

## PART III

## SECTION III MOTOR VEHICLES EXCEEDING 6000 POUNDS GROSS WEIGHT, DESIGNED FOR THE TRANSPORTATION OF GOODS OR MATERIALS, TRACTORS, AND ALL OTHER MOTOR VEHICLES NOT COVERED IN PART II

All the requirements for vehicles coming in this class are similarly expressed as in Part II

The performance, upon the application of both brakes simultaneously, is the same as that required for foot brakes for vehicles coming in Part II. The requirements for hand brakes is the same as that required for vehicles in Part II for the reason that this requirement is regarded as the minimum allowable for safety

RULE 301. A two-year period is allowed in which vehicles coming under Part III may be accommodated to meet the requirements as under Rules 200 and 201 of this Code

RULE 302. This rule is designed to allow the operation of brakes in a train of vehicles which corresponds to practice

## COLOR AND FORM OF TRAFFIC SIGNALS AND SIGNS IN RELATION TO SAFETY

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There are several principles of safety and efficiency in driving which have sound bases in psychology and practice I couple safety and efficiency together here because the two are largely identical. The principles to which I refer are:

- 1 The attention of the driver should be as little as possible distracted from his main business of guiding and controlling his car with respect to other cars, to pedestrians, and to fixed objects
- 2 Driving should, so far as possible, be a matter of established habit, making as few as possible demands upon the judgment or interpretative thinking of the driver In this respect it should be brought as nearly as possible to the condition of walking, which has been pretty thoroughly automatized by the human race.
- 3 For the furtherance of both of the above purposes, traffic regulations should be as uniform as possible, and signs and signals should be as distinctive as possible, lending themselves to ease

and certainty of learning and to the early evocation of automatic response to them

- 4 Regulations should be such as appeal to the common sense of the driver, and such as have a high probability of enforcement. Freak rules and dead-letter laws contribute to habits of recklessness and of disregard not merely of these regulations, but of others

These principles seem to be so generally accepted at present that they should need no argument or elaboration. I should add to them a fifth principle which, it is possible, is also accepted generally, but which needs to be emphasized, namely:

5. The benefits or deleterious effects of adequate or improper signals and signs cannot be measured solely in terms of accidents and traffic movements at the points at which these signs or signals occur, but are to be expected at other points, also, on account of the activation of or interference with the formation of safe habits.

The requirements of signs and signals for the fulfilling of the conditions imposed by these principles may be classified under four heads, viz: (1) color, (2) form, (3) position, and (4) rapid visibility. This classification is obviously an overlapping one, but is nevertheless convenient

*Color.* The problems of color in regard to traffic fall into two subdivisions: (1) color of luminous signals, and (2) color of fixed signs. In the second subdivision the problem is not serious, and its solution is approximately reached, except in so far as luminous and non-luminous signs in certain cases have identical significance. The problem is to be approached, therefore, through the consideration of luminous signals.

If all areas of the retina of the eye were as sensitive to color stimulation as is the fovea, or central point, signal practice might satisfactorily employ four colors—red, yellow, green, and blue. Unfortunately, the eye is not an instrument of this sort. The total area of the retina may be divided into three zones: (a) The central zone, in which so-called "normal" color vision occurs; (b) the medial zone, surrounding the central zone, in which only two colors are discernible, namely, yellow and blue. In this zone, reds appear as dark yellows or browns, the long-wave greens appear as pale yellow, the bluish greens appear as pale blue, and the violet as dark blue. Certain greens

intermediate between those that appear yellow and those that appear blue, appear as practically colorless. (c) In the third, or marginal, zone, all color stimuli tend to appear as colorless. These three zones are not sharply separated, but grade into each other, and the character of vision in any case is dependent not alone on the exact position, wave length, saturation, and intensity of the stimulus, but also upon its duration and motion, and upon the amount of practice of the individual in discrimination, and the degree of attention which is given to the particular observation. External conditions of smoke, fog, dust, and contrast with light of other colors are also influential when the sources of light are at some distance from the observer.

For practical purposes, therefore, the accurate and rapid discernment of color is limited to "central" vision (that is, the condition in which the eye is directed immediately upon the light). In "periphera" vision (when the median and outer zones of the retina are used), while discrimination *may*, under test conditions, be more or less possible, colors are susceptible of confusion under many conditions.

