d) Speed of vehicular traffic
(e) Width of roadway
(f) Complexity of intersection

Section 401--Functions of Safety Zones

Safety zones are used principally in cities to afford protection to pedestrians at street-car loading points or where they are unable to cross wide roadways safely without stopping. They may fill several useful functions:

(a) Provide opportunity for street-car passengers to await, enter or leave street cars in safety.
(b) Serve as loading points for buses on streets where there is both street-car and bus traffic.

(c) Expedite vehicular traffic by permitting it to continue in motion while street cars and buses are stopped for loading.
(d) Provide protection for pedestrians crossing the roadway.
(e) Expedite vehicular traffic by serving as divisional islands to separate opposing streams and hold vehicles in lanes.

Section 402--Loading Islands

Loading islands are warranted and should be established at street-car stops under any of the following conditions:

(a) Where both vehicular and pedestrian traffic are sufficiently heavy to require physical separation.
(b) Where the speed of vehicular traffic along the roadway is so high that physical protection is required for even a limited number of pedestrians.
(c) Where accident experience indicates the need.

Loading islands should be used by buses as well as street cars on streets where both types of vehicles are operated, but if a separate loading place is used by buses, it should be located on the corner away from the loading island, to avoid congestion in the adjacent traffic lanes.

Section 403--Types of Loading Islands

403a. The *permanent* type of loading island should always be used if possible in order to afford maximum protection to pedestrians (see Section 419a).

403b. The *removable* type of loading island may be used instead of the permanent type at points where permanent structures cannot be permitted because unobstructed use of the roadway may be required at times (see Section 419b).

403c. A *preliminary* type of loading island may be used where apparent need for it is indicated by conditions or suggested by public requests, but where it is considered advisable to make actual tests of the need before constructing a permanent island, or where insufficient funds are available for permanent construction. Preliminary installations should be replaced as soon as

possible with a type which provides more effective end protection (see Section 419c).

Section 404--Pedestrian Refuge Islands

Pedestrian refuge islands shall be used in urban areas on exceptionally wide roadways or in large or irregularly shaped intersections where there is a considerable amount of pedestrian traffic and where heavy volumes of vehicular traffic make it difficult and dangerous for pedestrians to cross. No such island shall be placed where there is less than 20 feet between it and the adjacent sidewalk or another island.

Pedestrian refuge islands should not be located in roadways carrying fast-moving vehicles unless they can be so placed, usually in the center of the roadway between the opposing streams of traffic, as not to create hazards to the vehicles. At any other point in such roadways where there is considerable pedestrian movement across the roadway it should be protected by other means, such as a pedestrian actuated traffic signal or a pedestrian overpass or underpass.

Pedestrians in any considerable number should not be required, particularly at uncontrolled intersections, to find their way through more than four lines of traffic without the refuge of a center island, or through more than three lines in one direction without an intermediate island. Such islands may also be desirable at signalized intersections to reduce the clearance period and expedite traffic.

Section 405--Direction of Flow at Islands

Whenever islands are established in roadway areas, the local traffic authority shall specify, in each case, whether vehicles may pass on both sides of the island or are restricted to passing only on the right, and standard signs designating such regulations shall be placed properly to inform the vehicle driver.

Article A-III--Design

Section 406--Elements of Design

Loading and refuge islands shall be designed first to afford as great protection as necessary to the car

rider or other pedestrian and second to create as little hazard as possible to passing vehicles.

The following are the principal elements in the design and construction of safety zones:

(a) Platform or pavement marking designating the restricted area.
(b) Protection of area on the end toward approaching vehicles.
(c) Protection of area along the side toward the curb.
(d) Reflectorization and illumination of end protection and area.

Section 407--Designation of Area by Platform

The area of a safety zone is frequently designated by the construction of a platform raised above the pavement level to approximately the same height as the adjacent sidewalks. Such platforms are generally made in permanent form of concrete or similar material but in some instances, for economy or convenience, platforms or loading islands are made of wood in less permanent forms.

When wooden platforms are used, they shall be built in the most substantial manner possible, the height shall be the same as that specified for the permanent type, and the outside edges shall be faced smoothly, similar to the curbing.

Section 408--Designation of Area by Pavement Markings

Pavement markings to designate a safety zone, where a platform is not used, shall be as permanent as possible, but shall not be considered as sufficient in themselves to protect pedestrians. When located in the line of traffic, they shall always be supplemented by adequate devices for end protection.

The so-called safety zone made by simple pavement markings with or without buttons but without other protection is *dangerous* and *is not recommended.*

Section 409--End Protection of Loading Islands

All loading islands shall have adequate physical protection at the end toward approaching traffic in the

form of an abutment to withstand the impact of colliding vehicles. On the approach side of the abutment, markings as described in Sections 229 and 238 for hazardous objects shall be used.

Wherever possible and particularly at rural or high-speed locations, the abutment should have an elongated prow extending from 20 to 50 feet into the V-shaped area avoided by vehicles diverging to pass on either side of the safety zone. The top surface should be rounded and should slope from within 2 inches of the pavement surface to 8 inches over a distance of 5 feet and then gradually upward until it reaches the abutment at an elevation of 18 inches.

Vertical posts (three or more) solidly set in the pavement in a curve so as to deflect colliding vehicles, or removable posts firmly set in deep sockets in the ground in a curve, so installed that they can be removed and the foundation holes covered, are permissible for temporary or removable zones; but they cannot be regarded as adequate protection against serious hazards to vehicles colliding with them.

Section 410--Side Protection of Loading Islands

Side protection of loading islands is warranted only where unusually hazardous conditions indicate its need. In some instances where an abutment is placed at the end of the loading space, but no platform is provided, properly designed side protection may be desirable.

Where side protection is deemed essential it should be provided by a line of fixed or firmly secured removable posts, not less than 3 feet high and set not more than 8 feet apart. In the absence of a raised platform a substantial sheet of metal, extending at least 12 inches above the pavement, should be placed along the line of posts, on the side of vehicular traffic, to prevent vehicle wheels from striking the posts, to divert such traffic away from the loading island and to serve as a splash plate.

In no instance should posts for side protection be located within a crosswalk.

Section 411--Pedestrian Refuge Island Protection

Since refuge islands are generally located on the medial line of a highway, where vehicular traffic passes in opposite directions on either side, only a moderate amount of end protection is necessary. When the island is located at a point where traffic passes in the same direction on both sides, it should be provided with the same type of end protection as a permanent loading island. Generally, refuge islands are short in length and quite frequently are located in crosswalk areas where no side protection is possible.

Section 412--Illumination and Reflectorization of Safety Zones

Floodlights and flashing lights as prescribed prior to the war emergency are still to be regarded as providing the best illumination for safety zones, but, if used, provision must be made for turning them out or reducing their intensity to meet blackout requirements.

For new safety-zone installations, the fixtures and wiring necessary to provide floodlights or flashing yellow lights will probably not be available during the war emergency. In their absence, the necessary night visibility shall be obtained by the use of beaded paint, reflectorized materials or reflecting buttons.

Section 413--Signs at Safety Zones

An appropriate standard sign of the reflecting type shall be placed on every safety zone in the line of traffic flow at the end toward approaching traffic. The height of the center of the sign shall be not more than 3½ feet above the pavement and, except in the case of pedestrian refuge islands located in the center of the roadway, shall indicate whether traffic must keep to the right or may use either side.

Appropriate signs mounted 8 feet above the pavement shall be placed along the curb of the sidewalk adjacent to all loading islands prohibiting parking opposite the entire length of the island and for such distance beyond the point opposite each end thereof as is necessary to permit easy passing by moving vehicular traffic. (Section 110, Act V, Uniform Vehicle Code.)

Section 414--Markings at Safety Zones

The approach to a safety zone in the line of traffic flow where floodlights or flashing yellow lights are not used shall be marked on the pavement as provided in Section 229 using reflectorized paint. The end of the zone toward approaching traffic shall be marked according to the standards presented in Sections 238 and 242.

Section 415--Shape of Safety Zones

Loading islands and pedestrian refuge islands located in straight streets are generally rectangular, frequently with the ends pointed or rounded. Pedestrian refuge islands in wide irregular roadway areas should be of proper shape to fit the general layout.

Section 416--Height of Platform

The platform height of all islands used by pedestrians shall be from 5 to 7 inches and in general shall conform to local standards of curb height for sidewalks. Where additional surfacing is anticipated on the roadway pavement, due allowance shall be made for it.

Section 417--Dimensions of Loading Islands

Loading islands shall be at least 4 feet wide and shall be long enough to provide adequate access to car entrances for the number of cars ordinarily stopped at the island at one time.

Because of the difference in widths of street cars, no standard distance from the rail can be specified. Platforms should be built to accommodate the narrowest car. If any cars are operated which would overhang the edge of the island, warning to this effect should be given by marking a safe clearance distance.

Section 418--Dimensions of Pedestrian Refuge Islands

Pedestrian refuge islands shall not be less than 3½ feet wide and the usable length shall not be less than 5 feet or less than the width of the approaching crosswalk.

Section 419-Summary Specifications of Loading Islands

419a. The *permanent* type of loading island should be designed in accord with the following specifications:

(a) Shape	Rectangle (V-shaped end preferred)
(b) Designation of area	
Platform	Concrete
Pavement	Fixed posts, with buttons or other reflecting material
(c) Dimensions	
Length	Providing access to all car entrances
Width	4 feet minimum
Height	5 to 7 inches, equal to adjacent curbs
(d) End protection	Sloping abutment (V-shaped preferred)
(e) Side protection	Platform curbing (posts and sheet metal guard optional)
(f) Markings	Stripes on end protection, including edge of platform (see Section 414)
(g) Sign	"Safety Zone" center not more than 3½ feet high
(h) Reflectorization	Highly reflectorized end

419b. The *removable* type should be designed in accord with the foregoing specifications except in the following items:

(b) Designation of area	
Platform	Wood
Pavement	Removable posts in deep sockets
(d) End protection	Removable posts
(e) Side protection	Same (optional)

419c. The *preliminary* type of loading island should be designed in accord with the foregoing specifications except in the following items:

(b) Designation of area	Removable posts with heavy bases
(d) End protection	Removable posts
(e) Side protection	Same (chain optional)

Section 420--Summary Specifications of Pedestrian Refuge Islands

Pedestrian refuge islands should be designed in accord with the following specifications:

(a) Shape	Rectangle in straight street; to fit plan in wide road intersection
(b) Designation of area	
Platform	Concrete
Pavement	Posts
(c) Dimensions	
Length	6 feet minimum, not less than crosswalk width
Width	3½ feet or more
Height	5 to 7 inches, equal to adjacent curb
(e) Side protection	Curbing
(f) Markings	End protection

Article A-IV--Location

Section 421--Loading Islands

Loading islands shall be located at street intersections with the end at the near edge of the crosswalk, unless such location is unavailable because of switches, turning movements or similar conditions. When a loading island is located in the middle of a long city block, a special crosswalk shall be marked giving access to it on the side of the island at one or more selected points.

In no case shall a loading island be established unless there is at least one available traffic lane 9½ feet wide between the curb and the island.

Section 422--Pedestrian Refuge Islands

Normally, pedestrian refuge islands shall be centered on the medial line of the roadway and within the lines of the crosswalk.

On roadways carrying eight lanes of traffic, at least two refuge islands shall be provided at each crosswalk, and when an island is on the medial line of the roadway, two additional islands shall be used.

On roadways with street-car tracks, and wide enough to carry two or more moving lanes of traffic on each side of the tracks, refuge islands should be provided on each side of the street-car tracks.

B--TRAFFIC ISLANDS

Article B-I--Legal Authority

Traffic islands are elements of street and highway design and as such require no other authority.

Article B-II--Application

Of the conditions which should be considered in determining whether or not a traffic island is warranted, the following are of major importance:

(a) Accident frequency
(b) Density of vehicular traffic
(c) Speed of vehicular traffic
(d) Requirements for physical regulation
(e) Width of roadway
(f) Complexity of intersection
(g) Physical obstructions in roadway, such as monuments and supports of overhead structures

Section 423--Types of Traffic Islands

Traffic islands of the divisional and channelizing types, which do not add materially to the total width of roadway, are applicable in highly developed urban areas as well as suburban and rural areas. Because of the space required for adequate rotary movement of traffic, rotary islands, except in the case of circles and small parks laid out with the original street system, have their principal application in suburban and rural districts, where the cost of land is not prohibitive.

Section 424--Divisional Traffic Island

As the potential speeds of automobiles have increased and highway surfaces have been improved, the hazards of higher passing speeds have vastly increased. While this condition has been met to some extent by widening the roadway to three, four and even more lanes, the hazard still remains so long as there is a common surface in the center of the highway which is accessible to traffic moving in opposite directions. The only adequate means of preventing such hazard is the installation of traffic islands in the form of raised medial strips, which may be of any width from a narrow curbing to a broad parked strip.

The divisional type of traffic island shall be placed longitudinally in a new roadway to separate the two different directions of traffic in a roadway of four or more lanes in open country.

This is also recommended for existing roadways where the width permits. It is recognized, however, that narrow divisional islands do not provide adequate traffic lanes for intervening movements and cross traffic. This can ordinarily be accomplished only by widening the roadway.

Divisional islands may also be used to separate streams of traffic under any of the following conditions:

(a) In a roadway of two lanes where it is desired to prevent vehicles going in the same direction from passing one another, as for example, at narrow bridges, viaducts or underpasses, or on dangerous curves or hillcrests.

(b) In a roadway of six or more lanes where it is desired to separate the slow moving local traffic serving the abutting property along the sides from the faster through traffic moving in the same direction nearer the center.

(c) In a roadway of any width where it is desired to provide a physical guide to traffic approaching a fixed obstruction, such as a bridge support or a safety zone.

(d) In a roadway at the ends of tunnels or bridges or where traffic is regularly stopped for toll or inspection purposes.

Section 425--Channelizing Traffic Island

While the hazard of collision will tend to prevent a motorist from diverging from a straight course on a narrow roadway, there is a tendency on the part of many drivers to wander without good judgment on wide roadways, especially at intersections where there is a broad expanse of pavement. This tendency can be checked by the installation of channelizing islands in areas not used by the normal flow of traffic.

The channelizing type of traffic island may be used in large or complicated intersections or in the approaches thereto of streets four or more lanes in width to guide vehicles into a proper path of travel through the area.

Section 426 Rotary Traffic Islands

The rotary type of traffic island may be used where two or more highways carrying heavy traffic intersect and it is desirable to raise the capacity of the intersection as nearly as possible to the combined capacities of the highways without grade separation, by compelling all traffic to flow to the right around the island located in the center.

Article B-III--Design

Section 427--Elements of Design

The elements of design used for traffic islands vary considerably from those used for safety zones. Safety zones must provide for the protection of pedestrians, while this feature is not necessary for traffic islands that do not also serve as pedestrian refuge islands.

Section 428--Designation of Area

In most cases traffic islands are designated by curbs. However, during the present emergency period, when curbs and posts will become hazards during blackouts and dimouts, designation by pavement markings or roughened surfaces are preferable for small areas in the direct line of traffic within an intersection that does not contain monuments or other obstructions and are not used to any considerable degree by pedestrians.

The use of high curbs or posts creates an unnecessary hazard to vehicles during blackouts when there is no need of channelizing traffic.

Where it is important that vehicle operators be able to see beyond the island, shrubbery should not exceed 2 feet in height, so that it will not obstruct the operator's view. No such limitation is necessary in the case of large rotary islands.

Occasionally conditions may warrant the use of mushroom buttons to designate the area of traffic islands, especially of the channelizing type.

Section 429--End and Side Protection for Traffic Islands

Traffic islands generally do not require any end or side protection other than the curbing, except that narrow divisional islands should be provided with slopes on the end toward approaching vehicular traffic to avoid damage to colliding vehicles.

Section 430--Illumination and Reflectorization of Traffic Islands

Illumination of traffic islands without high curbs is generally not necessary.

In rural locations or in the case of narrow islands in the line of traffic flow, the same methods of reflectorization shall be adopted as are specified for safety zones.

Where the narrow end of a traffic island with high curbs faces approaching traffic for the purpose of segregating or channelizing parallel streams of flow, an appropriate reflectorized or illuminated sign shall be used to mark its location.

Section 431--Signs at Traffic Islands

Small traffic islands with curbs more than 3 inches high in the line of traffic streams shall be protected by appropriate reflectorized signs unless adequately illuminated.

Section 432--Markings at Traffic Islands

Traffic islands in the line of traffic streams shall be marked in the manner provided for safety zones in Section 414 and obstruction markings in Section 238.

Section 433--Shape of Traffic Islands

The shape of a traffic island is dependent upon its location and the function it is to perform.

Traffic islands of the *Divisional* type are usually long and relatively narrow rectangles.

Traffic islands used for *Channelizing* purposes are likely to be any shape, although the majority are modifications of triangles.

Traffic islands of the *Rotary* type are usually circles or some modified form that approximates a circle or an ellipse. They may be extended in one direction to such degree that they become rectangles with rounded ends, while occasionally they are quite irregular in shape to fit peculiar conditions.

In any case, they should be of sufficient size and of proper design to permit reasonable speed around them and to make approaching vehicles from the various highways reduce speed sufficiently so that safe convergence will result. The distances between much used entrances and outlets should be sufficient to permit vehicles to weave through the stream to the desired outlet without interrupting continuous flow of traffic.

Section 434--Height of Traffic Islands

Traffic islands that also serve occasionally as pedestrian safety zones should be designed as to height and curbing to meet the requirements for safety zones. Otherwise they should be built with low, rounded or sloping curbs to minimize the possibility of damage to motor vehicles if they are mounted.

Section 435--Dimensions of Divisional and Channelizing Traffic Islands

Divisional and channelizing traffic islands shall preferably be not less than 2 feet wide, and they shall not extend into any intersection beyond the curb line of the crossway. In general, the widths shall be adjusted to maintain 10-foot lanes for traffic moving in a straight line, 12-foot lanes for traffic moving around curves, and 7-foot lanes for parallel parking.

When medial divisional islands are laid out they should be so planned as to width that if additional traffic lanes are likely to be required in the future, either by street widening or narrowing of the divisional island, or both, there will always remain a medial divisional island at least 2 feet wide, and if pedestrian crossings are required, there will also be opportunity for pedestrian islands at two-lane or three-lane intervals as called for in Section 404.

Consideration should also be given to provision for left turning vehicles while waiting for an opportunity to cross the opposing stream of traffic.

Section 436--Dimensions of Rotary Traffic Islands

Each rotary traffic island must be designed with particular regard for existing conditions and for the safety of pedestrians, especially as to roadway widths and curb radii. The following are governing considerations:

(a) The central island should be large enough for a vehicle traveling at the most desirable rate of speed to follow the inner curb closely. One hundred feet is recommended as the minimum radius, although short arcs of 75-foot radius may be permitted joining curves of larger radii. A speed of 20 miles per hour can be maintained without danger or discomfort around a circle of 100-foot radius, but the design should discourage speeds higher than 25 miles per hour.

(b) The central island should be large enough to afford adequate space for interweaving between any two entering streets.

Section 437--Summary Specifications of Traffic Islands

437a. The *Divisional* type of traffic island should be designed in accord with the following specifications:

(a) Shape	Rectangle
(b) Designation of area	Rounded concrete curbs with suitable filler
(c) Dimensions	Dependent upon conditions
(d) End protection	Curbing
(e) Side protection	Curbing
(f) Marking	Stripes on end protection and pavement approach lines if feasible when in line of traffic
(g) Sign	Arrows or appropriate sign when in line of traffic
(h) Reflectorization	Reflectorization of all end protection markings and signs when in line of traffic.

437b. The *Channelizing* type of traffic island should be designed in accord with the foregoing specifications except in the following items:

(a) Shape	To fit plan of location, usually triangular
(d) End protection	Low curb

437c. The *Rotary* type of traffic island should be designed in accord with the foregoing specifications except in the following items:

(a) Shape	To fit plan of location, frequently circular
(c) Dimensions	100-foot radius or more
(d) Protection	Rounded curbing
(e) Marking	Stripes on curbing opposite approach streets (optional)
(f) Sign	"ONE-WAY" opposite approaches
(g) Reflectorization	Reflectorization of signs and curb markings when used

ARTICLE B-IV--LOCATION

Section 438--Divisional Islands

Divisional islands separating streams of traffic moving in opposite directions shall be located on the medial line of a roadway.

Divisional islands separating streams of traffic moving in the same direction may be located to suit the conditions, usually with more restriction of space to the slower moving stream.

Section 439--Channelizing Islands

Channelizing islands are of such varying character and shape that no standards of location can be formulated. Usually they are located in areas, as shown by traffic patterns, not used by the normal flow, where they will not interfere with correct movement.

Section 440--Rotary Islands

Rotary islands may be located in the centers of large intersections of two or more major highways.

Section 441--Street Car Tracks in Rotary Islands

In case there is a street-car line passing through the intersection, the tracks should be routed through the island or around it in the direction of the vehicular traffic flow.

Sometimes a rotary island has been in use so long to antedate the advent of motor vehicles. In such cases it is not unusual for a double-track street-car line to be installed on one side of the island, with cars operating in both directions, one of which is opposite to the flow of other vehicles. Such a situation is both inconvenient and dangerous and should be corrected.

Section 442--Combinations of Islands

In many cases conditions are such as to warrant the location of several islands in combinations, of which the following are common examples:

(a) Two or three divisional islands in a wide highway
(b) Channelizing islands in the approaches to a large rotary island
(c) Curved divisional islands around a rotary island to separate streams of traffic from different entering highways

Section 443--Unwarranted Islands

Not infrequently traffic islands have been placed without due regard for the convenience of the traffic they are intended to facilitate and control, with the result that they hinder free movement, causing confusion and delay rather than expediting traffic.

