ing remedies may be needed at a particular point The psychologist, in turn, will use the reports and tabulations as a starting point in making an intensive scientific study of the individual differences of drivers and their effect on accident susceptibility There is also great need in every metropolitan police department of an accident investigation squad composed of trained men who will immediately visit the scene of every serious accident and collect all possible data not only for the purposes already mentioned, but for purposes of prosecution of those who appear to have been guilty of a violation of the traffic ordinance, or of criminal negligence

Every one who has looked at the subject of traffic accidents from a scientific standpoint agrees that there is vital need for these further studies—engineering, psychological, and other—of the underlying causes of accidents The investigators who first make a practical study of this sort leading to concrete conclusions will perform a great public service.

PRESENT STATUS OF LEGAL REGULATION OF AUTOMOBILE HEADLIGHTS, TAIL LIGHTS AND MOTOR-VEHICLE BRAKES IN THE UNITED STATES

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HEADLIGHTS

General Principles Followed In recent years the principle has become generally accepted that control of headlight devices should rest with the respective states and not with municipal or local authorities or with the federal government The general principle which has been followed in nearly all state legislation is that of creating a list of approved devices and making it illegal to sell or use devices not thus approved.

Basis of Approval of Devices. Some state official or commission is usually authorized to approve devices on the basis of definite specifications and tests In most states the official who has jurisdiction is given authority to establish the specifications under which tests shall be made The specifications which have been generally used, however, are those established by the Illuminating Engineering Society in 1920 and revised in 1922 These specifications have received ap-

proval as a tentative Standard by the American Engineering Standards Committee and are used (in some cases with minor modifications) in all of the northeastern states and in California, Oregon, Texas, and Wisconsin (specifications of 1920). In order to obtain uniformity of action, the northeastern states from Maine to Virginia, inclusive, together with the provinces of Ontario and Quebec, have joined in an informal organization known as the Eastern Conference of Motor-Vehicle Administrators These states have adhered more or less closely to a common list of approved devices established by this Conference.

The basic idea of the specifications mentioned is the accomplishment of two purposes, namely, the avoidance of excessive amounts of light in directions where it will be thrown in the eyes of other drivers and the provision of an adequate amount of light on or near the roadway This principle is applied through the specification of certain maximum candle-powers permitted at specified test points above the horizontal and of certain minimum values at other points. These test points are so distributed as to provide for reasonably uniform lighting on the road and at its sides The requirements leave considerable latitude to the designer in choosing the distribution of light, and there are several dozens of devices on the market which comply with these requirements

It should be noted further that the specifications apply to laboratory tests made as the basis for approval of the devices, rather than to road tests Nevertheless it is, of course, expected that the lights as used on the road will give a performance approximating that shown in the laboratory tests on which approval is based.

Uniform Vehicle Code and Recent Legislation The plan outlined above was accepted in the formulation of the Uniform Vehicle Code developed by the National Conference on Street and Highway Safety This code includes provisions whereby a motor-vehicle commissioner in each state would adopt and promulgate the current specifications recognized as standard, with the alternative that in states where constitutional provisions seem to make this course necessary the statute itself includes the detailed specifications recommended at the time by the recognized engineering societies During the past year new legislation has been adopted in many states, following more or less closely the proposed Uniform Vehicle Code, and some of these states at least have included the standard specifications. In others the officials appointed in accordance with the new laws are following these specifica-

tions. It is understood that new laws have been passed in the states of Delaware, Florida, Idaho, Maine, Michigan, Minnesota, New Hampshire, New Jersey, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, and Washington, while new rules and regulations have been promulgated by administrative order in Arkansas It may be noted that several of the states listed already had in use the plan described above Copies of the new laws have not been received from most of these states, so that it is impossible at present to say just what the new provisions in them are

Results Obtained by Regulation It must be stated that the results obtained by the plan of regulation followed have not been as good as were expected. The results have been disappointing for several reasons. One undoubtedly is that the number of automobiles on the highways has increased very greatly, so there has been a tendency for driving conditions in general to become more difficult, and the evils of dazzling headlights have been emphasized by the mere increase in numbers.