To conform to the principles I have outlined in the beginning, signal lights should, so far as possible, be such as can be discriminated in the medial zone. Yellow and blue are excellent colors for this purpose, and it is perhaps unfortunate that our traditions prevent us from using these colors, and these only, for traffic-signal purposes. However, the present standards for "red" and "green" permit of colors which are tolerably satisfactory, as these colors change toward yellow and blue, respectively, as they are moved outward on the retina from the center. It is desirable, however, that the "green" be made as bluish as possible under present standards, and possibly the limits of this color toward the blue should ultimately be extended. The standard "red" suffers from the fact that it tends to become darker in peripheral vision, but, unfortunately, the necessity of providing for a third color, "yellow," prevents the present use of a more orange-red, which would be more adequate. If yellow should be generally excluded as a signal color, the adoption of a more adequate "red" would be in order. The problem of yellow as a signal color has no bearing, so far as can be determined at present, on its use as a ground color for city and highway non-luminous signs.

The problem of signal colors is further complicated by the existence of a class of the population commonly known as "color-blind." In typical cases, the central vision of the color-blind eye is analogous to

the vision in the medial zone of the so-called "normal" eye—that is to say, in the central vision of the color-blind, only two colors are seen, and these are probably yellow and blue. On this account these color-blind persons are technically designated as dichromatic. The solar spectrum, for these people, appears in gradations of yellow, through the normal red, yellow, and yellowish green, and blue from the bluish green to the violet end, with a "neutral band" (colorless) between these two regions. The exact location of the "neutral band" differs in different cases, but in general lies in the region of the spectrum which for the "normal" is green. This "neutral band," according to the summary of Dr. Percy W. Cobb (who is probably our most reliable American expert in the physiology of vision), may be anywhere between wave lengths of 486 mm. and 505 mm., varying in individual cases.

The problem of the "color-blind" is further complicated by several factors:

1. The defect may occur in a restricted portion of the central area, surrounding parts of the area being "normal." Or, it may cover the whole central area, so that there is no distinction between central and medial portions of the retina, so far as color discernment is concerned, aside from the matter of greater practice in the use of the central portion.
2. There are two "types" of color-blindness, conventionally known as protanopia and deuteranopia. In the second of these types the spectrum appears as of "normal length"; in the first type the spectrum is shortened at the red end, so that extreme reds of certain intensities, which may be visible to the normal person and to the deuteranope, may be invisible to the protanope; and reds lying inside of this point may be relatively dim in intensity to the protanope.
3. There is no sharp division of classes of color-blind persons from normal persons, there are all degrees of "color weakness," ranging from extreme types of "color-blindness" to the normal (and perhaps to supernormal) color vision by gradations.

The percentage of "color-blind" persons in the total population has been variously estimated as including from 2 to 4 per cent of the males, and at lesser percentages for females. Statements have been made to the effect that there are no color-blind women, but this is a gross error. From measurements made by Dr. Haupt on school

children who may be taken as fair samples of the Baltimore school population, it is evident that the percentage of color-blindness and color-weakness among girls is somewhat less than among boys, and the same is probably true of adults. There are certainly many color-blind women, but they are not as easily caught as the men.

Determinations of this sort are usually complicated by a number of factors:

1. The factor of gradation, above mentioned, complicates all tests, making the division between "normal" and "color-blind" an arbitrary one.
2. Brightness, saturation, and other conditions influence actual color discrimination, as in the case of peripheral vision of the normal. Hence, the degree of apparent color-weakness varies according to the conditions of the test.
3. The presence of "secondary criteria" of brightness and saturation makes it possible for many color-blind people to pass tests of various types. This is especially true of women, because of their practice in the handling of colored materials, but it is true of many men, also.
4. On the other hand, lack of practice of many men in discrimination of colors of low saturation confuses them on many of the tests.

The Jennings test, which is in many respects one of the most competent, is especially vitiated by the third and fourth factor. Many color-blind get by this test successfully, even when carefully given, and many who appear color-blind on this test are really not so.

The most sensitive tests, of the Stilling and Ishihara type, are useless for practical purposes, since they do not distinguish between slight color-weakness, which may be of no practical importance, and more serious defects, and do not distinguish between restricted central defect and more extensive defects.

Tests have been devised which exclude secondary criteria and reduce confusion, but these are not commercially available. For many purposes the completion and standardization of these tests is of extreme importance, and should be facilitated, but, as I shall show, this is not an important matter for traffic.