No traffic island shall be established unless there are at least two available lanes not less than 20 feet wide between the island and the adjacent curb, except in the case of a divisional island on a two- or three-lane roadway in a dangerous location, such as a narrow bridge or curve.

DIVISION II--BLACKOUT CONDITIONS

INTRODUCTION

A very serious threat to wartime transportation is the possibility that at any time, in certain areas, it may be necessary to impose complete blackouts of any and all illumination visible to hostile airplanes. During a blackout, lights must be extinguished or shielded from direct view from the sky and be of such low intensity that their reflection from any surface, including the ground or roadway, cannot be detected from planes flying at an assumed minimum raiding height. Under the exceedingly low level of blackout illumination traffic cannot move normally and special traffic control devices must be devised or adapted to meet the emergency conditions.

It cannot be known, of course, just where the enemy may strike or threaten to strike from the air, but every community should know what to do if a blackout is ordered, and be ready, if need be, to deal effectively with blackout traffic. The purpose of Division II of this Manual is to set forth recommended practice regarding traffic control devices when blackouts are imposed by the military authorities as a protection against air attack. Special blackout traffic control devices are ordinarily warranted only when blackouts are frequent or, because of the threat of enemy action, seem likely to become frequent. However, this does not relieve local traffic officials of their responsibility for completing all reasonable preparations for such an eventuality.

The War Department Specification "Blackout Requirements for Highway Movement" describes the fundamentals of vehicle lighting equipment and is included in this Manual as Appendix III. Another War Department Specification "Traffic Control During Blackouts," covering the fundamentals of traffic control devices and traffic regulations appears as Appendix IV.

As these requirements are published and supplemental regulations not inconsistent with military needs are devised, local traffic authorities, working with representatives of the War Department and the Office of Civilian Defense, should prepare to meet these requirements, particularly those regarding traffic control devices, when the need for their application arises.

Division II should be regarded as supplementary to Division I. Traffic control standards for conditions of daylight and normal artificial illumination should not be lowered in order to take care of blackouts. Instead, where standard devices cannot be adapted to blackout use without material loss of normal effectiveness, special blackout devices must be provided in addition to existing equipment.

The key to the design of blackout traffic control devices, other than self-illuminated signs and signals, is found in the special headlamp prescribed for use during blackouts. This lamp is being produced under War Department specifications by several manufacturers, and it is expected that it will be made available for certain civilian vehicles, beginning with official emergency vehicles and essential transportation units, as soon as Army requirements have been filled. Only one lamp is used for each vehicle, mounted at a height between 36 and 55 inches from the ground, preferably 42 inches for ordinary passenger cars. Laterally the lamp should be approximately in the driver's line of vision (for passenger cars about 11 inches to the left of the center) to secure the greatest advantage from reflecting materials in signs and markings. The lamp must be aimed so that the top cut-off of the beam is between 2 and 3 inches below the lens opening at a distance of 10 feet. (See page 155)

The blackout headlamp has extremely low candlepower as compared with standard headlamps, and it provides safe illumination only for a driver whose eyes have become properly dark-adapted by at least 5 minutes in complete darkness. The beam pattern is such as to give uniform illumination to a level road surface between 20 and 100 feet in front of the vehicle, but none beyond a distance of approximately 200 feet. The lateral spread of the beam is wide enough to reveal light colored or reflecting objects at a reasonable distance to each side. Objects above the sharply cut-off top of the beam, even if highly reflectorized, are practically invisible, hence signs or other devices that are to be illuminated by the headlamp must be close to the ground.

Studies of traffic control devices under strict blackout conditions made by the U. S. Public Roads Administration in cooperation with the Ohio Department of Highways and other agencies, have demonstrated that it is possible to move civilian traffic at low speed

with reasonable safety during blackouts, if signs, markings and signals are designed and installed as herein prescribed. To a driver whose eyes are properly dark-adapted, the permitted intensity of illumination in signals and illuminated signs is sufficient for visibility and legibility. The road illumination from the approved blackout headlight is adequate for slow speeds, such as 15 to 20 miles per hour. Reflectorized pavement, curb and obstacle markings stand out brilliantly in the headlamp beam, and reflectorized signs, if mounted low and not too far from the road edge, can be clearly read at a safe distance.

Division II of this Manual, like Division I, is divided into four Parts, covering Signs, Markings, Signals and Islands. It deals, however, only with details in which blackout traffic control devices differ from standard devices. It is relatively brief, and no attempt is made to follow the style of Division I, either as to sectional organization or typography. It emphasizes the devices that have demonstrated especial utility in blackout tests, particularly pavement markings. Such markings are located in the direct beam of the blackout headlamps, and, in general, serve equally well under conditions of normal non-blackout illumination. Signs are treated at some length, as they can be very useful if effectively located. The principal traffic signal problem concerns the utility of signals during blackout periods and methods for reducing their illumination to an acceptable intensity. Islands obviously have no special application during blackouts, but they do require adequate marking, as provided in Part II.

PART I - SIGNS

Introduction

The use of signs for traffic control and guidance under blackout conditions is governed by the following considerations:

(1) The composition of blackout traffic and the possible duration of blackouts in any area are unpredictable, hence it is impossible to establish general warrants for the use of blackout signs.

(2) Low speeds and volumes of traffic during blackouts, and special regulations applicable only during blackouts, reduce or remove the need for many signs normally required.

(3) The limited intensity and restricted beam pattern of the blackout headlamp create special problems of sign design and placement.

Warrants

The need to provide special highway signs for blackouts is largely a local problem, and it must be met on the basis of local conditions. How far the authorities in each community should go depends on the probability of the occurrence of air raids and on the volume and type of essential traffic that will have to move during blackouts. The number of signs required during blackouts will be very small as compared with requirements under normal conditions. Until frequent or extended blackouts (not to be confused with dimouts) are ordered or appear imminent, the installation of special blackout signs can rarely be warranted, but plans and preparations for such installation should not be delayed until an emergency is actually present.

The composition of blackout traffic will depend on the proximity of war industries or defense facilities, and on the availability of blackout lighting equipment for vehicles. If large numbers of civilian war workers must travel to and from work, and if they can be supplied with approved vehicle blackout lights, a considerable volume of traffic may be expected and more signs will be warranted than if emergency vehicles alone are permitted to move.

Warning Signs

Under the low level of illumination imposed by blackout regulations, vehicles must be held to low speeds of travel. Ordinary civilian vehicles equipped with approved blackout headlamps will be limited to a speed of 15 miles per hour, and even emergency vehicles, exempted from legal speed restrictions, will rarely exceed 25 miles per hour. At such speeds many of the warning signs commonly used have little application. Pavement, curb and obstruction markings (See Part II) are for most purposes more effective than warning signs during blackouts, and if properly applied will make many signs unnecessary. There is little warrant, for example, for the installation of a curve sign where the alignment is clearly marked by a suitable center line and where vehicle speeds are far below the critical speed for the curve under consideration.

Guide Signs

Many guide signs may be dispensed with during blackouts, on the assumptions that traffic will consist mostly of local vehicles, the drivers of which are familiar with routes and crossroads, and that police and air raid wardens will be on hand to guide strangers.

Regulatory Signs

Even apart from the fact that emergency vehicles (the most important traffic to be expected during blackouts) on emergency missions are exempt from normal traffic regulations, few regulatory signs are needed for blackout traffic control. Since blackout regulations prohibit any overtaking and passing on two-lane roads, no-passing-zone signs at hazardous points are unnecessary. Normal parking regulations are also suspended during blackouts, and many other traffic regulations become inapplicable. (Appendix IV, page 188).

Blackout Illumination

The type of lighting permitted during blackouts very definitely fixes the types of signs that can be used, and their locations. The low beam-candlepower of the standard blackout headlamp requires that signs, if not self-illuminated, shall be effectively reflectorized. The sharp cut-off of the top of the blackout headlamp

beam makes it mandatory that all blackout signs, except those that are self-illuminated, be mounted as near the ground as is practicable. Good reflectorized signs, placed so that they will come well within the headlamp beam pattern, can be seen and read at useful distances. Standard reflectorized signs as normally mounted are too high for visibility. Ordinary painted signs, regardless of where they are placed, are of little value for blackout use.

A general change in the location of existing reflectorized signs would make them visible to traffic during blackouts, but such a change would have serious disadvantages at other times, when a much greater volume of traffic would be affected. Maintenance forces could hardly keep ahead of the weeds and splashings that would obscure the low-mounted signs, or the accidental destruction of signs mounted close to the pavement edge. For special blackout signs these disadvantages of location must be faced and dealt with, but it would be unwise to put all signs under the same handicap. If only a few signs were moved for blackout usefulness, the essential uniformity of sign location would be destroyed. Finally, blackout warning signs should generally be located nearer to the points where their messages are applicable than are signs under normal conditions. It follows, therefore, that duplicate signs must usually be installed where blackout signs are called for.

Signs treated with luminous paint are not recommended for highway use. They are expensive and do not stand up well under exposure to the weather. Phosphorescent paints do not retain adequate luminescence through long periods of darkness, while fluorescent paints require expensive "black light" sources for their excitation. Radio-active materials involve health problems in manufacture and handling. The following discussion and specifications therefore deal only with reflectorized signs and self-illuminated signs, the latter including both internally illuminated and externally illuminated (floodlighted) types.

Application

Although the number of signs needed during blackouts will be small, there are some conditions under which no other traffic control device provides an adequate substitute. Certain types of directional information, for example, cannot conveniently be shown in pavement markings, especially where it may be necessary to

make changes from time to time, as in the case of emergency route designations. Moreover, pavement markings can be used only on hard surfaces, and are not dependable where snowfall is heavy and frequent.

The following signs are generally to be regarded as essential for blackout traffic control:

1. STOP signs at certain intersections where traffic signals are not present or are extinguished during blackouts. These include:

    (a) Intersections of two or more heavily-traveled highway routes.

    (b) Intersections within or adjacent to military or strategically important areas.

    (c) High accident frequency locations.

2. Railroad crossing signs, if crossing signals are not present or do not function during blackouts.

3. Restricted overhead clearance signs.

4. One-way signs and turning regulation signs, where necessary for safety.

5. Certain information and guide signs. These may be of a temporary type required by special emergency movements, or permanently located where any considerable volume of traffic moves regularly.

Special regulatory signs intended to govern only during blackouts should be covered or removed at other times so that they will not give false or confusing messages. This applies particularly to blackout STOP signs at intersections normally controlled by traffic signals.

The use for other types of signs during blackouts is limited, and each case must be considered as a special problem. Advance warning of intersections, for example, will often be helpful both as a guide and as a safety device.

The choice between reflectorized, internally illuminated and externally illuminated signs should be base

principally on (1) visibility requirements and (2) location restrictions. Functional classification is not a determining element. A good reflecting sign is wholly satisfactory if it can be located where the blackout headlamp beam will fall upon it. An internally illuminated sign has chief usefulness (1) where it must be seen at long range (though it is readable at only a little greater distance than a good reflectorized sign) and (2) where it is not practicable to mount the sign low enough to fall within the headlamp beam. External illumination is appropriate where high mounting cannot be avoided, or where it is desired to make visible at short notice a standard sign at normal location and height. In legibility distance an externally illuminated sign compares favorably with a properly located reflectorized sign.

Design

Since a blackout sign is definitely an emergency device and in most cases will be used only in addition to a standard sign of the same import, it should be designed with the primary object of making it as effective as possible under blackout illumination. Daylight visibility is not required, and may even be undesirable where there is already a multiplicity of other daylight signs present. Reflectorization or illumination is of first importance.

Shape

When only the message or symbol on a blackout sign is reflectorized or illuminated, there is little to be gained by holding to the standard sign shapes prescribed in Division I of this manual. Cut-out reflectorized symbols, for example, have been found effective when attached to sign posts below standard signs, or mounted independently on low posts. A reflectorized word on a small black rectangular background will provide as much legibility as a larger sign with the same size of letter, though the sign will be somewhat more conspicuous (especially in moonlight) if designed with a white painted background of standard shape. If the entire sign background is reflectorized it should be of standard size and shape.

The approved design for internally illuminated blackout signs (Fig. 501) provides a rectangular face just large enough to carry a single word message in 3-inch

letters. This sign has poor contrast for daylight or normal night legibility, and even if it is suitably located for general use it is not desirable that the illuminating unit be built into the face of a standard sign.

If external illumination is used, it will ordinarily be applied to the face of a standard sign. The sign should be reflectorized if it is also to be useful under normal headlights, when the blackout "floodlighting" will be too faint to be seen. During blackouts, however, reflectorization will add nothing to visibility, as the sign will presumably be located outside the blackout headlamp beam.

Color

Under blackout illumination colors are less important than contrast. It is recommended that blackout signs (other than externally illuminated standard signs) be black and white, using reflecting materials that reflect a substantially white light.

Illumination

The basic design of illuminated blackout signs is determined by War Department Specifications as to permissible light intensities. The light source must in every case be shielded or screened against direct view from the air, and the sign face must not transmit nor reflect more than a specified maximum amount of light. War Department Specifications for illuminated signs are set forth in Appendix IV, (Page 183). A schematic drawing of the approved "interior-illuminated" sign is shown in Figure 501. This sign should be legible at a distance of at least 100 feet under blackout conditions, but not visible at all beyond 2000 feet.

A standard sign, "exterior illuminated" under blackout specifications, should be legible under blackout conditions at a distance of at least 50 feet. One arrangement for providing the required floodlighting is shown in Figure 2 of Appendix IV. In this arrangement the paper jacket is removed from the dry cell, and its zinc case is thus "grounded" to the light bracket. One contact in the light socket is also grounded so that it is necessary only to run a single wire from the center terminal of the dry cell to the light. A 0.06-ampere, 1.2-volt bulb in a white reflector completes the unit.

An interior-illuminated sign using two No. C dry cells may be expected to operate continuously for a little more than two weeks without attention. An exterior-illuminated sign, as specified above, will operate continuously for about 25 days. Either will, of course, operate much longer if turned off during non-blackout hours.

Reflectorization

Of the several types of blackout signs, reflectorized signs are least likely to be restricted by critical material shortages. They are also cheapest to make and maintain. If well designed and properly located they provide wholly adequate legibility.

The letters on reflectorized signs should be no smaller than the 6-inch standard alphabet of rounded letters, with generous spacing. The sign should be legible to a dark-adapted observer at a distance of at least 50 feet, under blackout headlamp illumination.

Many types of reflecting material are available but not all will meet blackout requirements. The choice lies not so much between the principal types of materials (buttons, coatings, and variously shaped unit "areas") as between materials of differing optical characteristics. Any reflecting material should be brilliantly reflective and highly "retro-directive." The latter term describes the ability of a reflector to return reflected light directly toward its source, regardless of the angle of the incident beam. A fuller discussion of reflecting materials will be found in Appendix II.

Either the message (or symbol) or the background of a sign may be reflectorized.

Location

Due to the slow speed of blackout traffic, it is recommended that blackout warning signs be placed at or very near the point of hazard. The limited range of blackout visibility also requires that route markers and destination signs be placed on the near side of wide intersections where turns are to be made, rather than at the far-side location otherwise standardized.

Height

All reflectorized signs used during blackouts must be mounted so that the top of the message is not more than about 24 inches above the road crown. Although the cut-off height of the blackout headlamp beam when properly adjusted will usually be somewhat higher than 24 inches at a distance of 50 feet from the vehicle, road surface irregularities may cause only intermittent illumination of the legend if the height exceeds about 18 inches. The lowest practicable mounting height consistent with good maintenance is therefore recommended.

Internally illuminated signs should be placed approximately at driver's eye level, or at such greater heights as may be necessary to meet special conditions. In no event, however, should they be mounted less than 3½ feet, nor more than 14 feet above the level of the roadway. If mounted over the roadway the bottom of the sign should be at least 14½ feet above the surface of the roadway.

Since the only practical application of externally illuminated signs is where the lighting fixture is attached to standard signs, provisions for mounting height prescribed in Division I of this Manual should apply.

Lateral Placement

Where a raised curb exists, reflectorized signs should be set so that the nearer edge is 12 inches back of the curb line. On 2-lane roadways without a curb, such signs should be placed as close to the edge of the traveled roadway as practicable, but in no event less than one or more than six feet from such edge. On 4-lane highways where no curb exists the nearer edge of the signs should be one foot from the edge of the traveled roadway. Reflecting signs should be placed at such an angle that at a distance of 50 feet the sign is approximately normal to the driver's line of vision.

Lateral placement of both externally and internally illuminated signs should be in accordance with the standards set forth in Division I of this Manual.

PART II - MARKINGS

Introduction

Effective pavement, curb and object markings are essential for traffic movement during blackouts. Markings as applied and designed in Division I covering normal conditions are satisfactory and should be used extensively for blackout conditions, except as modified by the following factors:

1. The need of markings is governed by actual or possible essential vehicular and pedestrian movement during blackouts. Locations having the heaviest movement during normal conditions are not necessarily the ones where the greatest need will exist for markings that are effective during blackout conditions.

2. To be effective for vehicular traffic during blackouts all markings must be reflectorized. The visibility of plain painted lines or markings is very low.

3. The visibility of transverse markings on the pavement surface is decreased during blackouts to a greater extent than that of longitudinal markings. To be effective for vehicular traffic, transverse markings generally require special treatment in addition to reflectorization.

4. Floodlights, street lights and other illumination used during normal conditions must be turned out or reduced in intensity during blackouts. It is often necessary, therefore, to provide additional markings to compensate as far as possible for the decreased illumination.

5. Since most standard signs are not effective during blackouts, it is desirable and sometimes necessary to use additional pavement and curb markings to perform some of the functions normally performed by signs in regulating, warning or guiding traffic.

6. Some of the pavement markings used during normal conditions, such as no-passing barrier lines on 2-lane roads, are not necessary during blackouts.

Application and Location

All pavement, curb and object markings employed to regulate, warn or guide traffic during blackouts shall be applied and located in a manner consistent with the requirements for normal conditions as set forth in Division I. Special markings that may cause confusion or unduly restrict the movement of traffic during daylight or while normal nighttime illumination is permitted shall not be used.

Markings effective during blackouts are desirable on all important highways. They shall in any event be applied on highways designated for such marking as a result of consultation between local officials responsible for traffic planning and the appropriate military and civilian defense authorities. The following markings shall be used:

(a) Center Lines - Center lines on all two-way paved roadways having an even number of lanes. Experience under test blackout conditions has definitely shown that a center line is essential and one of the most effective driving aids on paved surfaces.

(b) Lane Markings - Lane lines on all paved surfaces having an odd number of traffic lanes or where two or more lanes are available for traffic in a single direction.

Blackout regulations set forth in Appendix IV permit overtaking and passing when there are two or more lanes designated for traffic in the one direction. However, such a maneuver is extremely difficult to perform with safety unless each driver has a lane line to follow.

(c) Approach Lines to an Obstruction - Lines extended from the center or lane lines to guide traffic to the right or left of any obstacle or hazard in the roadway. When traffic is permitted to pass to either the right or the left, the area between the guide lines shall be marked with transverse lines (Figure 229).

(d) Diagonal Guide Lines - Diagonal guide lines extended from the lane or center lines to indicate when the pavement width changes to a lesser number of lanes.

Since drivers have a tendency under blackout conditions to travel immediately to the right of the center or lane line being followed, pavement edge lines; which may be mistaken for center or lane lines unless reflectorized guide posts are also used are not recommended.

(e) Delineators - Bi-directional delineators on the outside of all curves where the curvature is sharper than 12 degrees, and along all roads without a paved surface where the traveled portion of the roadway is not outlined by a marked contrast in color with the adjacent right-of-way.

(f) Approaches to Railroad Crossings Pavement markings at paved approaches to all railroad crossings except minor sidings or spurs.

(g) Limit Lines - Limit lines at all intersections where traffic signals are in operation during the blackout period, in conjunction with all STOP signs placed especially for blackout conditions or where it is deemed necessary for crosswalk lines to be visible to vehicular traffic during blackouts.

(h) Curb Markings - All curbs in the direct line of traffic, including those at the following locations:

1. Traffic islands.
2. Safety zones.
3. Irregular intersections.
4. Sharp curves.

Curbs shall also be marked along bridges, viaducts and other similar hazardous locations, and at important intersections for a distance of 15 feet back from the crosswalks.

(i) Warning Markings on Hazardous Objects - Physical obstructions in or so near a roadway as to constitute serious hazards to traffic, including installations designed for the control of traffic.

(j) Words, Route Directions and Arrows - The word "stop" in elongated letters shall be marked on the pavement in conjunction with all STOP signs on 4-lane highways designed for use during blackouts.

The effectiveness of words and route directions on the pavement in blackouts is limited unless the speed of vehicular traffic is below 15 miles per hour, but arrows properly placed are effective at somewhat higher speeds and should be used where guidance of traffic is important.

Design

In general, all pavement, curb or object markings for blackout conditions should be designed the same as when normal illumination is permitted. The following paragraphs indicate special design features that are permitted for normal conditions and necessary to obtain markings that are effective during blackouts.

Color

White is the most visible color for markings. Yellow paint is not as visible as white, although when both are reflectorized they are almost equally effective.

Reflectorization

To be effective for vehicular traffic, markings on pavements, curbs or objects must be highly reflectorized, with the exception of black lines used between white or yellow lines to form a stripe design on curbs or objects. All mandatory pavement markings shall be reflectorized unless adequately illuminated.

Delineators

Reflecting units or road delineator devices should be placed not higher than 22 inches above the crown of the roadway. For best effects, delineators with reflectorized coats should extend down to within 12 inches above the crown of the roadway.

All delineators shall, if possible, be placed 2 feet from the main traveled portion of the roadway and in any case not more than 6 feet from the edge. The spacing between delineators, when used on tangent sections of highway, shall not exceed 50 feet.

On curves and when used to delineate the approach to and proper course around obstacles, delineators shall be spaced as close as necessary to outline the curve or obstacle.

Transverse Lines

To be effective and observed by vehicular traffic, limit lines must be visible for a distance of 50 feet. Section 228 provides that such lines shall be at least 16 inches wide or where special emphasis is desired the "comb" design, described in Section 222 and illustrated in Figure 227 shall be used. Both provisions are especially important in blackouts.

Narrow crosswalk lines even if reflectorized will not be adequately visible to approaching motorists.

Curb Markings

Curbs at intersections, when marked, shall be either solid white or yellow.

Curbs marked between intersections to prohibit parking during blackouts shall be marked with alternate black and reflectorized white stripes. Curb markings to prohibit or restrict parking under normal conditions should be as prescribed in Section 231.

All curb markings, when used to designate parking restrictions, shall be applied to both the face and top surfaces.

Warning Markings on Hazardous Objects

When reflectorized paint or coatings are used to mark hazardous objects in the line of traffic, the marking should extend from the ground or road elevation to the height of the obstacle or to a point 36 inches above the road surface.

When reflector buttons or units are used, they shall be placed not more than 22 inches above the elevation of the road surface.

At locations where floodlights or flashing lights are used to mark hazardous objects during periods in which normal illumination is permitted, provision shall be made either to turn the lights off or reduce their intensity during blackouts to meet the War Department Specification "Street Lighting During Blackouts." When the floodlights or marker lights are turned off, reflectorized markings required at locations where lights are not used shall be applied, or illuminated signs or lanterns meeting War Department blackout specifications shall be provided.

PART III - SIGNALS

Introduction

The recognized need for restricted light output from traffic signals during blackout periods has fostered a large number of improvisations, particularly in connection with signal masking. It is difficult to obtain, through the use of a signal mask, the low level of ground brightness which is necessary to prevent aerial detection during blackouts and still have no material impairment of the normal daylight effectiveness of the signal. Thus far no adequate masking device has been brought to the attention of the Committee. Nevertheless, the interest shown in this problem is commendable and a satisfactory type of mask may yet be devised.

The signal problem that deserves the most thought and study by traffic authorities concerns the utility of traffic control signals during blackout periods. Vehicle speeds and volumes will in general be considerably below normal, and at those locations where little or no essential traffic is expected to conflict, signals should be extinguished. Other signals which, in the judgment of the proper local authorities, are necessary to safeguard or expedite important civil or military traffic movements, must be treated so as to conform with the standards presented herein.

Application

Traffic flow during blackouts will not consistently follow any established pattern. Maximum intersection capacities may be approached during relatively short periods of time, and for the intervening periods it is possible and likely that traffic will be very light. Because of this unpredictable irregularity and the likelihood that auxiliary police or other similar methods of intersection control will be available, it is probable that relatively few traffic signals will be useful or necessary during blackouts. In view of these complications, it is not feasible to formulate warrants for signal installation or operation. Instead, it is recommended that any signal installation, proposed or existing, at any of the following locations be analyzed with respect to its probable usefulness during blackouts. The decision to install or operate the signal should be based on such an analysis.

(a) Intersections of two or more heavily traveled highway routes.

(b) Intersections within or adjacent to military or strategically important areas.

(c) Intersections within shopping, business, office or amusement districts.

(d) High accident frequency locations, if accidents are of a type susceptible to correction by a traffic signal.

(e) Points of heavy pedestrian movement.

Flashing signals at most railroad grade crossings are of sufficient importance to justify their operation during blackout periods.

Design

The modification of any traffic signal to obtain the low illumination levels required during blackouts must not seriously impair the daylight effectiveness of the signal. As previously stated, numerous masking devices have been proposed and used experimentally, but the Committee is not aware of any adequate mask design up to this time. Voltage reduction appears to be a more satisfactory means of meeting the photometric requirements of the War Department.

A. Visibility and Illumination during Blackouts.

1. Traffic signals shall be clearly visible to dark-adapted road users on a clear moonless night at all distances from 10 to 300 feet.

2. The candlepower values of the light emitted in a vertical plane from a traffic signal lens shall not be in excess of the following:

Angle above horizontal	*Maximum candlepower*
90°	0.04
60°	0.05
40°	0.10
30°	0.15
20°	0.35
15°	0.60

3. The incident illumination on the street in front of any traffic signal shall not exceed .0006 footcandle at street level.

These requirements may be met by reducing the voltage on the signal lamps to approximately one-fourth the rated voltage (60-watt lamps at 26 percent, 100-watt lamps at 24 percent and 40-watt lamps at 29 percent of the rated voltage). Auxiliary transformers or resistors in the lamp circuit may be used for accomplishing this voltage reduction. The former is a more expensive method and involves the use of critical materials that are not readily obtainable, but has some ruggedness and reliability features not present in the resistor method. The latter is a very convenient, simple, and inexpensive method when ordinary general service lamps are used as resistors in the common return of the lamp circuit. At the common type of intersection where four signal lamps are illuminated for the major part of the cycle, lamps of the wattage shown in the following table provide the proper amount of resistance.

Traffic signal lamp	*Resistor lamp*	*Lumen output*
60 watt	1 - 150 watt	0.9
40 watt	1 - 10 watt and 1 - 100 watt in parallel	0.77
100 watt	1 - 60 watt and 1 - 150 watt in parallel	0.5

B. Special Pedestrian Signals.

Except at locations where heavy pedestrian movement is likely to conflict with vehicular traffic during blackouts, special pedestrian signals should be extinguished for the period of the blackout. Where they are necessary, the illumination shall be reduced during blackouts to the same level as that required for other traffic signals.

C. Flashing Signals.

1. Flashing yellow or red indications used for caution or stop signals shall either be extinguished or treated to comply with the requirements for traffic control signals.

2. Train approach signals conforming to the Association of American Railroads' standards shall be treated in the manner outlined in the War Department Specification, "Blackout of Railroads" (now in preparation). Other train approach signals shall conform to the photometric requirements for traffic control signals outlined herein.

Operation

Provision should be made in locations in danger of air raids for bringing those signals which must be operated during blackouts into conformity with the blackout requirements and for the immediate turning off of all others. This can often be accomplished from central points in interconnected systems but where such central control cannot be had, switches can be installed in the lamp circuit at each controller so that police or air raid wardens will be able to turn off or reduce the voltage on the lights (not the controller) in the event of an air raid or blackout.

In general, blackout traffic control regulations require that vehicle speeds be limited to 15 miles per hour. Where unusual hazards exist or where exceptionally free and safe movement is possible, lower or higher limit speeds may be required or permitted. If possible, interconnected signal systems that are to be operated throughout blackouts should be equipped so that the signals will be timed during the blackout as closely as possible to the specified limit speed.

Maintenance

The low level of signal illumination specified during blackouts makes it particularly important that signal lenses, reflectors and bulbs be cleaned regularly and at frequent intervals. Lenses and reflectors should be cleaned whenever bulbs are replaced. Even a moderate amount of dust will make a considerable difference in the intensity of blackout signal indications.

PART IV - ISLANDS

The only problem regarding islands during blackout conditions is to provide adequate visibility which is dealt with in Parts I and II.

APPENDIX I

Submittal of Applications for Preference Rating on Traffic Signal Equipment to the War Production Board

In view of the critical nature of the materials involved in the typical application to the War Production Board for a preference rating on traffic signal equipment, these applications receive most careful scrutiny.

When only a few individual purchases of critical materials are involved, such as five hundred feet of signal cable or a controller, application Form PD 1-A should be used. However, if the materials are required for a more comprehensive type of signal project, such as the installation of a progressive system of control along a given street, application for a Preference Rating Order P-19-e should be made in accordance with General Administrative Memorandum No. 148, issued by the U. S. Public Roads Administration and available in each State highway department. In either case, the bill of materials accompanying the application should show a complete list of all materials required for the proposed installation.

Conference with the War Production Board representatives who are reviewing these applications indicate that more prompt consideration is likely and less delay will ensue if certain supplemental information accompanies the application. Below in outline form are the items that have been found to be of particular significance in arriving at a decision regarding the urgency of traffic signal equipment applications:

I. *Description of area where improvement is proposed*

   A. Location with respect to essential war industries or military centers should be shown, preferably on a sketch map.

   B. Relation of improvement to activity in the area.

II. *Amount of traffic to be served*

   A. Flow diagram showing volumes of straight and turning traffic.

   B. Indication of average and peak volume conditions.

   C. Recent trends toward increase or decrease in traffic load.

III. *Nature of traffic to be served*

   A. Statement concerning composition of traffic (war workers, workers in nonessential industry, shoppers, etc.).

B. Statement concerning types of vehicles to be served (street cars, busses, trucks, passenger vehicles, etc.) and predominance of any one or more types if this is a significant factor.

IV. *Past experience at the location*

A. Accident record (covering one year, if possible).

1. Number of accidents (fatal, injury and property damage).
2. Number of fatalities.
3. Number of injuries.
4. Amount of property damage.
5. Collision diagram.

B. Congestion and delay to traffic.

1. Summarized facts, if available.

V. *Condition of existing equipment, if any*

A. Physical

1. Amount of mechanical wear, etc.

B. Functional

1. Outmoded
2. Inadequate for the traffic service required.

VI. *Proposed installation of new equipment*

A. Amount and type of equipment and materials required.

B. General lay-out and operating plans.

C. Alternate design, lay-out or materials considered, if any, with reasons for rejection.

VII. *Effort made to obtain equipment from other sources*

A. Transfer from locations where installation is not warranted under present conditions.

B. Attempts to purchase necessary materials from other Governmental units.

VIII. *Disposition to be made of existing equipment, if it is replaced or released.*

A. Transferred to another essential location.

B. Put in stock.

C. Sold for junk.

IX. *Statement summarizing principal reasons for proposed use of new equipment*

A. Urgency of improvement from standpoint of directly and immediately contributing to the war effort.

B. General transportation value of the improvement in reducing social and economic losses.

The representatives of the War Production Board urge that all applications involving $300 or more be submitted to them through the respective State highway departments and the Public Roads Administration with the recommendations of these agencies. This procedure will centralize and expedite their consideration in Washington.

If less than $300 worth of equipment is involved the applications may be submitted to the War Production Board directly. It is important that the application embrace the entire installation or improvement, i.e., a series of applications each with less than the $300 limitation may not be substituted for one application of, say, $1,200 value.

The importance of supplementing the preference rating application with the pertinent items from the above outline should not be underestimated. The length of time required to get a decision on an application depends largely upon the care with which the applicant has presented the essential facts of his case. Inadequately prepared applications awaiting further data seriously delay the processing for priority assistance.

APPENDIX II

MATERIALS AND SPECIFICATIONS

Inasmuch as general practice in the use of traffic control devices and specifications for the design and manufacture of such devices are treated in the former Manual on Uniform Traffic Control Devices, it has been an obvious responsibility of the Joint Committee in preparing a War Emergency Edition to recognize the existing shortage of materials and to propose a program appropriate for this condition. This Emergency Manual therefore states that certain types of signs are regarded as nonessential, that oversize and overhead signs should be used sparingly, and that traffic signals must be reserved for critical locations. It emphasizes the need for getting the maximum useful life from existing devices.

Specifications for materials and fabrication of traffic control devices are subject to change at any time as the list of critical materials changes. New materials and new applications are being developed, but many substitutes are themselves passing into high-priority classifications. The traffic engineer and the equipment manufacturer must use ingenuity in discovering suitable expedients when normal specifications can no longer apply.

SIGNS

From discussion with representatives of the War Production Board it is apparent that no one material can be specified as a universal alternative to metal for signs. Notwithstanding the Nation-wide scarcity of sign material of any sort, the problem is also largely localized by virtue of existing stocks, nearness to natural and commercial sources of possible sign material, and perhaps other factors.

In view of this, and the further fact that alternative materials themselves often become critically scarce, it is necessary for the present to leave the determination of substitute sign material principally in the hands of the local authorities, who will use whatever can be obtained. It is hoped, of course, that the situation will become more stabilized as time passes, and that some allotment of selected materials for highway signing will eventually be possible. In the meantime, local authorities who have no choice other than to use critical materials for signs vitally needed to protect and expedite important traffic movements would encourage favorable consideration in the War Production Board by submitting their applications for preference rat-

ings on sign material through their respective State highway departments and the U. S. Public Roads Administration. A complete and detailed statement of the urgency of the proposed signing and all related factors, similar to that suggested for traffic signal equipment applications in Appendix I, should accompany such applications.

New steel for highway signs is not now obtainable. Specifications for metal signs, included in Appendix B of the former edition of the Manual on Uniform Traffic Control Devices should be referred to, however, as a guide to the refinishing and salvage of old signs. Metal signs, unless destroyed by accident or neglect, can be refinished many times before being scrapped. It is reported that even embossed steel signs can be satisfactorily flattened and re-processed with new designs.

Ordinary wooden panels, once almost universal for highway signs, are again likely to be widely used. Specifications for wooden signs prepared in 1927 by the Joint Board on Interstate Highways can be found in Appendix B of the previous edition of this Manual, and are recommended for current application.

Other materials that may be expected to give reasonably satisfactory service in highway signs (most of them under priority restrictions in varying degrees) include compressed fiber board ("tempered Masonite" or equivalent), waterproof plywood, vulcanized fiber, and asbestos millboard. All of these have the advantage of being more convenient to handle than thick wooden panels, but the fiber compositions are not as easily worked with ordinary woodworking machinery in the sign shop. Phenolic-resin bonded plywood is not available for civilian use, but plywood bonded with cold-setting urea-resin glue is almost equally weather resistant and is recommended for use in signs if it can be obtained. All fiber or plywood signs should be painted as specified for wooden signs, with special attention to edges, to prevent undue absorption of moisture.

PAINT

Paint chemistry has been greatly affected by recent research and by war restrictions. Specifications must be flexible, to take advantage of new developments and to permit substitutions of less critical materials.

For painting signs the following Federal Specifications[1] suggested:

Black paint: TT-P-61, dated March 31, 1931, with Amendment 1, dated October 1934, and Emergency Alternate Federal Specification

E-TT-P-61, dated January 6, 1942.

Yellow paint: TT-P-53, dated February 12, 1937, and Emergency Alternate Federal Specification

E-TT-P-53, dated February 24, 1942.

White paint: TT-P-101a, dated March 11, 1936, with Amendment 1, dated January 30, 1940, and Emergency Alternate Federal Specification

E-TT-P-101a, dated August 28, 1942.

The Emergency Alternate Specifications are issued "in the interest of conservation of certain strategic materials" in each case.

There are no Federal specifications for white and yellow paints of the enamel type for exterior use.[2] A U. S. Treasury Department Procurement Division specification, No. 359, dated July 8, 1939, covers exterior white enamel, but this formula calls for glyceryl phthalate resin, a synthetic material of a critical nature. It is therefore suggested that spar varnish (Federal

1. Federal specifications are issued by the Director of Procurement for the use of all departments and establishments of the Government. They may be purchased ($.05 per copy for those listed here) from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. The Emergency Alternate Federal Specifications and the Procurement Division specification subsequently referred to are obtainable (without charge) from the Federal Catalog Section, Treasury Department Procurement Division, Washington, D. C.

2. Enamels are characterized by free-flowing qualities, the absence of brush marks and, ordinarily, a harder and glossier surface as compared with oil paints. They are more brittle and hence more liable to crack when used on wooden signs. On the other hand, oil paints usually dry more slowly, especially under adverse drying conditions, a disadvantage when many signs must be finished at one time and drying space is limited.

Specification TT-V-121a, dated May 7, 1935, with Amendment 3, dated October 8, 1941, and Emergency Alternate Federal Specification E-TT-V-121a, dated August 28, 1942) be substituted for the glyceryl phthalate vehicle, although the quality will thereby be lowered somewhat.

For outdoor yellow enamel the U. S. Department of Agriculture, Forest Service, has its own specification, recommended by the National Bureau of Standards. Outdoor black enamel is covered by Federal Specification TT-E-521, with Amendment 2, dated October 11, 1940, and Emergency Alternate Federal Specification E-TT-E-521, dated April 25, 1942.

The standard yellow color for warning signs was originally defined by the Joint Board on Interstate Highways in terms of dominant wave length, purity and integral reflection of pigment. Color cards showing the recommended standard for "Highway Yellow," with suitable tolerances, may be obtained on request from the U. S. Public Roads Administration. Scarcity of chrome yellow pigment may make it impossible to meet this standard of yellow during the emergency, but it may be approximated with a partial substitution of yellow ochre, as provided for in Emergency Alternate Federal Specification E-TT-P-53.

TRAFFIC PAINT

Traffic paint, for pavement, curb and obstacle marking in white and yellow, is covered by Federal Specification TT-P-115, dated April 29, 1942, and Emergency Alternate Federal Specification E-TT-P-115, dated August 28, 1942. The latter specification refers to white paint only, presumably due to the difficulty of obtaining a satisfactory substitute for chrome yellow pigment. Since a bright yellow apparently cannot be produced from non-critical earth pigments, clear white markings may have to be used during the emergency, rather than a compromise that is neither white nor yellow.

The standard yellow for traffic markings is the "Highway Yellow" prescribed for highway signs, referred to above.

The reflectorizing of traffic paint by incorporating glass beads in its surface, is a patented process, the specifications for which should be obtained from the patentee or licensee.

REFLECTING MATERIALS FOR SIGNS

Reflecting materials for signs are of various types, including "buttons" of glass or transparent plastic, shapes or "areas" of glass, plastic or metal having multiple lenses or facets, and "coatings" consisting usually of minute glass spheres embedded in the surface of a pigmented binder. The last-named type is available either for liquid application direct to the sign surface or in fabric form for cementing in place.

To be effective under headlamp illumination, especially during blackouts, reflecting materials should be highly "retro-directive". That is to say, the incident light should be reflected accurately back toward its source, with only enough divergence or scatter to include the driver's eye in the cone of reflected light. For long-range reflecting buttons, this "divergence angle" (the half-vertex angle of the cone) should be of the order of one degree. The reflecting material should also function through a reasonably wide angularity of the incident light, since the headlamp beam, of course, cannot always strike the sign surface perpendicularly. Most materials are effective up to 25 or 30 degrees from the perpendicular, more than is ordinarily needed. In blackout signs somewhat greater divergence angles are desirable, since these signs are read at close range, when the angle (at the sign) between the blackout headlamp beam and the driver's line of sight becomes relatively large.[1]

Specifications for reflecting elements should be based on performance tests, both as to optical efficiency and as to physical resistance to weather. Retro-directive reflectors of glass or transparent plastic should meet the SAE specification for Class A "Reflex Reflectors" set forth in the 1942 Handbook of the Society of Automotive Engineers.

Specifications for glass-bead reflecting coatings have not yet been formulated by any national agency.[2] These materials have been developed to a high degree of efficiency during recent years, and in many applications compare favorably with standard reflecting buttons. Their lower unit brightness is to a considerable degree offset by the larger reflecting area covered by them—the entire area of a symbol, for example, instead of only a pattern

1. For a detailed discussion of retro-directive reflectors see "Reflectors Used in Highway Signs and Warning Signals" by G. A. Van Leer, Jr., in Journal of the Optical Society of America. Vol. 30, No. 10, October 1940, pp 462-487.

2. A War Department specification "Reflectorized Coating System (Retro-directive)" is in preparation.

of bright spots. As a basis for specifications, one proposed method of testing measures their reflecting qualities as a ratio between the average intensity of illumination falling upon a given area of the material at a given distance from the light source and the intensity of the reflecting light returned to a point closely adjacent to the light source, both intensities being measured by a standard light meter. Another method of testing compares their brilliance with that of a standard diffusing white reflecting surface.

SIGNALS

Specifications for "Adjustable Face Traffic Control Signal Heads" have been published by the Institute of Traffic Engineers and approved as an American Standard by the American Standards Association. A tentative standard for "Pre-timed, Fixed Cycle Traffic Signal Controllers" has also been issued by the Institute.[1] It is apparent that during the war emergency these specifications cannot continue to be met in respect to many details. Non-ferrous metals cannot be had for housings, for example, and certain electricwl equipment is restricted. The problems of redesign to make use of substitute materials are being worked out by the manufacturers. For the time being, however, traffic engineers must design their signal systems with wartime conservatism and some sacrifice of flexibility and efficiency, if they expect to establish the high priority necessary for the obtaining of any equipment at all.

1. See TRAFFIC ENGINEERING HANDBOOK, Institute of Traffic Engineers and National Conservation Bureau, Appendices I and II.

APPENDIX III

BLACKOUT REQUIREMENTS FOR HIGHWAY MOVEMENT

War Department Specifications Published by the

OFFICE OF CIVILIAN DEFENSE

Prepared under the direction of the Chief of Engineers, United States Army, by the Engineer Board, with suggestions of the National Technological Civil Protection Committee, the National Defense Research Committee, the National Bureau of Standards, the Interstate Commerce Commission, the Office of Defense Transportation, and the War Production Board.

FOREWORD

The standards specified herein may be imposed by military authority during specified periods and in specified areas. Independent of such action these standards afford guides to civilian authorities as to measures that can be taken by them to conform their conduct with what may eventually be prescribed.

Due to the scarcity of certain critical materials which will be involved in the manufacture of the equipment called for in these specifications, it is probable that only the most exposed communities in the continental United States will be able to procure the equipment. For this reason these specifications are being given only a limited distribution at this time.

BLACKOUT REQUIREMENTS FOR HIGHWAY MOVEMENT

1. Scope

This specification describes the equipment required by road users, military or civilian, who move on any highway, road, street, alley path, or other way, or on any exposed area which permits aerial observation of direct or reflected light, within those areas and during those periods specified by proper military authority. Traffic control measures and special traffic control devices specified for blackouts are included in War Department specification, *Traffic Control During Blackouts.* (Now in preparation.)