There are two forms of "color-blindness" not included in the above summary, namely: "total" color-blindness and "blue weakness." In total color-blindness the individual sees no colors, the entire spectrum appearing in shades of grey. Cases of this kind are so rare

that the discovery of one is an event of some importance, hence, there is no need of considering these in this connection.

Blue weakness is a reduction of the stimulating effect of blue, with perhaps in some cases, a shortening of the spectrum at the violet end. It is surmised that this is more frequent among women than among men, and it may be somewhat prevalent, but no competent tests for it, susceptible of extensive application, have been developed. This defect, however, is not of importance for traffic conditions, as it has no known bearing on any of the colors employed.

At first glance it might seem that the refusal of drivers' licenses to seeming "color-blind" individuals might be the solution of the problem of color-blindness as regards traffic. This is an attempt at solution, however, which I believe is not merely inefficacious, but actually detrimental.

The designation "color-blind" is necessarily arbitrary on account of the gradations from "normal" to "color-blind" above mentioned; and there is not any certainty that the "color-weak" who just pass the test are more efficient under driving conditions than those who fall below.

Varying results will, of course, be obtained with tests of varying types, and the tests which are least unreliable require a time for their administration which could not be given under routine conditions, and require an expertness in application which we cannot hope to find in the average examiner.

Moreover, the number of seriously color-blind who successfully pass such tests as can be administered introduce not only an element of unfairness, but also the potential danger of assuming that drivers who pass the test are normal, when many of them are not.

The practical solution of this problem is indicated by the close resemblance of "color-blindness" to peripheral color-vision. If signal colors are made of the highest possible efficiency for peripheral vision of normal drivers, there is then no "color-blindness" problem, since these colors indicated above are precisely the colors which the "color-blind" can discriminate in central vision (and in peripheral, too), as well as can the "normal."

The importance of adopting "safe" colors for signals does not depend solely on the incidence of color-blindness and color-weakness, but also on the fact that we want all drivers to be able to distinguish the signals as quickly and accurately as possible in moderately peripheral vision. The traffic problem is not the railroad problem, and we

do not want drivers to form the habit of depending on central vision for signals. Pedestrians and other cars have to be watched. In this connection I may quote from a letter from Dr. Cobb:

"As to the color filter for the red and green signals, it would seem to me the ideal would be to have transmissions which would represent the two parts of the spectrum, divided in this region (the region of the color-blind 'neutral bands')"

*Confusing Use of Colored and Other Signals and Signs* It is important (in accordance with the principles set forth in the beginning) that signals, so far as possible, shall mean one thing, and one thing only. This is especially important for the positive "stop" signals. If red is to mean "stop," and if the driver is to form the habit of stopping automatically, without thinking or consideration of other possible meanings, then, of course, red must not be used for any other purposes. Some of the confusing (and, therefore, dangerous) ways in which red is actually used are as follows:

- (a) Indicating a bridge division, parkway end, or other fixed obstacle where the actual intention is that the motorist shall "keep right" without stopping.
- (b) Indicating a bend in the road
- (c) Indicating a railroad crossing, but not the actual approach of a train
- (d) As a fixed or flashing signal indicating a safety zone.
- (e) Indicating a temporary stop, as at a boulevard, where the motorist is expected to resume motion at discretion, although the sign does not change
- (f) Indicating a temporary obstruction in the street
- (g) Indicating a fire-alarm box at street corner
- (h) As tail-lights and brake-lights

With regard to the last use, however, it should be said that the tail-light and brake-light problem is one which is not at present soluble; more work needs to be done on this before opinion is fixed, and it is not a problem to be settled theoretically.

Fatal accidents have occurred as a result of the use of red lanterns on road obstructions, and at points of the other misuses, traffic obstruction and confusion are frequently observed, although, perhaps, accidents at these points may not be directly traceable to the misuse of the lights. The more important factor, however, is that the misuses prevent the proper training of the motorist, and are, therefore, conducive to accidents at other points. Drivers will never be trained to

the point of automatic, unreflecting stop on the red light so long as the other uses are retained. The driver's task should not in these cases be reflective. It should not be that *this particular* red signal means stop, but that any red signal means stop, or else we should omit red from the stop signs and substitute something else.