2. Objective

Blackout equipment required herein is designed to afford maximum safety of ground movement commensurate with provision of reasonable freedom from detection by enemy aircraft.

3. Dark Adaptation of Eyes

Because of the low level of illumination required for blackout and the time required for the human eye to become adapted for vision at such low illumination, no road user, except in emergency, should move in a blackout until his eyes become properly dark-adapted. At least 5 minutes in complete darkness is normally required for such adaptation.

Motor-Vehicle[1] Blackout Equipment

Only those motor vehicles and motor-vehicle combinations employing approved equipment (appendix B) as specified below shall move during blackouts.

a. Required Equipment on All Motor Vehicles

(1) *Blackout driving lamp* - One, and only one, approved blackout driving lamp shall be employed on all motor vehicles. This lamp shall be securely mounted on the front of the vehicle, between the left side and the center, as near as possible to normal line of operator's vision, and far enough forward to eliminate appreciable reflection of light from any portion of the vehicle. The mounting height shall be not less than 36 nor more than 55 inches, measured from road level to the bottom of the slot in the mask, and in no case higher than the top of the rim of the steering wheel. (Preferable mounting height is approximately 42 inches.) With vehicles on level surface and carrying normal load, the unit shall be so adjusted that bottom of slot is horizontal, and so aimed that the visual cut-off of the top of the beam, on a vertical screen 10 feet in front of the lamp, is at least 2 and not more than 3 inches below the bottom of the horizontal slot in the headlamp mask. [Studies sponsored by the Joint Committee in cooperation with the Ohio Department of Highways indicate that probably the most desirable mounting position on passenger cars is 11 inches off the center of the vehicle, toward the driver's side. The headlamp can be mounted in this position on most passenger cars without difficulty. For further discussion of the mounting location, see introduction to Division II. — *Joint Committee.*] When mounted on motorcycles, the lamp shall be placed on the front, near the center, as near as possible to normal line of operator's vision, and far enough forward to eliminate any objectionable reflection of light from any portion of the motorcycle.

(2) *Combination blackout tail and stop lamp* - One approved combination blackout tail and stop lamp shall be securely mounted on extreme rear of the vehicle or vehicle combination, as near the *left* side as practicable, with red tail light below and amber stop light above, and aimed straight to rear so as to be clearly visible to traffic approaching from the rear. Such lamps shall be mounted not less than 20 inches nor more than 50 inches above road level. When mounted on motor cycles, this lamp shall be mounted on rear fender.

1. See appendix A for definitions of terms used in this specification.

(3) *Blackout front clearance lamps* – Two approved clearance lamps, showing white light only for emergency vehicles (appendix A) and amber light only for all other vehicles shall be securely mounted on the front of motor vehicle, or motor–vehicle combination, one on each side, as near the sides of the vehicle and as close to usual headlight level as is practicable, and aimed straight ahead with face of lens vertical and slot horizontal. One such lamp is required on the front at the center of motorcycles.

b. Additional Equipment Required on all Oversized Motor Vehicles and Motor–Vehicle Combinations

(1) *80 inches or more in width*

(a) An additional combination tail and stop lamp shall be securely mounted on the extreme rear as near the *right* side as practicable and at the same height and alignment as left combination tail and stop lamp.

(b) Two approved red reflectors shall be securely mounted on the extreme rear and two approved amber reflectors shall be securely mounted on the extreme front on each side, as low on the vehicle as practicable, and in no case higher than 30 inches above road level.

(2) *Over 35 feet in length* – There shall be securely mounted on each side, one approved amber reflector near the front, one approved amber reflector at the center, and one approved red reflector at the rear. These reflectors shall be installed as low as practicable, and in no case higher than 30 inches above road level.

c. Optional Equipment

(1) *Reflectors* – Approved reflectors are highly recommended to mark the sides and ends of all vehicles. Such reflectors should be mounted as low as practicable, and not higher than 30 inches above road level. Amber reflectors only shall be mounted on the front or on the sides at or near the front, and red reflectors only shall be mounted on the rear or on the sides at or near the rear of the vehicle.

(2) *White paint and reflectorized materials* – Flat white paint, reflectorized paint, or other reflectorized materials are highly recommended for use on bumpers, hub caps, and lower portions of vehicles.

(3) *Vehicle identification signs or signals and destination signs* – The intensity of light emitted from this equipment shall be such that the maximum distance from

which signs or signals are visible is not more than 2,000 feet when viewed on a clear, dark, moonless night, by observers whose eyes are thoroughly dark-adapted. Signs or signals should be legible for at least 100 feet. Signs utilising light letters on a dark background are preferable to those having dark letters on a light background. New signs or signals manufactured for use on vehicles during blackouts shall employ a minimum of strategic or critical materials. Design and approval and marking shall conform to paragraphs 12 and 13. This equipment shall be of rugged construction and not subject to derangement, tampering or misuse in service.

d. Interior Lights

(1) *Instrument and dashboard lights* – Because normal illumination on dashboards and instrument panels tends to destroy dark adaptation and serves as an annoying glare source which distracts the driver, instrument and dashboard lights shall be extinguished, unless the illumination provided is of low intensity and deep red in color. Use of radioactive materials on indicator dials and/or pointers, although not as satisfactory as deep red illumination, may be employed.

(2) *Other interior lights* – Other interior lights shall be extinguished, rendered inoperative, completely obscured[2] from outside view, or conform to requirements of appendix D.

5. Street-Car and Trolley-Bus Blackout Equipment

Only those street cars and trolley busses which conform to the following requirements shall be operated during blackouts:

a. Blackout Driving Lamp – One, and only one, approved motor vehicle blackout driving lamp shall be securely mounted on the forward end of the street car, or trolley bus, between left side and center, near the normal line of sight of the operator. Mounting height and adjustment of this lamp shall conform to paragraph 4a (1). (Double end operation requires installation of one such driving lamp on each end of the car. Lamps shall be so wired that only the lamp facing in direction of movement is in operation.)

b. Blackout Combination Tail and Stop Lamp – One approved motor vehicle combination blackout tail and stop lamp shall be mounted on the rear of street cars in a central position, red tail light below, amber stop light above, and shall be clearly visible to traffic approaching from the rear. The mounting height of such lamp shall be not less than 20 nor more than 50 inches above road level. (Double

2. See War Department specification "Blackout of Buildings."

end operation will require installation of one combination tail and stop lamp on each end of the car.) Lamps shall be so wired that only the lamp facing away from direction of movement is in operation. Two combination tail and stop lamps shall be mounted on the rear of trolley busses as specified in paragraph 4b (1).

c. Blackout Clearance Lamps - Two amber clearance lamps, of the design approved for use on the front of motor vehicles, shall be mounted on the front of a street car, as near the sides and as close to normal headlight level as practicable, and aimed with face of lens vertical and slot horizontal. (Double end operation will require two such lamps on each end of car.) During blackouts these marker lamps shall be in operation at all times when street car or trolley bus is in roadway, whether such vehicle is moving or standing.

d. Reflectors

(1) *Front and rear* - Two approved red reflectors shall be mounted on the rear and two approved amber reflectors shall be mounted on the front, one on each side, as low as practicable and in no case higher than 30 inches above road level. (Street cars used for double end operation shall be equipped throughout with amber reflectors.)

(2) *Sides* - There shall be mounted on each side one amber reflector near the front, one amber reflector at the center, and one red reflector at the rear, mounted as low as practicable and in no case higher than 30 inches above road level. (Street cars used for double end operation shall be equipped throughout with amber reflectors only.) Such reflectors shall conform to approved standard (appendix B).

e. Arc Protection - Operators shall be instructed to "coast" over section breakers. Trolley wheels should be replaced by proper carbon shoes wherever practicable.

f. Interior Lights - Interior lighting of street cars and trolley busses shall conform to requirements of paragraph 4d.

g. Optional Equipment - See paragraph 4c.

6. ***Blackout Equipment for Bicycles, Push Carts and Other Vehicles Propelled by Human Power***

No bicycles, push carts or other vehicle propelled by human power shall move in traffic unless equipped front and rear with approved reflectors and/or approved blackout flashlights or lanterns.[3] Mounting height of reflectors shall be not more than 24

3. See War Department specification "Blackout Flashlights, Lante[illegible] and Flares." (Now in preparation.)

inches above road level. Number reflectors only shall be mounted on the front and red reflectors only shall be mounted on the rear. In addition to such required equipment, application to the lower portion of these vehicles of flat white paint, reflectorized paint, or other reflectorized materials is highly recommended.

Animal-Drawn Vehicles and Ridden or Herded Animals

Animal-drawn vehicles and ridden or herded animals shall not be driven over the highway during blackouts unless protected with one or more blackout flashlights or lanterns of approved type.[3] Such lights shall be so displayed that the presence in the roadway of the animals and vehicles is rendered clearly visible to approaching traffic. Approved reflectors mounted as described in paragraph 6, and/or flat white paint, reflectorized paint, or other reflectorized materials, are highly recommended for use on animal-drawn vehicles. Equipment recommended for use by pedestrians in paragraph 9 is also applicable to animals.

8. Projecting Loads

Loads projecting more than 4 feet beyond the front or rear of any vehicle shall be protected by approved red reflectors (appendix C) and/or lanterns[3] placed at the end of the load. When reflectors are used, they shall be securely mounted at a height above road level of not more than 30 inches. Side projection of loads shall not be permitted.

9. Blackout Equipment for Individuals

Pedestrians and traffic control personnel should not stand or move in the roadway during blackouts except when absolutely necessary. Any pedestrian or traffic officer whose duties require him to be in the roadway during blackouts should wear white or reflectorized leggings, or anklets equipped with clear reflectors of suitable size and approved type (appendix C), and should carry an approved blackout flashlight or lantern.[3] If white or reflectorized leggings or anklets equipped with approved reflectors are not available, white handkerchiefs or other light-colored material should be tied around the lower portions of the legs. Under blackout conditions, pedestrians are generally not visible from moving vehicles. For this reason, pedestrians must learn to keep out of the path of moving vehicles during blackouts and not depend on vehicle operators to see them.

10. Luminescent Materials

Luminescent materials, including radioactive, phosphorescent and fluorescent materials, are not generally recommended for outdoor use on vehicles or individuals because of their relatively low sustained brightness in comparison with starlight or moonlight, the high rate of deterioration of most of these materials when exposed to sunlight and moisture, and their high cost.[4]

3. See War Department specification "Blackout Flashlights, Lanterns, and Flares." (Now in preparation.)

4. See War Department specification "Luminescent Materials." (Now in preparation.)

SUMMARY OF BLACKOUT EQUIPMENT REQUIRED ON VEHICLES[2]

Equipment	Type of vehicle	Location	Mounting height	Alignment
Blackout driving lamp.[1]	Motor vehicles (except motorcycles). Street cars and trolley busses.	1 on the front, far enough forward to eliminate objectionable reflection of light from vehicle, between left side and center and as near as possible to normal line of operator's vision.	At least 36 inches and not more than 56 inches above road level (measured to bottom of slot), but not higher than top of rim of steering wheel. (Preferred height approximately 42 inches.)	With vehicle on level surface and carrying normal load, so adjust lamp that bottom of slot in mask is horizontal. Then so aim lamp that light beam is projected straight forward and visual cut-off of top of beam on a vertical screen 10 feet in front of lens is at least 2 inches and not more than 3 inches below bottom of slot. Fasten lamp securely in this position.
	Motorcycles	1 on front at center.		
Combination blackout tail and stop lamp.[1]	Motor vehicles	1 unit on extreme rear, as near left side as practicable.	As near normal tail light level as practicable, but in no case lower than 20 inches nor higher than 50 inches above road level.	Aim straight to rear with lens vertical; red tail light below and amber stop light above.
	Street cars	1 unit on extreme rear at center.		
	Motor vehicles 80 inches or more in width. Trolley busses.	2 units on extreme rear - 1 as near left side as practicable, the other as near right side as practicable.		
Blackout front clearance lamp[1] (white for emergency vehicles,	Motor vehicles (except motorcycles.) Street cars.	1 on each side of front of vehicles and as near sides as practicable.[3]	As near normal headlight level as practicable.	Aim straight ahead with lens face vertical and slot horizontal.
S.A.E. amber for all other vehicles).	Motorcycles.	1 on front at center.		
Reflector (amber except when on rear or on sides near rear; red when on rear or on sides near rear).[4]	Vehicles 80 inches or more in width.	On the front, 1 on each side; on the rear, 1 on each side.	As low on vehicle as practicable, but in no case higher than 30 inches above road level.	Surface vertical and horizontal axis parallel to sides or ends of vehicle.
	Motor vehicles or motor-vehicle combinations more than 35 feet in length.	On each side, 1 near the front, 1 at the rear, and 1 near the center.		
	Bicycles, push carts, and other vehicles, propelled by human power.[5] Animal-drawn vehicles.	At least 1 on the front and 1 on the rear.	Not more than 24 inches above road level.	

1. Proper operation of blackout vehicle lights.--When properly installed, all normal lights will function [illegible] blackout switch in "Off" position. When blackout switch is in either "Park" or "Drive" position, normal lights will be turned off automatically.
2. Instrument lighting.--Provision may be made for use of low intensity deep red light to illuminate i[illegible] panels and dashboards during blackouts. White [illegible] not suitable for this purpose. Radioactive materials may be employed on indicator dials and/or p[illegible]
3. Street cars used for double end operation shall have 2 front clearance lamps on each end.
4. Street cars used for double end operation shall have amber reflectors throughout.
5. Approved blackout flashlights or lanterns may be substituted for reflectors.

Where phosphorescent materials are used, they shall conform to Corps of Engineers Tentative Specification No. T-1235, dated January 16, 1942, entitled "Phosphorescent Coating System." Radioactive markers shall conform to Corps of Engineers Tentative Specification No. T-1249, dated February 19, 1942, entitled "Markers, Luminous (Radioactive)."

11. Treatment of Shiny Surfaces

It is desirable that all chromium, aluminum, stainless steel, glossy paint, and other highly reflective surfaces be covered with lustreless paint (drab brown is recommended) or otherwise treated to minimize reflection of light in an upward direction. Reflectors and reflectorized materials, used as recommended in paragraph 4c., do not materially facilitate detection from the air.

12. Design Approval

Design approval of all blackout equipment required by this specification, including exterior and interior lighting units, switches, reflectors, signs, signals, and luminescent materials, together with installation and use instructions to be supplied with this equipment, shall be based on reports submitted to the War Department by a testing laboratory accredited by the War Department. A list of the laboratories which have been accredited as of this date is attached hereto, but does not constitute a part of this specification.

13. Marking of Approved Equipment

Approval of design shall be indicated by a marking which includes the words, "BLACKOUT (insert item of equipment)—WAR DEPARTMENT STANDARD." Units shall also display code numbers to be assigned by the War Department at time of approval which shall be placed directly beneath or after the word "Standard." This marking, together with manufacturer's name, shall be placed on each unit of approved equipment at a location which will facilitate inspection after installation.

APPENDIX A

DEFINITIONS

Vehicle – Any device in, upon, or by which any person or property is or may be transported.

Motor Vehicle – Any vehicle which is self-propelled, but not operated upon rails or by means of overhead trolley wires.

Street Car – A vehicle or train of vehicles for transporting persons or property and operated upon rails principally on a public roadway.

Trolley Bus – A vehicle not operated on stationary rails or tracks but which receives power from overhead trolley wires.

Motor-Vehicle Combination - any train of vehicles which includes at least one motor vehicle.

Emergency Vehicles - The following are considered emergency vehicles:

Vehicles of the armed forces of the United States and its allies.

Vehicles of the fire departments.

Vehicles of Governmental police agencies.

Ambulances and special public utility service vehicles, when properly identified and in emergency service.

Such vehicles engaged in civil defense as may be designated by proper local military or civilian authority, when marked by proper identification sign or signal and when in emergency service.

Emergency vehicles, other than those of the armed forces of the United States and its allies, shall display in the lower right hand corner of the windshield (or other conspicuous place where this is not feasible) a certificate signed by the appropriate military or civilian defense official.

APPENDIX B

DESIGN, MANUFACTURE AND INSTALLATION OF MOTOR VEHICLE BLACKOUT EQUIPMENT

1. General[5] - Motor-vehicle blackout equipment shall conform to photometric and mechanical performance tests and to interchangeability requirements set forth on drawings referred to below. It is not the intent of this specification to discourage development of improved methods of construction and substitution wherever possible of materials less critical than those now indicated. Such modifications shall not only be permitted but are urgently desired.

2. Blackout Driving Lamps - The approved blackout driving lamp shall conform to latest revision of Quartermaster Corps Drawing No. 09126-Y entitled "Blackout Driving Lamp."

3. Blackout Combination Tail and Stop Lamp - The approved blackout combination tail and stop lamp shall conform to latest revision of Quartermaster Corps Drawing No. 08243-X, entitled "Lamp, Blackout Tail and Blackout Stop."

4. Blackout Clearance Lamps

a. *Front clearance lamps*

(1) *Emergency vehicles* - The approved front clearance lamp for emergency vehicles shall conform to

5. The Quartermaster Corps drawings mentioned in this appendix will be furnished only to manufacturers on bona fide requests submitted to the Engineer Board, Fort Belvoir, Virginia.

latest revision of either Quartermaster Corps Drawing No. 08235-X, entitled "Lamp, Parking with Blackout Device Fender Mounting," or Quartermaster Corps Drawing No. 08236-X, entitled "Lamp, Parking with Blackout Device."

(2) *Other vehicles* – The approved lamp for other than emergency vehicles shall conform to requirements specified for front clearance lamps for emergency vehicles, except that the light emitted therefrom shall be amber instead of white. Such amber shall conform to Color Specification for Electric Lamps in the 1942 Handbook of the Society of Automotive Engineers.

5. Wiring and Switches

a. *General* – Blackout switches and wiring should be so arranged that when the switch is turned to light the blackout equipment, this switch will automatically disconnect all other normal lights on the vehicle, such as head, tail, parking, stop, license plate, driving, passing, fog, spot, backing, dome, stop, trunk, turn signal, standard marker and identification lights. Instrument panel lights, however, may remain lighted, if they provide red illumination. The switch and wiring arrangement should also provide a parking position, connected to light all blackout equipment on the vehicle except the blackout driving lamp. The blackout circuit should be separately fused.

b. *Motor vehicles (except motorcycles)* – The wiring and switches of the approved blackout lighting equipment on motor vehicles (except motorcycles) will meet the requirements of this specification if they conform to the latest revision of Quartermaster Corps Drawings Nos. 09126-W, 09129-W and 09124-W, entitled "Blackout Wiring Diagram for Commercial Vehicles," "Blackout Wiring Diagram for Commercial Trailers," and "Blackout Switch for Commercial Vehicles," respectively.

c. *Motorcycles* – The wiring and switches of the required approved blackout lighting equipment on motorcycles will meet the requirements of this specification if they conform to latest revision of Quartermaster Corps Drawings Nos. 09187-W and 09186-W, entitled "Wiring Diagram for Blackout Lighting of Commercial Motorcycles," and "Blackout Switch for Commercial Motorcycles," respectively.

d. *Stop lights and other automatic lights* – All lights on the vehicle controlled by automatic switches, such as stop lights, dome lights, trunk lights, etc., shall

either be made inoperative, disconnected, or the wiring circuits changed to require manual switching. When practicable, these lights shall be connected to terminal LS indicated in Quartermaster Corps Office Drawing No. 09128-W. (Blackout clearance lamp indicated on this drawing is not required.)

e. *Directional signalling devices and other manually operated lights* - Such lights shall be made inoperative and shall not be used during blackouts.

APPENDIX C

RETRODIRECTIVE REFLECTORS

An approved reflector shall possess light reflection and optical performance characteristics required by S.A.E. specification Reflex Reflectors, in the 1942 Handbook of the Society of Automotive Engineers.

APPENDIX D

EQUIPMENT FOR PROVIDING REDUCED INTERIOR ILLUMINATION IN VEHICLES

1. Directional Characteristics - The design and installation of equipment used for providing reduced interior illumination in vehicles during blackouts shall be such that no direct light is projected outside the vehicle through windows, doors, or other light openings.

2. Construction - Equipment shall be of rugged construction and not subject to derangement, tampering or misuse in service. Use of strategic and critical materials shall be avoided wherever possible.

3. Allowable General Illumination - Maximum illumination incident on a horizontal plane at seat level shall under no conditions exceed 0.006 footcandle. The color of light used for general interior illumination shall be white, yellow, orange or orange red.

4. Step Wells - Only orange or orange-red light shall be utilized for illuminating step wells on street cars, trolley busses, and motor busses. This light shall be of such intensity that the incident illumination on any surface visible from outside above the horizontal shall under no conditions exceed 0.02 footcandle.

5. Fare Boxes - Only low-intensity deep red illumination shall be used for fare box lighting.

6. Treatment of Shiny Surfaces - Unless light emitted from equipment used for reduced interior illumination of vehicles is directed in such a manner that it does not strike chromium, aluminum, porcelain, stainless steel, or other shiny surfaces, thes

surfaces should be covered with lustreless paint or other non-reflecting material.

LABORATORIES ACCREDITED BY THE WAR DEPARTMENT

Electrical Testing Laboratories, Inc.,
New York City, New York

APPENDIX IV

TRAFFIC CONTROL DURING BLACKOUTS

War Department Specification

Prepared under the direction of the Chief of Engineers, U. S. Army, by the Engineer Board, with suggestions of the National Technological Civil Protection Committee, the National Bureau of Standards, the Interstate Commerce Commission, the Office of Defense Transportation, the Public Roads Administration, the Highway Traffic Advisory Committee to the War Department, and the War Production Board.

FOREWORD

The standards specified herein may be imposed by military authority during specified periods and in specified areas. Independent of such action these standards afford guides to civilian authorities as to measures that can be taken by them to conform their conduct with what may eventually be prescribed.

Due to the scarcity of certain critical materials which will be involved in the manufacture of the equipment called for in these specifications, it is probable that only the most exposed communities in the continental United States will be able to procure the equipment. For this reason these specifications are being given only a limited distribution at this time.

SECTION I

General

1. Scope

This specification sets forth necessary measures for the control of traffic under blackout conditions and prescribes blackout lighting requirements for illuminated traffic control devices. It applies in those areas and during those periods prescribed by proper military authority. Equipment required by road users in these same areas and during these same periods is described in War Department Specification, "Blackout Requirements for Highway Movement."

2. Objective

Traffic control measures and lighting requirements specified herein are designed to provide for the greatest safety and ease of ground movement commensurate with provision of reasonable freedom from detection by enemy aircraft.

3. General Considerations

a. *Safety of Normal Traffic Movement.* Safety of normal traffic movement requires that installation of blackout traffic control devices should not increase the hazard of traffic movement during hours of normal illumination.

b. *Economy of Materials.* Because of the importance of conserving materials for more essential war needs, blackout requirements should be met, insofar as practicable, by modification or relocation of existing devices, rather than by procurement of new devices.

c. *Characteristics of Blackout Traffic.* The hazard of movement under the low levels of illumination permitted during blackouts and the limited availability of approved lighting devices will result in a general reduction of vehicular and pedestrian traffic. Blackout traffic will be largely local, and speed of movement will be much lower than that normally prevailing.

4. Preparation of Plans

Within areas designated by proper military authority, local authorities responsible for traffic control should immediately make such surveys, plans, and preparations as are required to carry out the provisions of this specification. This may include arrangements for periodic "in-service" inspection of blackout equipment required under this specification and under the War Department Specification, "Blackout Requirements for Highway Movement." Special legislation may be necessary in civilian communities within continental United States.

5. Construction of Blackout Equipment

Blackout equipment required by this specification shall be of rugged construction and shall not be readily subject to derangement, tampering, or misuse in service. Use of strategic and critical materials shall be avoided wherever possible.

6. Design Approval

Design approval of all illuminated traffic control devices, appurtenances to existing illuminated devices, specified herein shall be based on reports submitted to the War Department by a testing laboratory accredited by the War Department. A list of laboratories which have been accredited is attached hereto, but does not constitute a part of this specification.

7. Marking of Approved Equipment

Approval of design for devices specified in paragraph 6 shall be indicated by a marking which includes the words, "BLACKOUT (insert item of equipment) WAR DEPT. STANDARD." Approved equip-

ment shall also display code numbers, to be assigned by the War Department at the time of approval, which shall be placed directly beneath or after the word "Standard". This marking, together with manufacturer's name, shall be placed on each unit of approved equipment at a location which will facilitate inspection after installation.

SECTION II

Traffic Regulations

8. Definitions

Vehicle - Any device in, upon, or by which any person or property is or may be transported.

Motor vehicle - Any vehicle which is self-propelled, but not operated upon rails or by means of overhead trolley wires.

Street car - A vehicle or train of vehicles operated upon rails principally on a public roadway.

Trolley bus - A vehicle not operated on stationary rails or tracks but which receives power from overhead trolley wires.

Motor vehicle combination - Any train of vehicles which includes at least one motor vehicle.

Emergency vehicles - The following are considered emergency vehicles:

(1) Vehicles of the armed forces of the United States and her allies.

(2) Vehicles of the fire departments.

(3) Vehicles of governmental police agencies.

(4) Ambulances and special public utility service vehicles, when properly identified and in emergency service.

(5) Such vehicles engaged in civilian defense as may be designated by proper local military or civilian authority, when marked by proper identification sign or signal and while being used in emergency service.

Pedestrian - Any person on foot.

9. Existing Traffic Regulations

All existing traffic rules, laws, and regulations shall remain in force during a blackout except as modified by the provisions of this specification.

10. Dark Adaptation Period.

No road user, except in emergency, shall move in a blackout unless his eyes are properly dark-adapted. At least 5 minutes in complete darkness is required after any exposure of the eyes to light intensities higher than those permissible during blackouts; and, whenever practicable, road users should remain in complete darkness for 20 to 30 minutes before moving in a blackout.

11. Action Required Under Blackout

(a) *Road users employing approved blackout devices.* When a blackout is in effect, road users employing approved blackout devices[1] are permitted to move, provided their eyes are properly dark-adapted. While waiting for their eyes to become dark-adapted, such road users shall stop off the traveled portion of the roadway.

(b) *Road users not employing approved blackout lighting devices.* When a blackout is in effect, those road users not properly employing approved blackout devices[1] as required are not permitted to move. If a blackout is initiated when such road users are operating under other than blackout conditions, such road users shall comply with the provisions of the following sub-paragraphs and immediately thereafter extinguish all lights. However, the time elapsed between initiation of a blackout and extinguishment of lights shall not exceed 5 minutes under any circumstances.

(1) *Motor vehicles, motor vehicle combinations, and trolley buses.* Such vehicles shall immediately be parked or stopped as required below for the duration of the blackout.

(a) In every case, roadway space shall be left for the passage of traffic.

(b) No motor vehicle or trolley bus shall be parked in violation of blackout parking regulations (see sub-paragraph 12f).

1. See War Department Specification, "Blackout Requirements for Highway Movement."

(2) *Street cars.* Street cars shall be stopped at regularly established loading points or other safe and convenient locations in order that passengers can be discharged. After passengers are discharged, street cars shall proceed to nearest mid-block location, or other point sufficiently removed from intersecting roadways, in order to provide maximum visibility and clearance for passage of traffic. Wherever practicable, cars shall be spaced far enough apart to permit passage of emergency equipment and personnel.

(3) *Bicycles, pushcarts, and other vehicles propelled by human power.* These vehicles shall be removed from the roadway and sidewalk, if possible. Otherwise, they shall be parked out of the main traveled portions of the roadway, sidewalk, or other thoroughfare in a manner which does not endanger traffic moving thereon or block access to emergency installations.

(4) *Animal-drawn vehicles and ridden or herded animals.* Animal-drawn vehicles and ridden or herded animals shall be drawn off the main traveled portions of the roadway and placed in such position that adequate space for passage of other traffic is provided. Animals shall be tethered or otherwise securely restrained.

(5) *Stopped and stalled vehicles.* Approved reflectors[1] or other approved blackout devices[2] shall be used to render clearly visible to approaching traffic any vehicle which is stopped or stalled[3] in the main traveled portions of any roadway.

(6) *Pedestrians.* During a blackout, pedestrians not equipped with devices in par. 12*g*(5) below should not stand, enter, or move upon the roadway except when absolutely necessary.

1. See War Department Specification, "Blackout Requirements for Highway Movement."

2. See War Department Specification, "Blackout Flashlights, Lanterns, and Flares."

3. Vehicles properly parked at the curb, or in any other authorized parking area, are not considered as stopped or stalled vehicles.

12. Blackout Rules of the Road

a. *Emergency vehicles.* Emergency vehicles when performing an emergency mission are exempted from the provisions of this paragraph. However, such vehicles shall not be operated in a reckless or negligent manner.

b. *Obedience to blackout traffic control devices.* No road user shall disobey the instructions of any applicable blackout traffic control device unless directed to do so by authorised traffic control personnel.

c. *Vehicular speed.* No person shall operate a vehicle during a blackout on any roadway at a speed that is greater than is reasonable or prudent under the existing conditions, and in no event at a speed which endangers the safety of persons or property. Speeds in excess of fifteen (15) miles per hour shall be deemed unreasonable and imprudent. However, where unusual hazards may exist, lower speeds may be required or, if exceptionally free and safe movement is possible, higher speeds may be permitted. Such lower or higher speeds shall be designated by signs of types specified herein.

d. *Overtaking and passing*

(1) No vehicle shall overtake and pass another vehicle proceeding in the same direction unless there is more than one traffic lane designated for traffic movement in the direction of overtaking and passing. On three lane roads overtaking and passing is prohibited, except at locations where the center lane is specifically designated and appropriately marked for movement in the direction of the overtaking and passing.

(2) Irrespective of the number of traffic lanes available for use in the direction of movement, the operator of any vehicle approaching from the rear of any other vehicle that has stopped at a crosswalk or at any intersection shall bring his vehicle to a stop before entering the crosswalk or intersection, unless the standing vehicle is one properly parked at the curb, and shall proceed only after yielding the right of way to pedestrians or cross traffic.

e. *Limitations on turning around.* No driver of any vehicle shall turn such vehicle on the same roadway so as to proceed in the opposite direction except where a dead end street or a road block makes such action necessary.

f. *Parking.* Normal parking regulations shall be altered where feasible in order to increase on-street parking space. Time limits on parking shall not be operative during a blackout. Taxi stands and commercial loading and unloading zones may be utilized for parking except where expressly forbidden by local action. Parking shall be prohibited at any point where the parked vehicle obscures any blackout traffic control device.

g. *Pedestrians.*

(1) No pedestrian shall move or walk in the traveled portion of the roadway, where sidewalks or paths are provided off the roadway, except for the purpose of crossing said roadway.

(2) Pedestrians shall come to a stop before entering any roadway.

(3) Pedestrians shall cross a roadway only at authorized crosswalks in areas where such crosswalks are provided; in areas where crosswalks are not established, pedestrians may cross the roadway provided they yield the right of way to approaching traffic and take all necessary precautions for their own safety.

(4) Pedestrians shall obey blackout traffic control and pedestrian signals[1] when such signals are in operation.

(5) Pedestrians should wear white or reflectorized leggings, anklets equipped with clear reflectors of approved type[2], white handkerchiefs tied around the lower portions of the legs, or other highly reflective leg bands, and should carry an approved blackout flashlight or lantern.[3]

13. Special Regulations

Such other special regulations as appropriate local authority deems advisable may be imposed during a blackout, provided such regulations do not conflict with provisions contained herein.

1. See Appendix C.

2. See War Department Specification, "Blackout Requirements for Highway Movement."

3. See War Department Specification, "Blackout Flashlights, Lanterns, and Flares."

14. Revision of Current Regulations

Local traffic authorities should review current regulations and make any modifications necessary to eliminate conflict with the regulations specified in this section.

SECTION III

Classification of Roadnet

15. General

Since proper control and supervision of blackout traffic require that control devices and enforcement be concentrated on those roads carrying the heaviest blackout traffic flow, it is necessary that the street and highway system in all critical areas be classified in accordance with the needs of blackout traffic movements. This classification must be based on the probable requirements of military and civilian traffic and the relative importance of each roadway serving such traffic.

16. Coordination

In order to insure that military needs are provided for, especially those which may arise in dealing with possible enemy operations, classification of the roadnet should be determined by direct consultation between the local military authority and civilian authorities responsible for traffic planning. Because traffic movements are not restricted to political or military boundaries, roadnet classification of adjacent areas must be coordinated.

17. Basis of Classification

For traffic control purposes the roadnet should be classified as follows:

a. *Primary System.* The primary system should ordinarily[1] include:

(1) Strategic military highways.

(2) U. S. highways and State routes (within continental United States).

1. In certain metropolitan areas it may be desirable to include the entire road net in the primary system.

(3) Heavy traffic routes ordinarily designated as through streets or roads, such as main radial routes and main "cross-town" or circumferential routes.

(4) Access roads to military establishments, war plants, and similar installations.

(5) Access roads to police stations, fire stations, hospitals, and other public protection and welfare installations.

(6) Access roads to vital railroad, airline, and communication centers; water plants; power facilities; and similar installations.

(7) Roads on which regular urban transit routes are operated.

b. *Secondary system (alternate and feeder).* The secondary system of roadways should generally comprise the following:

(1) Roads which parallel and which are actually used as relief or alternate routes to the primary system, especially those in the vicinity of vital installations.

(2) Important local feeders to the primary system.

c. *Tertiary (residual) system.* Parts of the roadnet not classified as primary or secondary should be designated as the tertiary system.

18. Survey

In conjunction with or immediately after the classification of the roadnet, local traffic officials should initiate a survey to reveal needs in connection with the use of blackout traffic control devices. This survey should provide the following information:

a. Locations where existing illuminated traffic control devices may be extinguished during blackout.

b. Locations where existing traffic control devices must be altered or modified for blackout use.

c. Locations where additional traffic control devices, including signs, signals, and markings, must be provided.

d. Locations where unwarranted traffic control devices exist, and amount of equipment thereat which can be diverted to blackout use.

e. A listing of additional materials and equipment needed.

SECTION IV

Traffic Control Devices[1]

19. Switching Requirements for Illuminated Devices

Switching facilities must be provided and personnel assigned to insure that light from all illuminated traffic control devices provided for normal use will be extinguished or adequately reduced to comply with provisions of this specification within five (5) minutes after initiation of a blackout. Similar arrangements must be made for turning on illuminated devices used solely during blackouts. All illuminated traffic control devices not covered in this specification shall be extinguished during a blackout.

20. Traffic Markings

a. *General.* Markings should be employed extensively on roadways used by blackout traffic. Markings are required on all primary routes and are highly recommended for secondary routes and hazardous locations. For pavement markings[2], a reflectorized coating is preferable to reflector units.

b. *Center lines.* Center lines shall be marked by paint, reflectorized coatings, or reflector units on all two-way hard-surface primary routes having an even number of lanes.

c. *Lane lines.* Lane lines shall be marked by paint, reflectorized coatings, or reflector units on all hard surface primary routes having a total of more than one lane available for travel in a single direction.

d. *Guide lines.* Guide lines shall be used to indicate the safe limits for traffic to pass to the left and/or right of any obstacle or hazard in the roadway. Such lines may be placed on the pavement. However, where markings cannot be satisfactorily applied to the roadway surface (e.g. an earth or gravel roadway), approved reflector

1. See Appendix D, "Summary of Recommendations and Requirements for Blackout Traffic Control Devices."

2. See Appendix A.

units[1] or lanterns[2] shall be employed to delineate the safe approach to and proper course around such obstacles.

e. *Obstacle markings.* All obstacles in or near the roadway shall be painted white or otherwise marked – by use of a reflectorized coating system[1], reflector units[1], or lanterns[2] – in such a manner as to provide as much visibility as practicable. Paint or reflectorized coatings shall be applied in a distinctive, characteristic pattern as required in Appendix A. Specific types of obstacles for which markings are required include the following:

(1) Bridge abutments, parapets, piers, and culverts.

(2) Vertical walls or other obstacles located at any sharp changes in roadway alignment.

(3) Barricades, protective walls, stored materials, or other temporary obstacles.

(4) Rocks, trees, guard rails, and other such hazards or obstacles in or near the main traveled portion of the road.

(5) Pedestals, posts, safety zone buttresses, and traffic control devices in or near the roadway.

(6) Such other hazards from which protection is deemed necessary.

f. *Curb markings.* Curb markings may be advantageously employed wherever parked cars will not interfere with their use. Vertical or sloping faces of curbs along primary routes shall be painted or marked by reflector units, reflectorized coatings, or other highly reflective materials at locations designated below:

(1) Channelizing islands, whether divisional, medial, or rotary.

(2) Safety zones and pedestrian islands.

(3) Urban street intersections – to a distance of at least 15 feet back from crosswalks.

1. See Appendix A.

2. See War Department Specification, "Blackout Flashlights, Lanterns, and Flares."

(4) Sharp curves.

(5) Bridges, viaducts, and similar hazardous locations.

g. *Marginal delineators.* Marginal delineators are recommended for outlining the roadway and indicating the proper course for vehicles. They are particularly advantageous on curves and on roads where pavement markings cannot be applied. When marginal delineators are used on curves to the right, both the right and left edge of the roadway should be outlined on the curve and for short distances on tangents thereto. On unpaved primary roads, one row of approved reflector units shall be placed on the driver's right for each direction of traffic movement.

h. *Transverse pavement markings.* Transverse pavement markings should be used to outline intersections to indicate pedestrian cross walks, stop lines, and other limit lines; and to provide an advance warning for railroad crossings. Transverse pavement markings are required on the primary system at all intersections regularly controlled during blackout by traffic control personnel or traffic control signals.

21. Traffic Signs

a. *Use.* All primary routes shall be posted with such signs as are required to guide, safeguard, or regulate traffic thereon. The needs of hazardous locations on roads of the secondary system should also be studied. On both primary and secondary roads, attention should be given particularly to route turns and junctions, locations requiring stop or one-way regulation, sharp curves, railroad crossings, and similar critical locations.

b. *Types.* Ordinary untreated daylight signs are of little value for blackout use. Approved type reflectorized signs are satisfactory for blackout use provided they are used at locations where they will not be obscured by parked cars, placed not further than 12 feet from the right edge of any traffic lane they are designed to control, and mounted sufficiently low that the top of the message is not higher than 24 inches above the road crown. When signs are necessary, and the foregoing requirements cannot be met by reflectorized signs, approved exterior- or interior-illuminated signs[1] shall be used.

1. See Appendix B.

22. *Traffic Signals*

a. *Use of traffic signals during blackouts.* Since a reduction in the amount and speed of traffic will result under blackout conditions, many signals required during normal operation are unnecessary during blackouts and should therefore be extinguished. While final determination of which traffic signals are to remain operative during blackouts must be based to a large extent on the knowledge and experience of the responsible local traffic authority, blackout operation of signals may be warranted at any of the following locations:

(1) Intersections formed by two or more routes of the primary system.

(2) Intersections formed by routes of the primary system with important routes of the secondary system.

(3) Points of heavy pedestrian movement.

(4) Intersections within shopping, business, office, or amusement districts.

(5) Locations subject to high accident rates.

b. *Illumination requirements.* Traffic signals operated during blackouts shall conform to requirements specified in Appendix C.

23. *Other Illuminated Signalling Devices*

a. *Pedestrian signals.* Pedestrian signals shall either be extinguished or the illumination shall be reduced to comply with the photometric requirements for traffic signals as specified in Appendix C.

b. *Railroad grade crossing signals.* Grade crossing signals conforming to the A.A.R. requirements shall be treated in the manner outlined in War Department Specification, "Blackout of Railroads" (now in preparation). Grade crossing signals other than A.A.R. Standard shall conform to the photometric requirements for traffic signals as outlined herein.

c. *Flashing signals.* Flashing signals shall either be extinguished or the illumination shall be reduced to comply with the photometric requirements for traffic signals as specified in Appendix C.

d. *Miscellaneous signalling devices.* Any illuminated area or part of a traffic signal device, differing from standard devices, shall meet the photometric requirements for standard type traffic signals as specified in Appendix C.

24. Street Illumination.

a. *General illumination.* At points of heavy pedestrian movement, points controlled by traffic officers, hazardous locations, and focal points of the traffic flow, general street illumination[1] may be required.

b. *Fire and police box markers.* In order to discourage indiscriminate use of fire and police alarm boxes during blackouts, when fire and police agencies are likely to be flooded with unimportant requests for assistance, fire and police box markers shall be extinguished. However, call box flasher lights utilised for signalling to police patrols need not be extinguished, provided such lights are orange-red or red in color, are clearly visible at a distance of 200 feet, and are not detectable by dark adapted observers on a clear, moonless night at distances greater than 2000 feet.

SECTION V

Administration

25. Planning.

Local agencies charged with traffic control responsibilities should review their emergency traffic control plans to insure that they meet all requirements of this specification. Generally, the greatest effort should be concentrated on that portion of the road-net which has been selected to form the primary system (par. 17a.). Proper training and instruction of traffic personnel must be carried out to insure that efficient performance will be obtained. In addition, required equipment must be procured, issued and/or installed to the end that traffic control and protective devices will be operative when required. Equipment procured for traffic control personnel should include approved illuminated batons[2], approved

1. See War Department Specification, "Street Lighting During Blackouts."

2. An approved type baton is described in Engineer Board Tentative Specification, entitled, "Reflectorized Traffic Baton."

blackout flashlights[1], and leggings treated with an approved reflectorized coating system[2]. Provision should also be made to insure that police and road maintenance crews have proper mobility, adequate equipment and supplies, and necessary communication facilities.

26. Enforcement.

Traffic control during blackouts involves the following police responsibilities:

a. Enforcement of War Department Specification, "Blackout Requirements for Highway Movement."

b. Enforcement of blackout traffic regulations.

c. Regulation of traffic at intersections and other bottleneck locations.

d. Provision of guidance and information to traffic.

e. Handling of traffic accidents.

f. Emergency re-routing of traffic.

27. Maintenance.

Assurance of continued and efficient operation of the devices described herein requires that a system be formulated for periodic inspection, repair, cleaning and replacement of damaged, worn, or dirty parts, as well as the acquisition and storage of adequate replacement materials.

Appendix A

TRAFFIC MARKINGS

1. General.

Traffic markings for blackout purposes should have the highest light reflection properties obtainable. Retro-directive materials which return a maximum of reflected light toward the light source

1. See War Department Specification, "Blackout Flashlights, Lanterns, and Flares."

2. See Corps of Engineers Tentative Specification, "Reflectorized Coating System (Retro-directive)."

are most desirable. Luminescent materials[1] are not satisfactory for use as traffic markings, and their use is not recommended.

2. Color.

White is the most satisfactory color for blackout traffic markings.

3. Materials.

a. *Paint.* Paint when used alone should preferably conform to Federal Specification, "Paints, Traffic, Exterior, White-Class A".

b. *Reflectors.*

(1) *Coatings.* Reflectorized coatings should conform to Corps of Engineers Tentative Specification, "Reflectorized Coating System. (Retro-directive)".

(2) *Units.* Reflector units should possess retro-directive characteristics equal to or better than those specified for Class A reflectors by SAE Specification, "Reflex Reflectors", 1942 Handbook, Society of Automotive Engineers.