It is entirely feasible to do away with the non-stop use of red. This is a matter of detail. It is also possible to use something other than colors for stop and go. This has actually been tried out by railroads, and has, I believe, been found satisfactory. The mechanism employed in these lights is a vertical row of three lights for go, three horizontal for stop, and an oblique row for caution. The devices for these linear signals are no more complicated than the present three color mechanisms used in traffic. There is no obstacle to further experimental use of these systems, since a central clear or yellow lamp, two green lamps above and below, two red lamps on each side, and two yellow lamps for the diagonal, indicate the signal to the driver trained to colors as clearly as do the present color signals.

Another source of confusion is the flashing light now used for various purposes. It may mean "keep right," as at a safety zone; but, unfortunately, on the highway it may mean "keep left," and intend warning of approach to a curve or cross road.

Actually, along a certain western railroad, red lights are kept flashing all night to indicate the crossing.

We may eliminate red for these signs and we may use fixed and flashing lights so that the latter means only one thing but the problem of yellow light still remains. At safety islands, yellow means keep right. At intersections it means merely "don't enter intersection." On some roads, unfortunately, it means a curve, or road end. The motorist discriminates these varying uses, but we don't want him to make any more judgments than are necessary. In my opinion, yellow should be abolished as a significant color. It is rapidly being abolished as a warning sign between red and green at intersections, and need not be retained between green and red. Other means of notifying the approaching motorist that the signals are about to change are at hand, even if the stop-go colors are retained. I shall not go into details on these points, but a simplification and standardization of these present confusing usages can be made with very little trouble.

*The Problem of Informative Signs.* The confusion in city and highway signs of an informative nature is extreme. Directive signs on the highway are absurd in many cases, and exasperating in prac-



tically all cases. At many points the stranger actually has to stop and read the signs. This stopping is frequently obstructive of traffic, and actual danger is introduced. The problem of directive signs which shall be maximally effective is not one to be solved by theoretical consideration, but needs experimental attack at once.

The proper means of emphasizing the names of important points; the usefulness of special signs for the "straight ahead" route at intersections; the effect of standard patterns in arrangement on a single sign, as compared with separate signs, the practicality of alphabetical arrangement; these are the types of specific problems needing to be worked out experimentally by arranging an experimental road crossing at which various signs can be tested at different speeds.

Certain other road signs are productive of bad habits on the part of drivers. Marking gentle curves with a "dangerous curve" sign, (a frequent occurrence), has led to the situation in which drivers pay little attention to these signs. A similar situation seems to exist in regard to the non-differentiated markers of road crossings. Another deceptive current practice is the marking of one really dangerous curve and placing no marking at a more dangerous curve a mile further on. The only salvation of the motorist on these roads is in assuming that the signs do not mean much.

In general, there is too much literature on signs along the road. Even the latest standards leave regrettably much to be gathered by reading. In addition, in many states, due proportion between sizes of material which *has* to be read, and the formal part of a sign is neglected. For example, the words "speed limit" and "miles per hour" are, in many cases, painted large, and the numbers "15" or "20" entirely too small.

It is in the cities, however, that the skill of the motorist in reading as he runs is put to the extreme test with consequent confusion of traffic and jeopardy of motorist and pedestrian. Washington is perhaps not the worst city in this respect, but it is bad enough to serve as a horrible example. In unfamiliar streets, one has to stop and read a sign, sometimes lengthy and wordy, in order to find out just what kind of parking, if any, is allowed. A detailed examination of the signs in various parts of the city shows that color means nothing, and shape means nothing, and that there are not even standardized verbal formulations which can be differentiated with a minimum of reading. Many other details, such as the inadequate placing of the signs, and using two signs where one would be clearer, help to confuse the system.

Such conditions, which are common throughout the country, are not excusable. They militate against both convenience and safety.

By simple symbols and forms, and intelligent standardization, the greater part of this confusion and inefficiency can be obliterated. In this connection, I should like to refer to the system of "parking" and "no parking" signs which General Gaither has introduced in Baltimore, and which although not perfect, have at least simplified the driver's problems. One can see nearly a block away from a given place whether one can park there or not, and if so, how long. After reading a few signs no more have to be read thereafter. This system is commended both by the public and the Police Department, and should be a model for other cities.

The distribution of literature on the street surface is another matter of acute importance. I have few data concerning this system, but I believe it is a practice which needs serious consideration. Aside from its usefulness in certain weather and lighting conditions, it is a distraction of the driver from his more important job. Where other vehicles and pedestrians are moving, the driver has no business to attend to street surface carefully. Where there is no traffic, the signs are not important. In general, the angle of vision from which literature on the street must be read is not the angle from which either pedestrian or road surface may be watched efficiently.