4. Design.

a. *Longitudinal lines.* Longitudinal lines (center lines and lane lines) shall be at least 4 inches in width when white traffic paint alone is used. It is preferable that center lines be continuous, especially on curves. If broken center lines are used, however, the spaces between lines shall not exceed 20 feet; and each section of line shall be at least 10 feet in length. Lane lines should be of some distinctive pattern in order to prevent confusion with center lines. When reflectorized coating materials of the type recommended in sub-paragraph 3b(1) are used, the width of longitudinal lines may be reduced to 3 inches.

b. *Transverse lines.* Where stop lines or other limit lines are used, they should be visible to approaching traffic at a distance of at least 50 feet during a blackout. An example of a satisfactory application of transverse markings at an intersection is given in figure 1. The use

1. See War Department Specification, "Luminescent Materials."

of reflectorised materials for marking crosswalks is unnecessary; such crosswalks may be indicated by ordinary paint lines of a width normally used therefor within each community.

c. *Obstacle markings.* Obstacle markings shall be painted on or affixed directly to the obstacle. They shall extend from ground or road elevation to the height of the obstacle or to a point approximately 36 inches above the elevation of the road. Painted markings or reflectorised coatings shall consist of stripes formed alternately of material having low light reflective properties and recommended white traffic paint (sub-par. 3a above) or reflectorized coating material (sub-par. 3b above). Such stripes shall be at least 4 inches in width and shall slope downward at an angle of 45° to the horizontal in the direction traffic must move around the obstacle.

d. *Delineation markers.* Reflector units or road delineator devices covered with a reflectorised coat should be placed not higher than 22 inches above the crown of the roadway. The spacing of reflectors or lanterns used to delineate the approach to and/or proper course around obstacles shall not exceed 25 feet. On tangents, the spacing of center, lane, or marginal delineators shall not exceed 50 feet; on curves, such shorter spacing shall be used as is necessary to outline the curve. Bi-faced delineators are recommended for marginal delineation on two-way roadways. Where both sides of a road are delineated for the same direction of traffic movement, reflector units or devices shall be placed opposite each other on a line normal to the course of the roadway.

Appendix B

BLACKOUT TRAFFIC SIGNS

1. Reflectorized Signs

The legend or symbol on reflectorised signs shall be legible at not less than 50 feet when viewed by dark-adapted drivers on a clear, moonless night with the only incident light being that emitted from an approved blackout driving lamp[1] properly aimed and mounted. Reflector units or buttons used in signs shall possess photometric characteristics as required for Class "A" reflectors by SAE Specification, "Reflex Reflectors", 1942 Handbook of the

1. See War Department Specification, "Blackout Requirements for Highway Movement."

Society of Automotive Engineers. Reflectorized coatings used in signs shall meet all requirements of Corps of Engineers Tentative Specification, "Reflectorized Coating System (Retro-directive)".

2. Illuminated Signs

a. *Exterior-illuminated signs.* Light sources used with exterior-illuminated signs shall be shielded in such a manner that no direct light is projected above the horizontal and no glare will be produced in the direction of approaching traffic. The surface brightness of exterior-illuminated signs shall not exceed the values shown in the following table:

Maximum Diameter of area (feet)	Allowable Brightness (footlamberts)
0 - 1.9	0.0120
2 - 3.9	0.0030
4 - 5.9	0.0016

One method of obtaining the approved surface illumination on a white sign, the maximum diameter of which is 2 feet or less, is to use a 1.35 volt, 0.06 ampere, T-3-1/4 miniature screw base incandescent lamp (operated from a No. 6 dry cell battery) mounted in a mat white reflector at a distance of approximately 15 inches in front of and 4 inches below the top of the sign (Fig. 2).

b. *Interior-illuminated signs.* Interior-illuminated signs shall be legible to dark adapted observers on a clear, moonless night at a distance of at least 100 feet, and shall not be detectable by such observers beyond 2000 feet. An approved type of interior-illuminated sign is described in Corps of Engineers Tentative Specification No. T-1567, entitled, "Box, Sign, Interior Illuminated" (Fig. 3).

Appendix C

BLACKOUT TRAFFIC SIGNALS

1. Visibility

a. *Normal operation.* Traffic signals shall not be altered or modified for blackout purposes in any manner that will tend to impair their normal usefulness and visibility; and, except during blackouts, normal signal indications shall be maintained during all periods of operation.

b. *Blackout operation.* During blackouts, traffic signals shall provide distinctive signal indications which are clearly visible to dark adapted road users on a clear, moonless night at all distances from 10 feet to 300 feet.

2. ***Photometric Requirements***

a. The candlepower values of the light emitted in a vertical plane from a traffic signal shall not be in excess of the following:

Angle Above Horizontal	*Maximum Candlepower*
90°	0.04
60°	0.05
40°	0.1
30°	0.15
20°	0.35
15°	0.6

b. The incident illumination on the street in front of any traffic signal operated during blackouts shall not exceed 0.0006 footcandle at street level.

3. ***Suggested Methods of Meeting Photometric Requirements***

The foregoing requirements may be met by use of standard 60-watt traffic signal lamps operated during non-blackout periods at rated voltage, and during blackouts at approximately 26% of rated voltage (100 watt traffic signal lamps must be operated at 24% and 40 watt lamps at 29% of rated voltage). This voltage reduction may be accomplished either by use of auxiliary transformers or by inserting resistances in series with the lamp circuit. If the latter method is used, ordinary general service lamps may be employed as the resistors. (Fig. 4). With the usual type of four-way signal (signals in which four lamps operate in parallel for the major part of the traffic cycle), resistor lamps indicated in the following table provide proper resistance. Such resistor lamps should be of same voltage rating as traffic signal lamps employed.

Traffic Signal Lamp	*Resistor Lamps*	*Lumen Output*
60 watt	1 - 150 watt	0.9
40 watt	1 - 10 watt and 100 watt in parallel.	0.77
100 watt	1 - 60 watt and 150 watt in parallel.	0.5

APPENDIX D

SUMMARY OF REQUIREMENTS AND RECOMMENDATIONS FOR BLACKOUT TRAFFIC CONTROL DEVICES

PART I - TRAFFIC MARKINGS

ITEM	MATERIALS	REQUIRED PATTERN, HEIGHT, SPACING	USE[1]
Center lines[2]	Paint[3]	Continuous lines preferable to broken lines. If broken lines used, minimum lengths of lines 10 feet and maximum length of open spaces 20 feet.	*Required* on two-way hard-surface primary routes having an even number of lanes.
	Reflectorized coating[3]		
	Reflector units.	Not over 50 foot spacing on tangents; shorter spacing on curves.	
Lane lines[2]	Same as for center lines.	Must be easily distinguishable from center lines.	*Required* on hard-surface primary routes having over one lane available for travel in one direction.
Guide lines[2]	Paint[3]	Must be continuous lines.	*Required* to right and/or left of any obstacle in the roadway on primary system.
	Reflectorized coating[3]		
	Reflector units	Maximum height 24 inches; maximum spacing 25 feet.	
Obstacle markings	Paint[3]	Alternate black and white stripes extending to height of obstacle or at least 36 inches above roadway.	*Required* on all obstacles in or near the roadway on primary system, except on vehicles properly parked.
	Reflectorized coating[3]		
	Reflector units	As necessary to delineate obstacle.	
	Blackout lanterns		
Curb markings	Paint[3]	Must cover vertical or sloping face of curb.	*Required* on primary system on vertical or sloping faces of curbs of channelizing and pedestrian islands, safety zones, urban intersections to distance at least 15 feet back from crosswalks, sharp curves, bridges, viaducts, and other hazardous locations.
	Reflectorized coating[3]		
	Reflector units	Any convenient location on curb.	
Marginal delineators	Reflector units	Bifaced units *recommended*. Maximum height 22 inches; spacing not over 50 feet on tangents, less on curves.	*Required* on unpaved primary roads, on driver's right, for each direction of movement; on both sides of curves to the right.
	Reflectorized coating[3]		
Transverse markings	Paint[3]	See Figure 1.	*Required* for stop lines at intersections regularly controlled during blackouts by traffic control personnel or signals. Recommended for crosswalks, stop and limit lines.
	Reflectorized coating[3]		

[1] In addition to *required* markings listed in this column, similar markings are highly *recommended* for use on the secondary system and at hazardous locations.
[2] Minimum width of paint lines 4 inches; minimum width of reflectorized lines 3 inches.
[3] White is most desirable color.

PART II - TRAFFIC SIGNS[1]

TYPE OF SIGN	PHOTOMETRIC REQUIREMENTS[2]	MOUNTING	USE
Reflectorized signs.	Legible for at least 50 feet when illuminated by approved blackout driving lamp.	Not more than 12 feet from right edge of lane to be controlled; top of message not more than 24 inches above road crown.	Wherever not obscured by parked vehicles or other obstructions.
Exterior illuminated signs.	Light sources so shielded that direct light is not projected above horizontal and glare is not produced in direction of approaching traffic. See Appendix B for allowable surface brightness.	Must be within range of vision of approaching traffic.	Illuminated signs must be used wherever required legibility cannot be obtained by reflectorized signs.
Interior illuminated signs.	Legible for at least 100 feet; not detectable beyond 8000 feet.		

PART III - TRAFFIC SIGNALS[3]

TYPE OF SIGNAL	PHOTOMETRIC REQUIREMENTS[2]	SUGGESTED METHOD	PROBABLE SIGNAL LOCATIONS
Traffic control signals. Flashing signals.	Normal signal indications maintained except during blackouts. During blackouts, signals must provide distinctive color indications at all distances from 10 to 800 feet. Maximum allowable incident illumination on street 0.0006 footcandle. For maximum candlepower values above horizontal, see Appendix C.	Reduction in voltage to approximately 26 percent of rated voltage for 60 watt lamps, 24 percent for 100 watt lamps, and 29 percent for 40 watt lamps.	Intersections formed by two or more routes of the primary system, by routes of the secondary system with routes of the primary system and those within shopping, business, office, and amusement districts; points of heavy pedestrian movement; locations subject to high accident rates.
Pedestrian signals.	Same as for traffic control and flashing signals.	Extinguishment recommended.	

[1] Blackout traffic signs are required on primary routes wherever needed to guide, safeguard, or regulate traffic, giving particular attention to route turns and junctions, locations requiring stop or one-way regulation, sharp curves, railroad crossings, and similar critical locations.
[2] War Department design approval required. See paragraph 6 of main body of specification.
[3] Traffic signals should be extinguished during blackouts wherever practicable.

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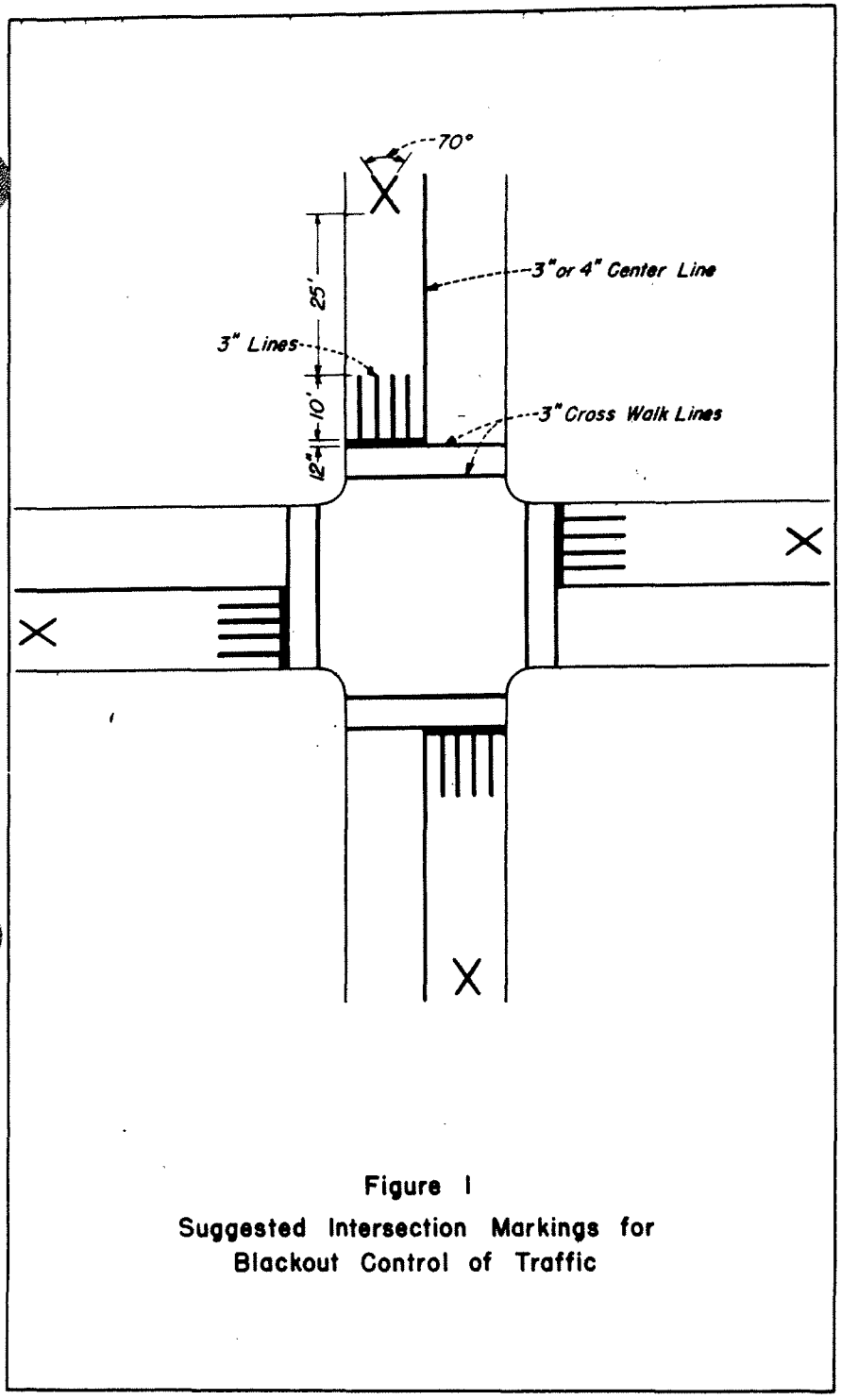


Figure 1

Suggested Intersection Markings for Blackout Control of Traffic

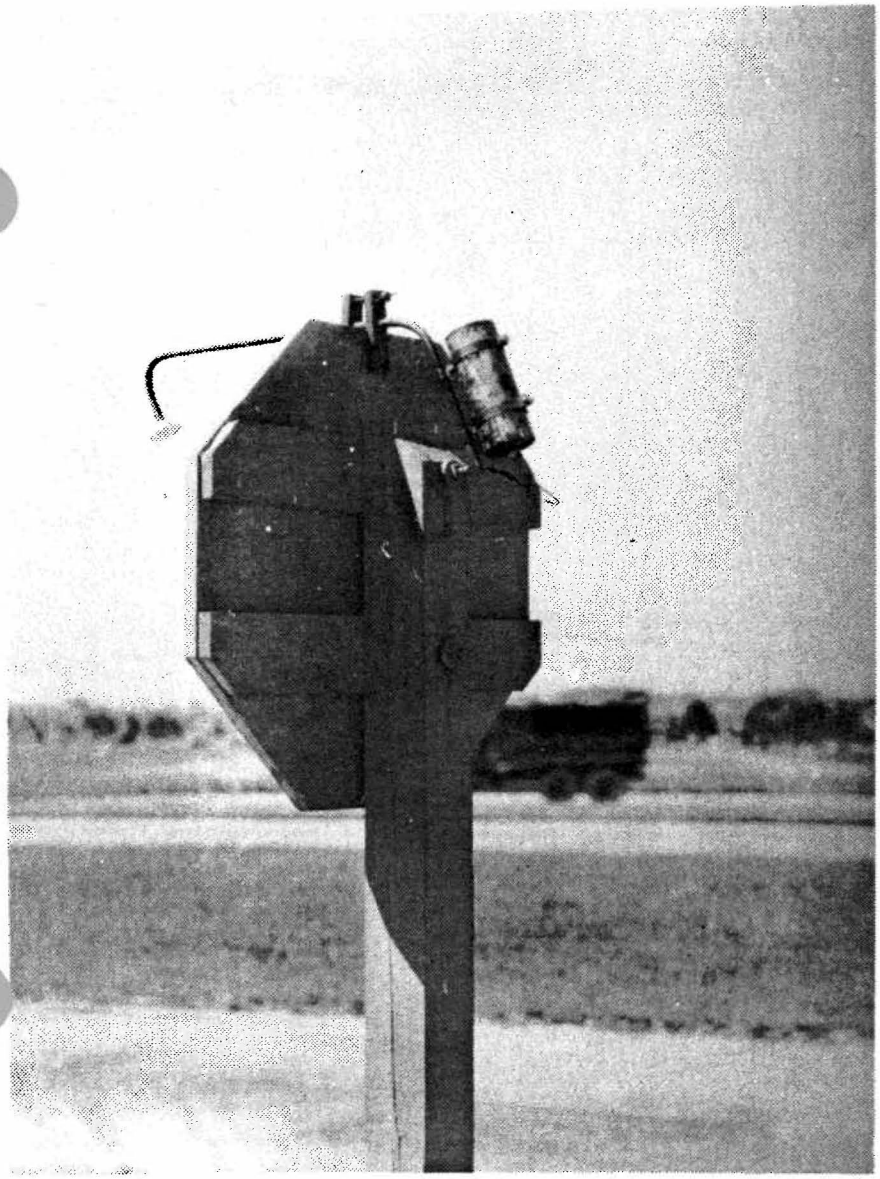


Figure 2.
Exterior-Illumination Fixture Attachment to Traffic Sign

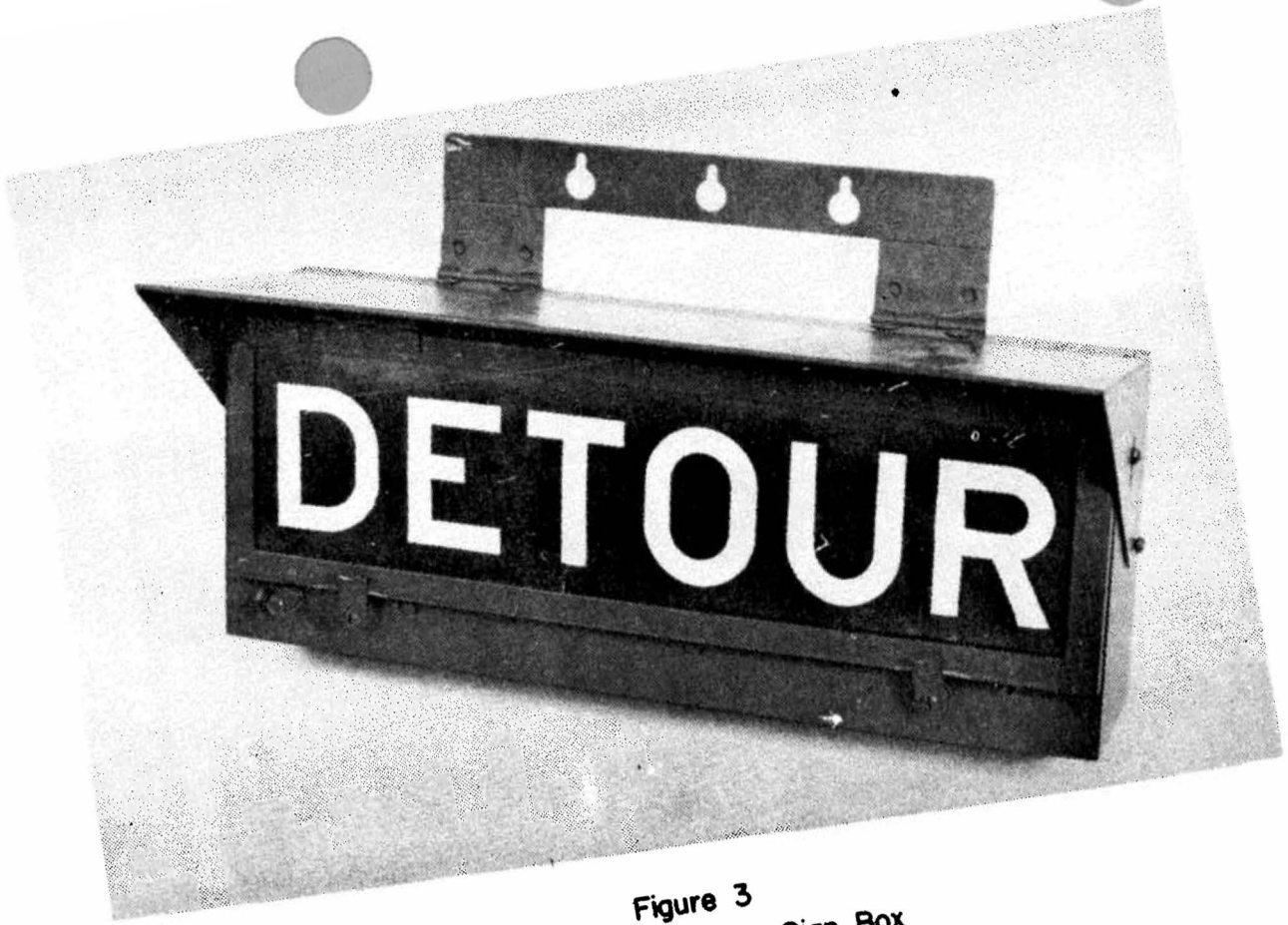


Figure 3
Interior-illuminated Sign Box

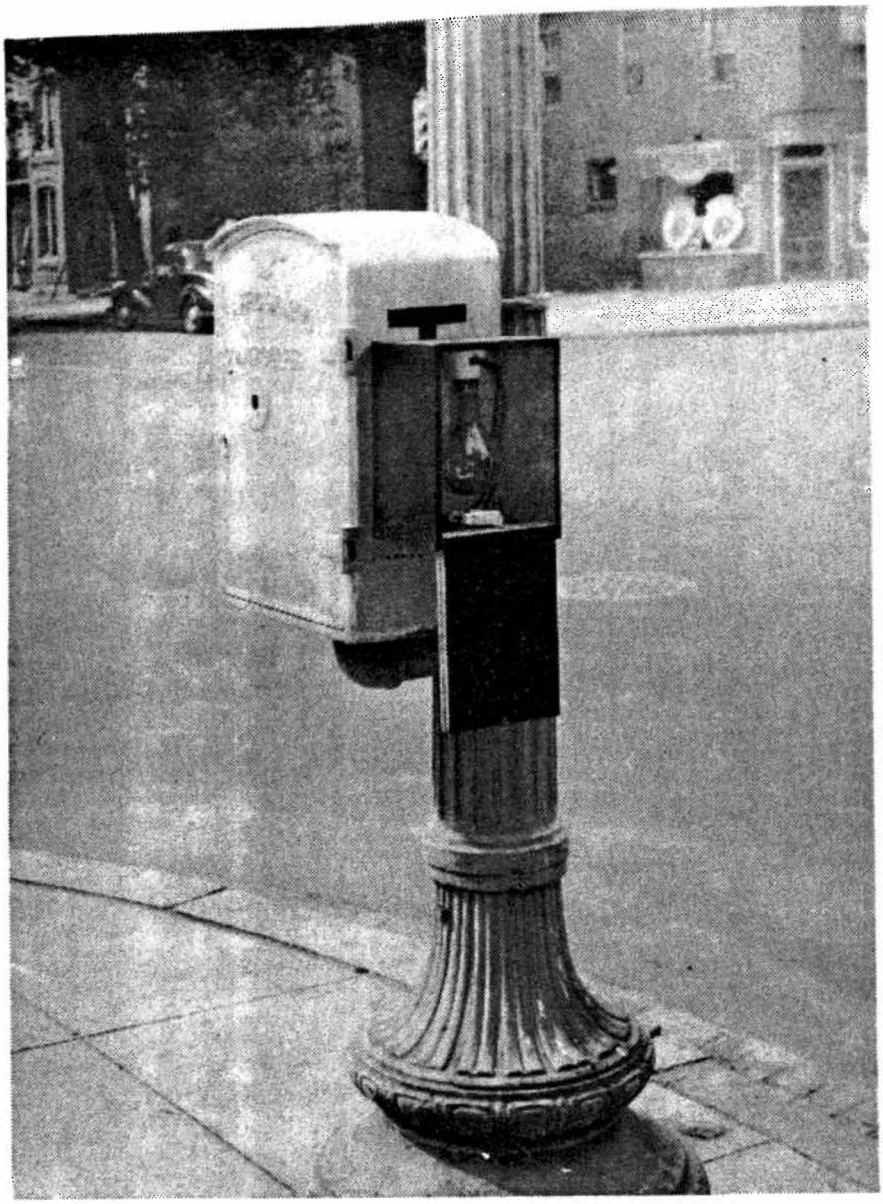


Figure 4

Use of General Service Lamp as Resistor for Reduced-Voltage Operation of Traffic Signal

Fig 140

Fig 145

Fig. 141-a

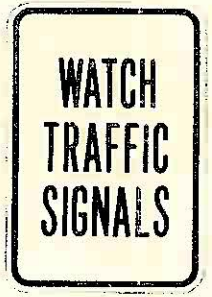


Fig 141-b

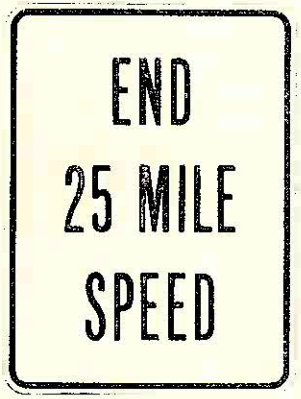


Fig 141-c

Fig 142

Fig. 144-a

Fig. 144-b

Fig. 144-c

Fig. 144-d

Fig. 143-a

Fig. 143-b

Fig. 147

Fig. 147.1

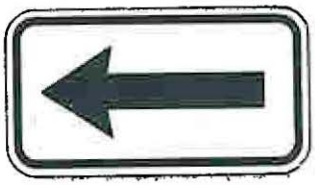


Fig. 148-b

Fig. 148-a

Fig. 148-c

Fig. 148-d

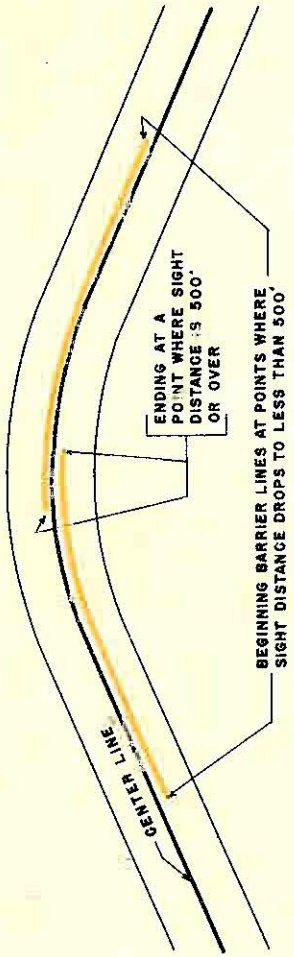
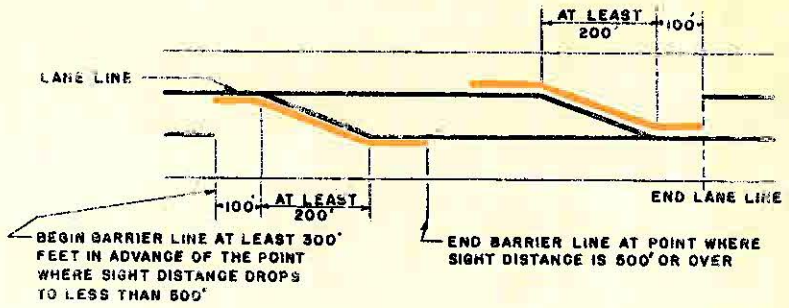
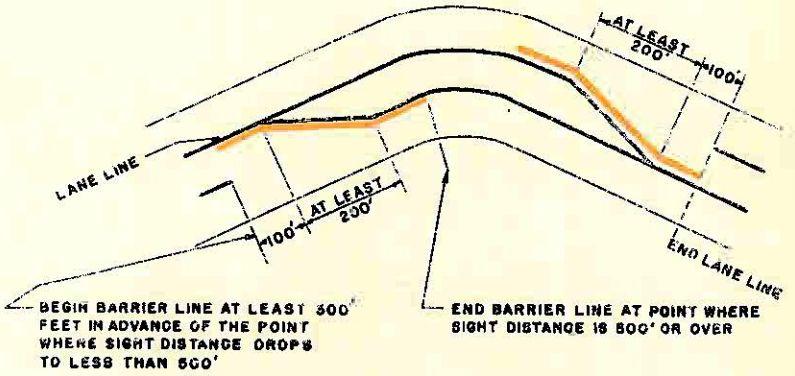


FIGURE 204.1a - PAVEMENT MARKINGS - EMERGENCY STANDARDS
TWO LANE HORIZONTAL CURVE
WHERE SIGHT DISTANCE IS LESS THAN 500'



PLAN VERTICAL CURVES



PLAN HORIZONTAL CURVES

FIGURE 204.1b - PAVEMENT MARKINGS - EMERGENCY STANDARDS
(THREE LANE PAVEMENTS)

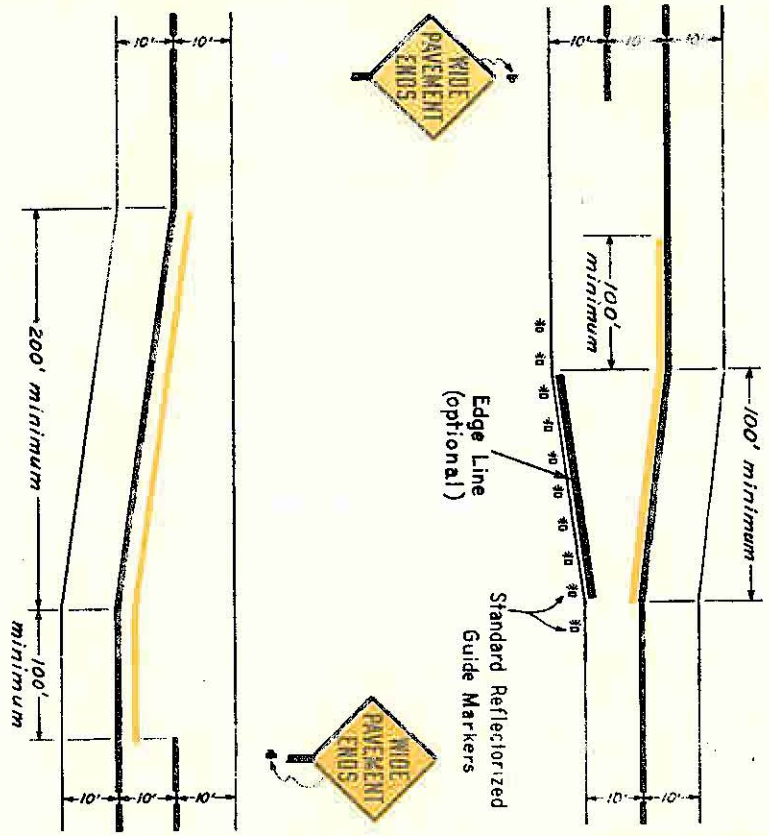


FIGURE 213 a - STANDARD PAVEMENT MARKINGS
AT POINTS WHERE PAVEMENTS CHANGE IN WIDTH
TRANSITIONS FROM THREE LANES TO TWO LANES

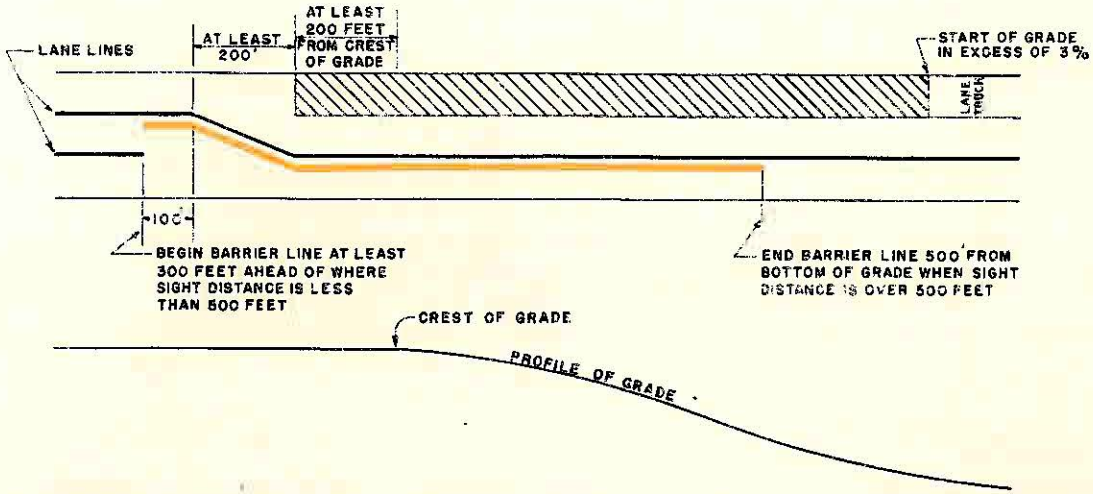


FIGURE 204.1c - PAVEMENT MARKINGS - EMERGENCY STANDARDS
PERMITTING USE OF 2 LANES FOR UPHILL
TRAFFIC ON 3 LANE ROAD

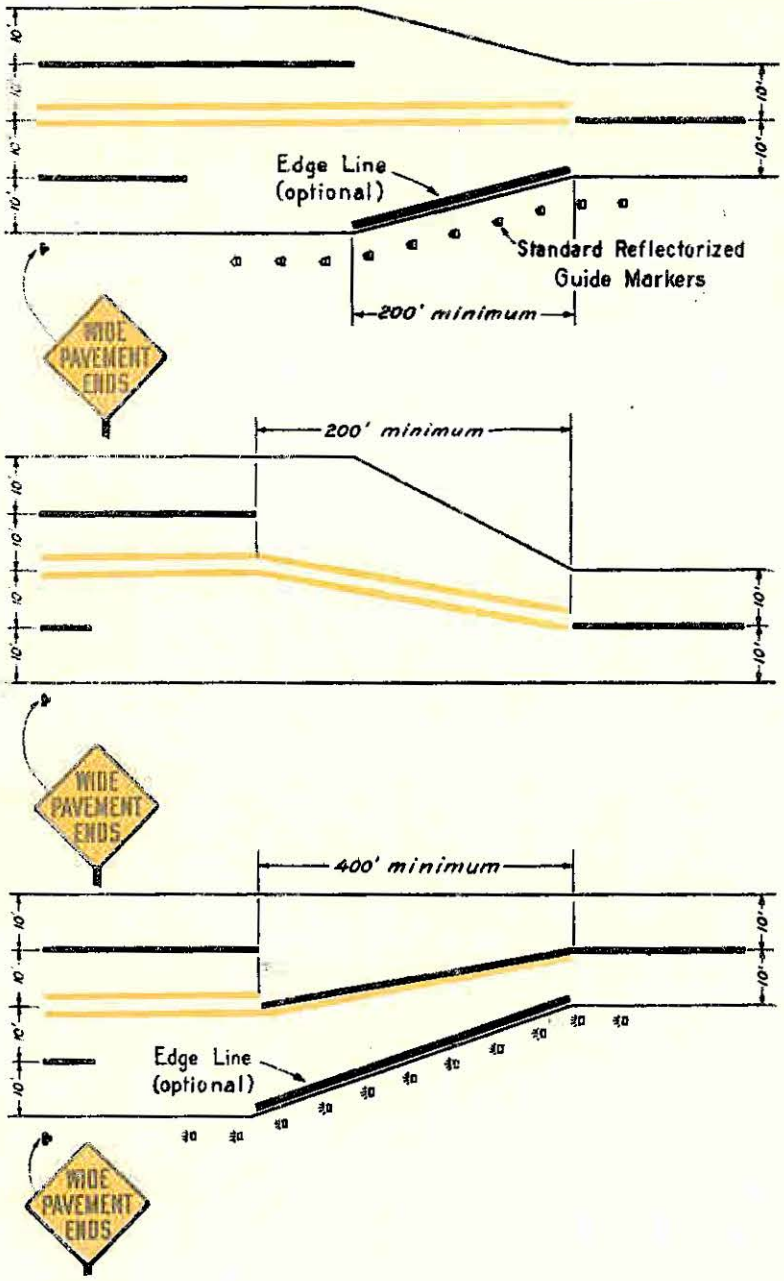


FIGURE 213 c - STANDARD PAVEMENT MARKINGS
AT POINTS WHERE PAVEMENTS CHANGE IN WIDTH
TRANSITIONS FROM FOUR LANES TO TWO LANES

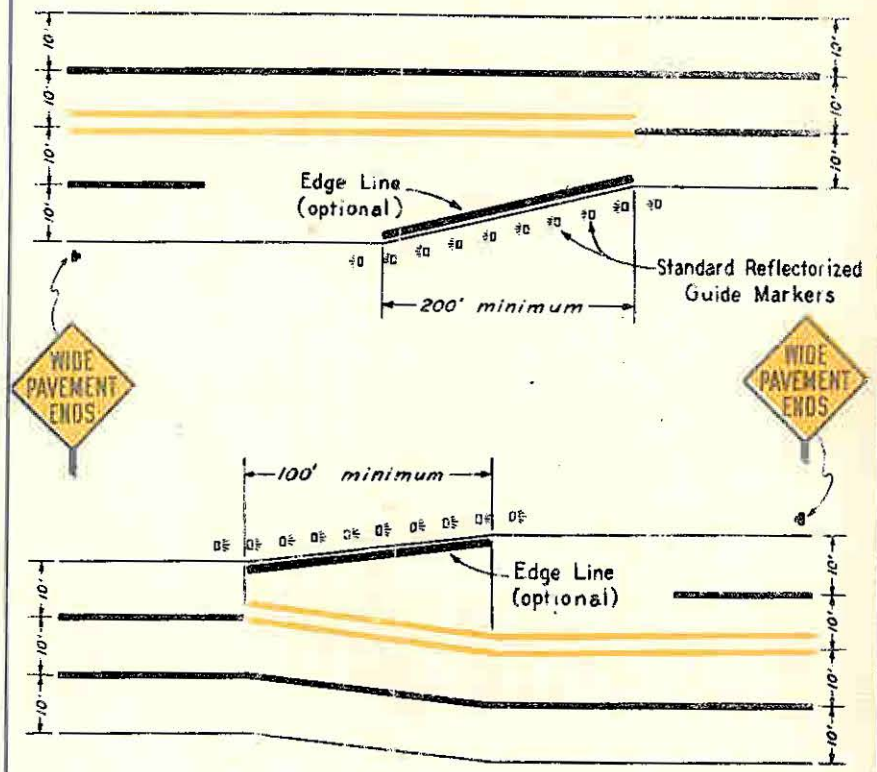
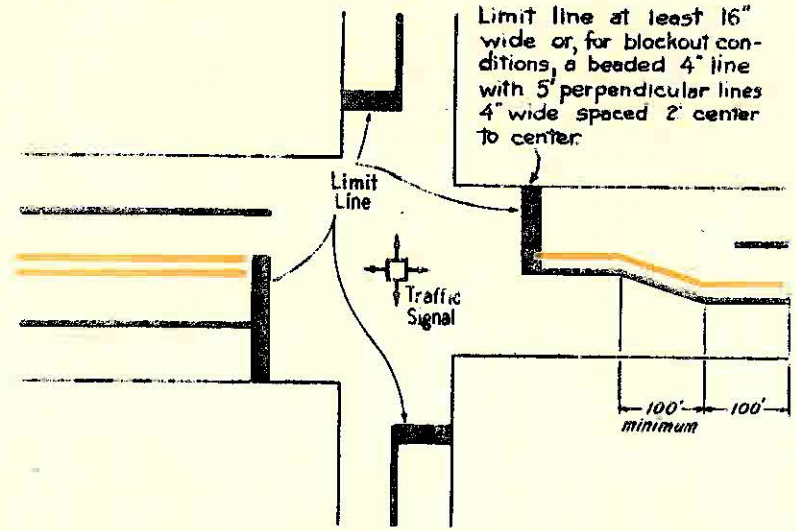
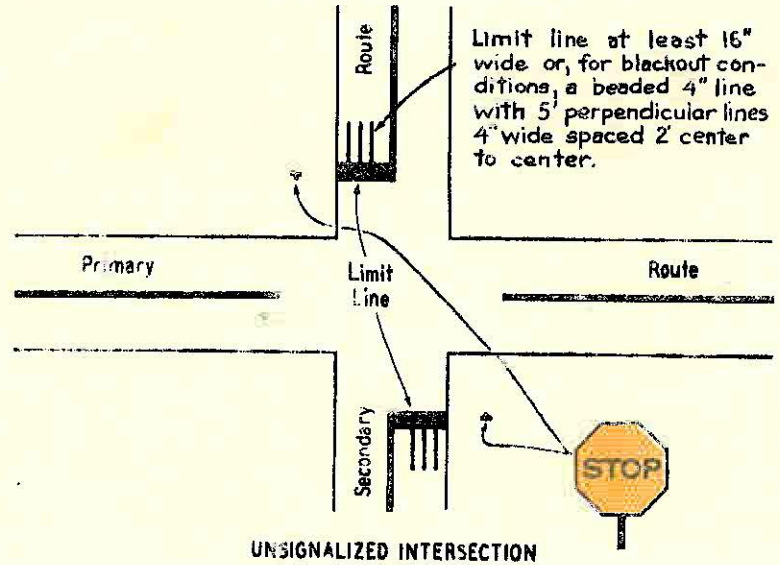


FIGURE 213 b - STANDARD PAVEMENT MARKINGS
AT POINTS WHERE PAVEMENTS CHANGE IN WIDTH
TRANSITIONS FROM FOUR LANES TO THREE LANES