As regards lines on road surfaces, the use of paint is only a makeshift. Partly obliterated lines promote carelessness in observing them, and to the too prevalent tendency to cross them at places even where distinct. Bright metal markers are a great improvement, and I notice a greater tendency of drivers to respect them than to respect white lines. The superiority of metal in all weathers and lighting conditions is important. All of these factors bear directly on the formation of safe driving habits, which are the most important objective.

Parking signs painted on the sidewalk are irritating to the drivers, because of their low visibility in certain conditions of light, and also when wet with rain. The unsightliness of elevated signs, and their danger to pedestrians, is a real factor in the matter, but it is probable that bright metal markers in the sidewalk are the solution of the problem. The objection which General Gaither and others make to such markers is based on the probable liability of pedestrians to trip or slip on them, but this objection may not be final.

The necessity of decreasing the driver's need of reading signs puts emphasis on the matter of color, shape and symbols. As regards shapes

and symbols, which have to be considered together, the problem cannot be considered solved as yet. The newer standards of shape are a vast improvement on the meaningless chaos they are replacing, but whether they are as satisfactory as possible is still to be determined. It is not at all certain that round and octagonal are satisfactory safety signs. As long as discs of color are employed in traffic semaphores, the octagon and disc are certainly not the best for "stop." If the linear semaphore should replace the color system, the fixed stop signs should be in the form of a bar, that is, a horizontal rectangle. In any case, the form of a temporary stop sign needs to be considered in relation to the form of permanent stop signs, as at the end of a one way street, or a closed street. In this respect, as in others, city and highway signs need to be worked out together, since we do not wish the driver to form two distinct sets of habits when one should suffice and would be safer.

It should be obvious that only a few shapes of signs can be used, if the system is to fulfill our requirements. The square, long rectangle, diamond, and triangle are available and their character lends itself to the rapid and efficient formation of habits. Either the disc or the octagon (which is practically its equivalent) might be added if need be. This means that only a few of the most important signs can have a truly distinctive shape, others must be assigned shapes by groups. By the use of a few symbols, however, there can be further differentiation and the resultant complication of the learning problem is much slighter than might be expected.

The possibilities in the way of parking signs are well illustrated by General Gaither's system. In the case of signs predominantly for highway use, the speed-limit signs are particularly important. These cannot have a specific shape, but the addition of a specific symbol is sufficient. For example; if the limit numbers are made large and enclosed in a narrow-lined circle, the formal words, "Speed limit" and "miles per hour" can be made relatively small, as they would have to be read on but one sign in order to make all other signs of this class intelligible.

Cautionary signs with regard to road conditions may be all of the same shape, but at least two degrees of caution should be indicated. The most promising suggestion I have so far received for them is a set of diagonal stripes on the sign, indicating the direction (right or left) of the curve, reading upward, with three black stripes for a mild curve, five for a sharp one. "Road ends" would similarly be indicated by horizontal stripes. Some signs of this type are in use, but

conflict unfortunately in their significance. A distinctive portable sign for road under repairs, instead of the red flag, is much needed

The placing of signs is another matter of importance in the training of drivers. For example: drivers are continually failing to see "no left turn" signs, which, unfortunately, are of various types and positions. Such failures frequently tend to an embarrassing, if not actually dangerous, situation for the driver, and the emotional results are not conducive to good habit formation.

The lack of standard positions for semaphores is another common cause of confusion, and one-way street signs are far from satisfactorily standardized, both as regards type and position. Standardization is the fundamental need in all features of signs and signals, if safety is to be increased. But bad standardization is worse than none. Preceding the establishment of standards, experimental investigation is badly needed in regard to matters which have hitherto been too much subject to theory and guess

## A SURVEY OF ACCIDENTS INVOLVING TRUCKS AT HARTFORD, CONNECTICUT, JANUARY 1-JULY 1, 1927

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### FOREWORD

A purpose of the following study is to emphasize two aspects in the field of research:

1. The effort which business may make in research and in the application of research to its problems
2. The method of applying a statistical approach to a local situation.

All the figures in the following study are taken solely from state records, including the allocation of causes.

This study is being printed in pamphlet form with charts, and will be amplified with preliminary pages, emphasizing the chief causes and suggesting tentative remedies.

The situation has been presented to the truck owners and drivers through the Hartford Chamber of Commerce

The main point which has been emphasized is that the remedies are tentative, that the truck owners and drivers must make their own