SIGNALIZED INTERSECTION



UNSIGNALIZED INTERSECTION

FIGURE 228 - PAVEMENT MARKINGS
AT RURAL INTERSECTIONS

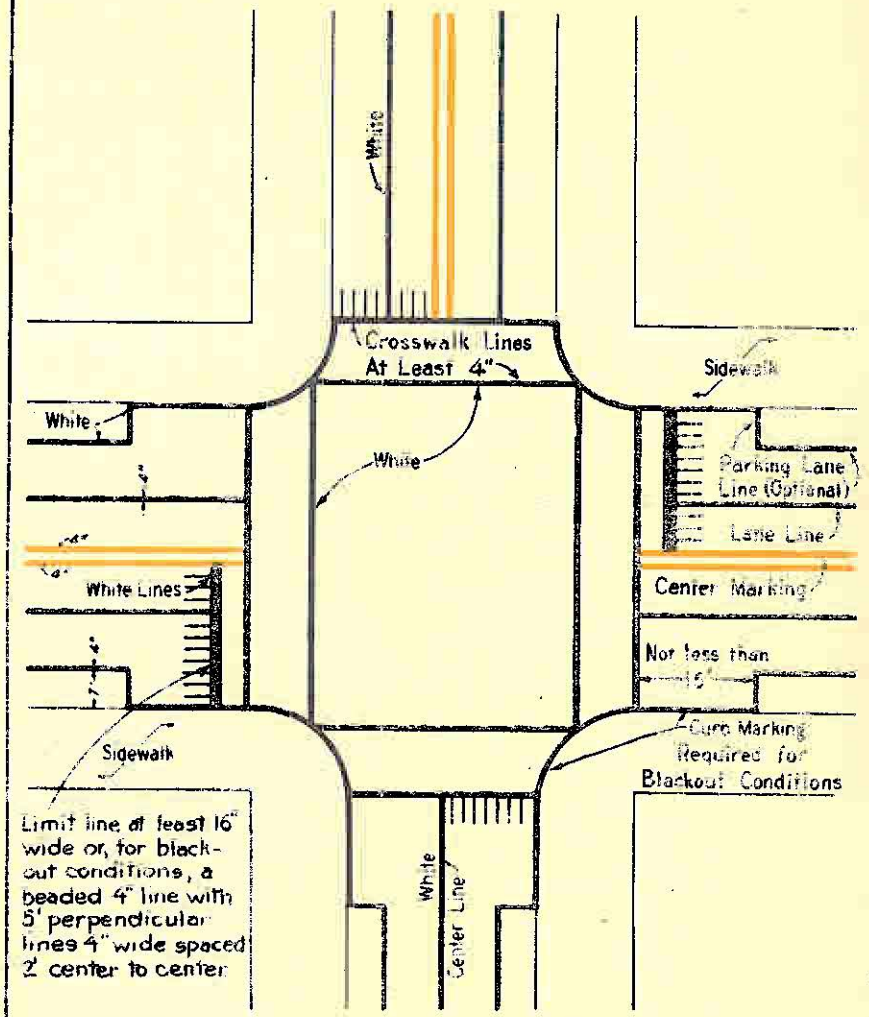


FIGURE 222 - PAVEMENT MARKINGS
AT URBAN INTERSECTIONS

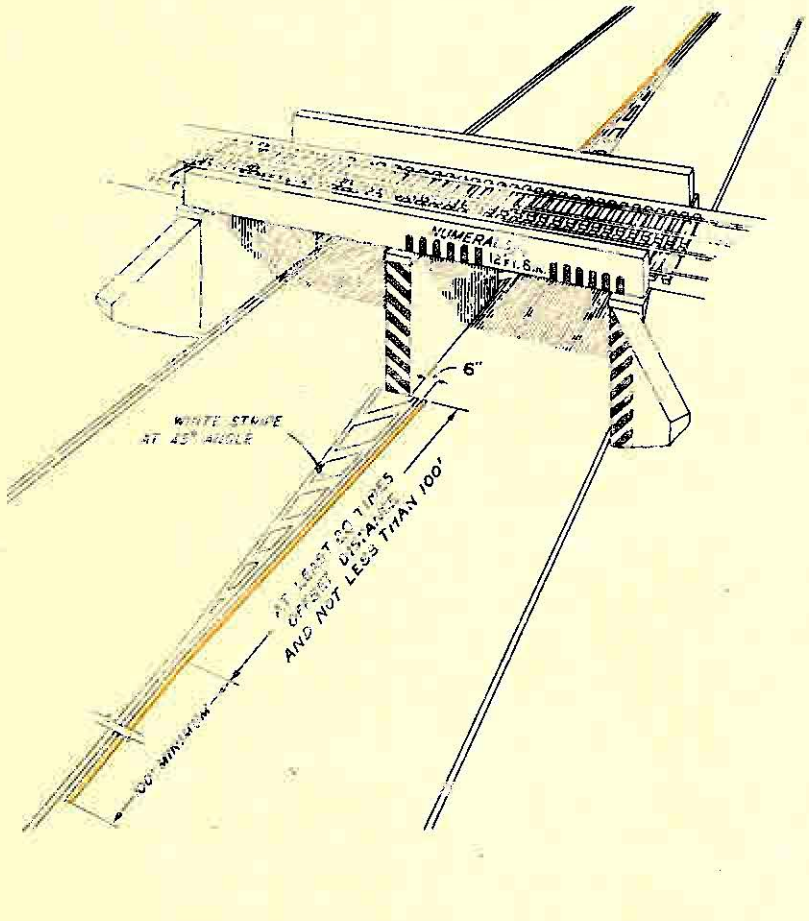


FIGURE 229 - STANDARD OBSTRUCTION MARKINGS
TYPICAL DIVIDED UNDERPASS

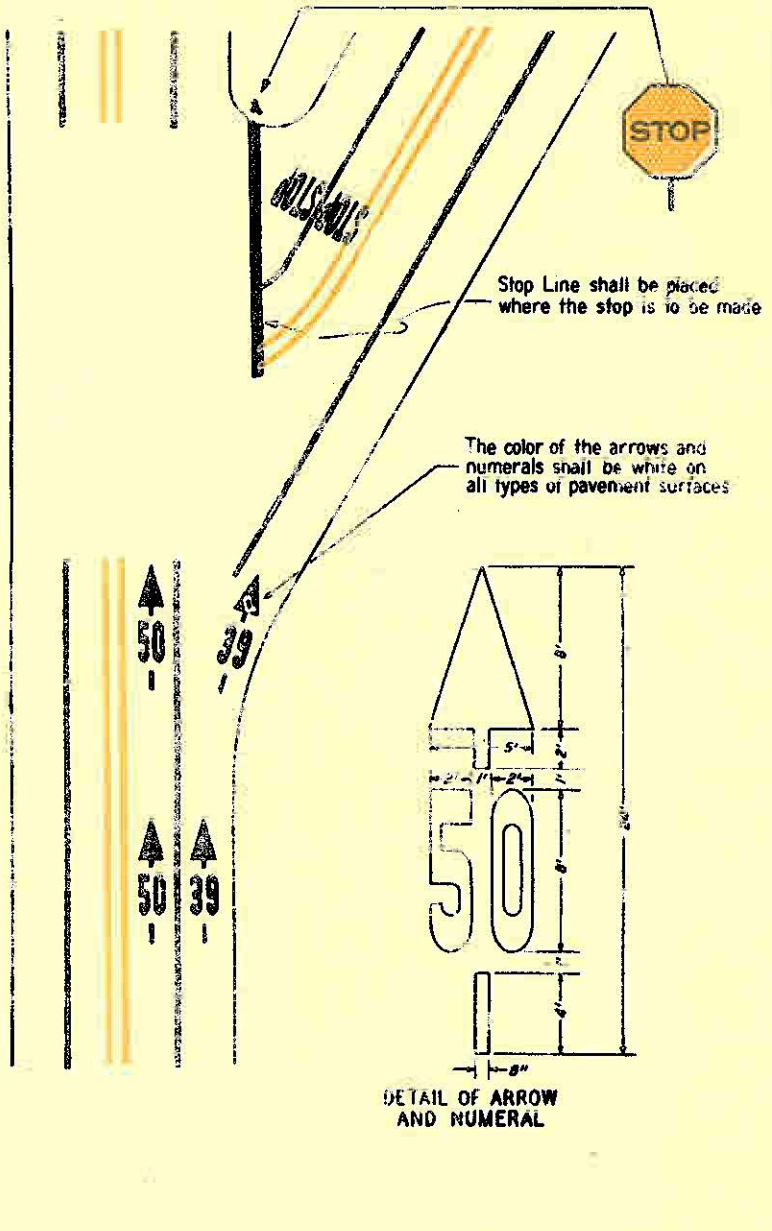


FIGURE 232 - STANDARD PAVEMENT MARKINGS
PAVEMENT ROUTE MARKING
RURAL INTERSECTIONS

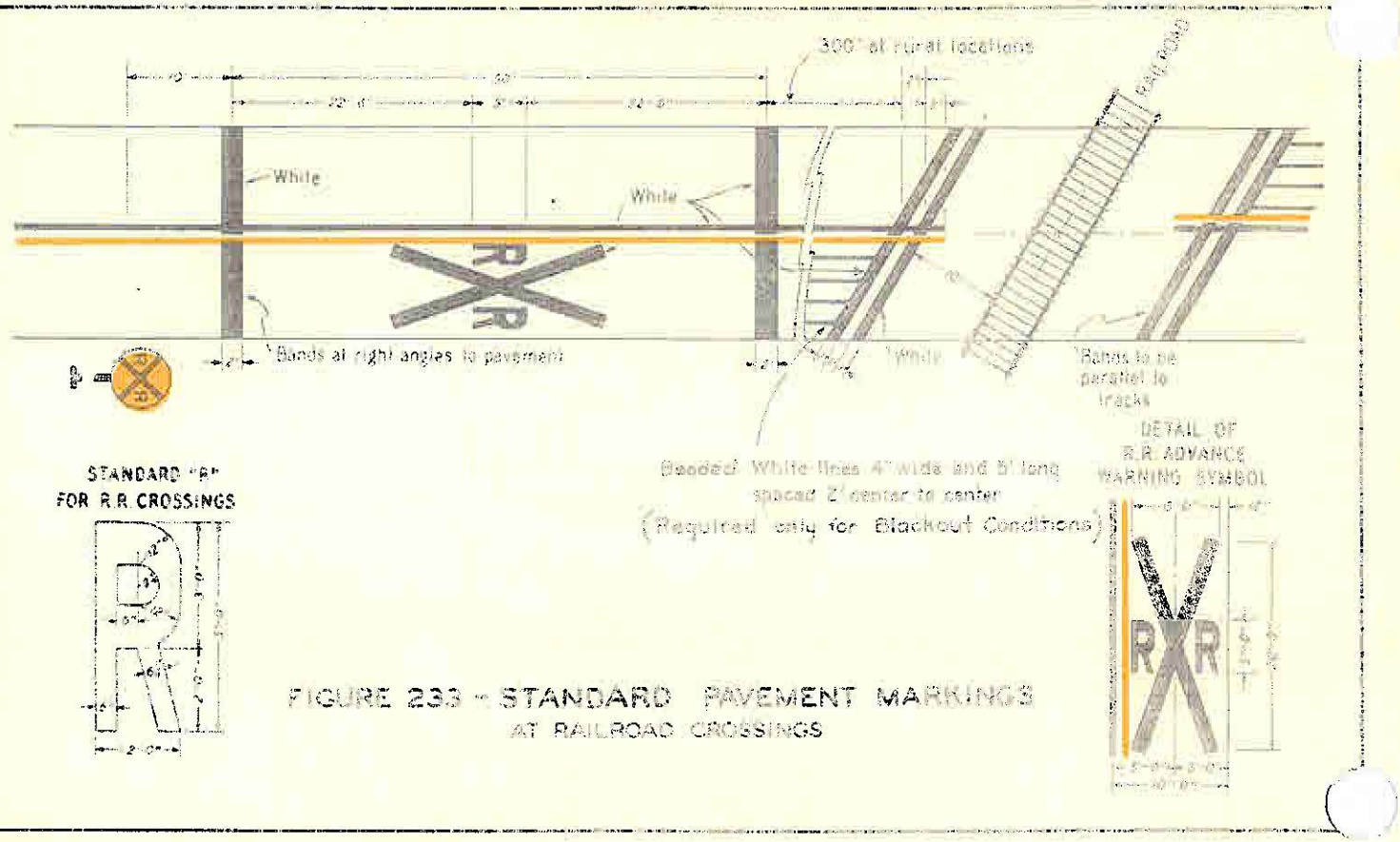
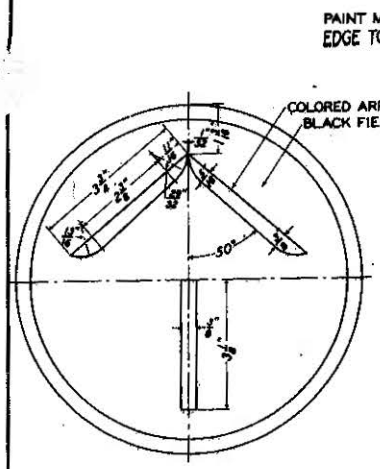


FIGURE 233 - STANDARD PAVEMENT MARKINGS AT RAILROAD CROSSINGS



NOTE:

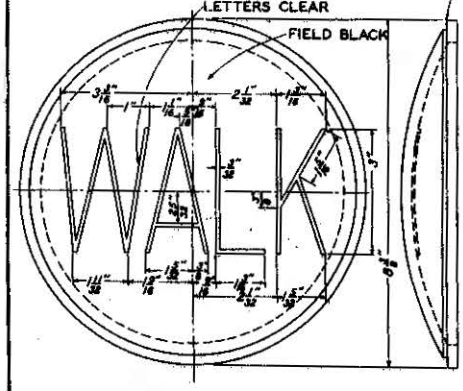
ALL LENSES SHALL BE KOPP OR CORNING GLASS 8-3/6" DIAMETER PRISMATIC DIFFUSING OR APPROVED EQUAL THEREOF.

THE LENS GLASS SHALL BE OF APPROVED COLOR CONFORMING TO I.T.E. SPECIFICATIONS FOR THE PARTICULAR FUNCTION OF THE LENS; NAMELY, RED, AMBER OR GREEN.

ALL LENSES SHALL BE GIVEN ONE COAT OF BLACK OPAQUE ENAMEL OF A THICKNESS SUFFICIENT TO TOTALLY OBSCURE LIGHT OF 100-WATT LAMP PLACED BEHIND IT. THE ENAMEL SHALL BE FREE FROM ALL PIN HOLES. THE ENAMEL IS TO BE APPLIED ON THE OUTSIDE SURFACE OF THE LENS IN SUCH A MANNER THAT WHEN THE LENS IS IN USE, THE ARROW SHALL BE THE ILLUMINATED PORTION OF THE LENS. THE ENAMEL SHALL BE BAKED OR FIRED INTO THE GLASS. THE ENAMEL SHALL BE HARD AND DURABLE AND SHALL NOT PEEL OR FLAKE OFF WHEN SUBJECTED TO THE HEAT OF A SIGNAL LAMP WHEN THE LENS IS IN USE OR WHEN THE LENS IS WASHED.

THE ARROW SHALL BE REPRODUCED ON THE LENS IN CONFORMANCE WITH THE DIMENSIONS AND SHAPE SHOWN ON THIS DRAWING.

FIGURE 329



NOTE:

THE LENS SHALL BE KOPP OR CORNING GLASS 8-3/8" DIAMETER CLEAR WITH THE WORD "WALK" RAISED ON THE INNER SURFACE, OR APPROVED EQUAL THEREOF.

THE LENS SHALL BE GIVEN ONE COAT OF BLACK OPAQUE ENAMEL OF A THICKNESS SUFFICIENT TO TOTALLY OBSCURE LIGHT OF 100-WATT LAMP PLACED BEHIND IT. THE ENAMEL SHALL BE FREE FROM ALL PIN HOLES. THE ENAMEL IS TO BE APPLIED ON THE INSIDE SURFACE OF THE LENS IN SUCH A MANNER THAT WHEN THE LENS IS IN USE, THE WORD "WALK" SHALL BE THE ILLUMINATED PORTION OF THE LENS. THE ENAMEL SHALL BE BAKED OR FIRED INTO THE GLASS. THE ENAMEL SHALL BE HARD AND DURABLE AND SHALL NOT PEEL OR FLAKE OFF WHEN SUBJECTED TO THE HEAT OF A SIGNAL LAMP WHEN THE LENS IS IN USE OR WHEN THE LENS IS WASHED.

THE WORD "WALK" SHALL BE REPRODUCED ON THE LENS IN CONFORMANCE WITH THE DIMENSIONS AND SHAPE SHOWN ON THIS DRAWING.

FIGURE 332.1

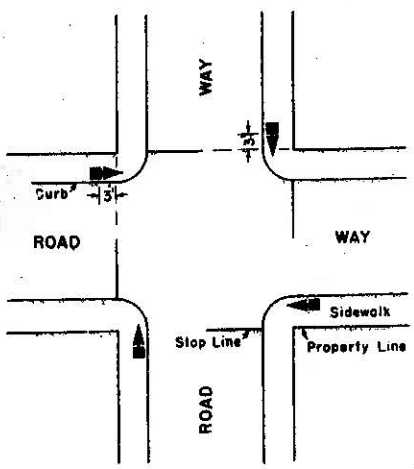


Fig. 343

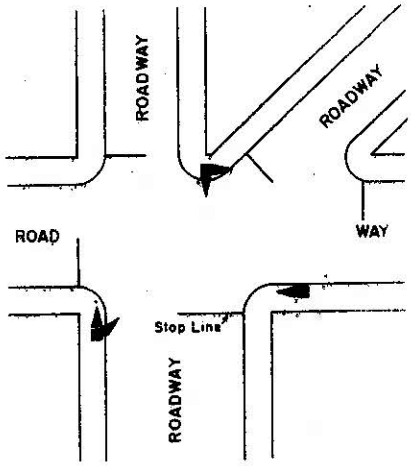


Fig. 343 a

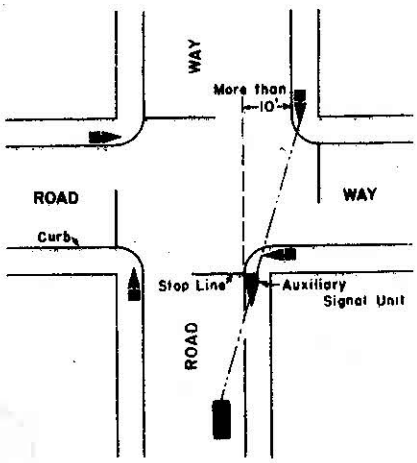


Fig. 347 b

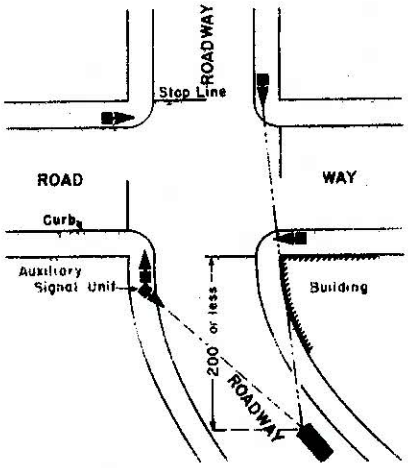


Fig. 347 c

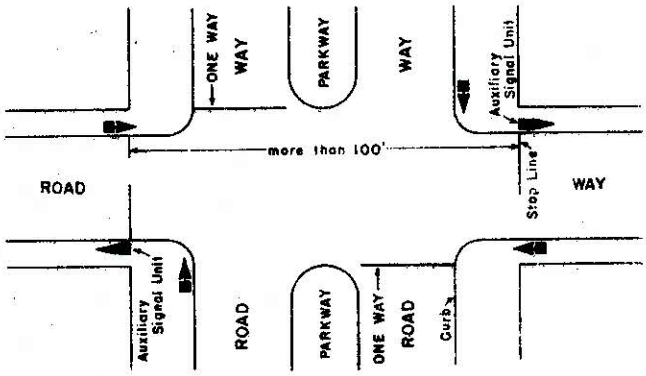


Fig. 347 c

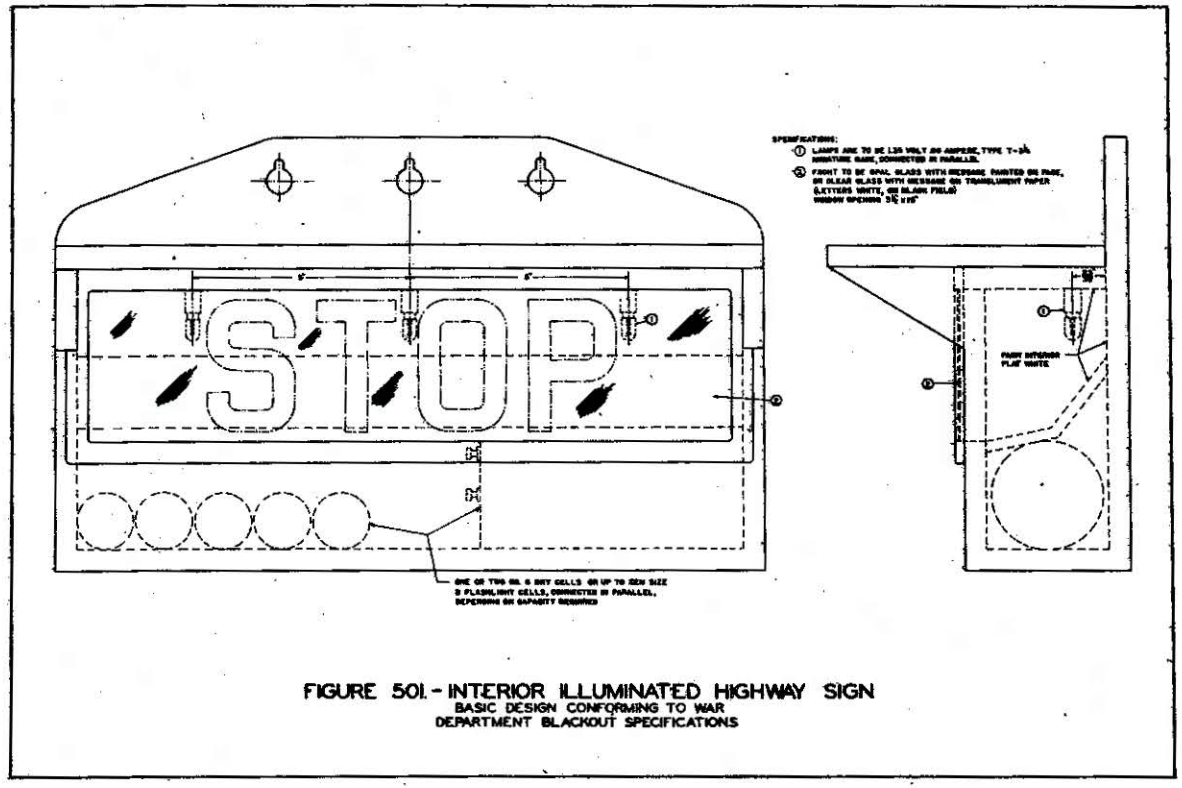


FIGURE 501 - INTERIOR ILLUMINATED HIGHWAY SIGN
BASIC DESIGN CONFORMING TO WAR
DEPARTMENT BLACKOUT SPECIFICATIONS