A second reason, and the most important one, is that the plan of approval of devices is not in itself sufficient to insure good driving conditions All it can do is to make sure that the great majority of cars are equipped with headlights which are capable of giving a good driving light without excessive glare Whether or not such good performance as they are capable of is obtained from headlights depends on the care with which they are adjusted, and in general the majority of headlights are not properly adjusted Repeated surveys in various jurisdictions have shown this fact, and extensive campaigns for the education of drivers and service stations in the adjustment of headlamps have not produced entirely satisfactory results Nevertheless, in those states or jurisdictions where intelligent and continuous efforts at enforcement have been made, conditions have been materially improved. Several states have adopted the plan of recognizing official adjusting stations, which are required to show that they are qualified to adjust headlamps properly. In one state (Texas) the law provides that every car must have its headlights adjusted at least once a year as a prerequisite for registration. The results thus obtained are reported to be satisfactory in general.

A third reason which prevents the system of regulation outlined from being entirely satisfactory is that the direction from which the headlight beam is thrown from a car with relation to the road necessarily varies somewhat For example, if the headlights be directed

satisfactorily for driving with the car unloaded, they may be thrown too high when the car is loaded Furthermore, on rough or rolling roads, or at the brow of hills, conditions are often such that the direct beams are thrown in the eyes of opposing drivers It is inevitable that some glare will be produced under such conditions so long as headlights with beams fixed in position are used.

In spite of the three difficulties mentioned, it is not likely that present driving conditions at night are as bad as they would have been if the development of headlights had not been guided by the use of standard specifications It should be noted, also, that these specifications have controlled development in all states quite irrespective of legal requirements in the separate states because manufacturers have outfitted their cars to conform with the requirements of those states which were most rigid in their rules and enforcement. To a considerable extent other states have, therefore, benefited by the efforts made by a few.

Attempts at Improvement in Lamps and Regulations Discussion following the first session of the National Conference on Street and Highway Safety developed very strongly the objections to the standard specifications and the desirability of finding some means of improving headlighting conditions The first reaction was the proposal that the specifications then current be discarded and something entirely new be devised, but it appeared wiser not to discard the old specifications until some definite alternative was proposed The Society of Automotive Engineers undertook research on this problem, and later formed a joint committee with the Illuminating Engineering Society This joint research committee has not yet produced any very definite results, but the work carried on has led to the formal recognition of the fact that the old specifications are probably as good as can be formulated so long as headlights with fixed beams are to be used. Consequently there is at present no likelihood that these specifications will be materially altered

In the meantime development of commercial types of lamps has gone forward. The most notable recent improvement has been the introduction of double-filament lamps, which have made practicable the use of beams which can be depressed at the will of the driver. The use of such depressible beams meets the third difficulty described above and gives a margin of control, which helps to reduce the difficulties resulting from poor aiming or focusing of lamps. The introduction of these depressible beams has been a very notable step in

advance, but has introduced certain legal difficulties which are not yet entirely cleared up These difficulties arise from the fact that specifications used were formulated to cover fixed-beam lamps, and no general agreement has been reached on the requirements which ought to be enforced in the case of lamps with depressible beams Discussion of this question is very active at the present time, and will presumably reach some conclusion in the near future It is almost essential that settlement of the question be reached very soon, because a large percentage (probably 30 or 40 per cent) of the cars now being turned out are equipped with some type of depressible-beam headlamp. The advantages of this type are undoubted, and still wider use of them ought to be encouraged.

The other line of development along which progress has not been so rapid is the improvement of devices in the direction of making them less sensitive to adjustment In general, adjustment involves two elements: First, focusing, or properly placing the filament in the reflector, and, second, aiming the beam thus obtained Aiming is relatively simple, but proper focusing seems to be beyond the ability of the ordinary driver or garageman' It is possible so to design devices that a considerable misplacement of the filament does not have a serious effect, and the manufacture of headlight bulbs has been perfected to such an extent that it is possible to make them accurately enough to avoid any necessity for focusing in proper types of reflectors. In other words, it is possible to make headlamps in which the only adjustment necessary is aiming. Unfortunately, however, the specifications used provide for testing with the lamps properly adjusted and do not put any penalties on those lamps which are bad when out of adjustment, nor give any advantage to those types in which adjustment is less important This detail, also, is under discussion in connection with the standard specifications.

Conclusion. In brief, legal regulation is making considerable progress toward uniformity in the various states, and standardization of equipment makes for uniformity throughout the country The general principles followed in regulation at present are apparently as good as could be devised, but intelligent enforcement and further improvement of specifications is desirable in order to encourage the use of those types of devices which will not only meet the specifications under laboratory tests, but will give satisfactory performance on the road In particular, the development of devices having a fixed focus and controllable beam should be encouraged.

TAIL LAMPS AND REAR SIGNALING LAMPS

The Illuminating Engineering Society in 1922 adopted specifications governing the acceptability of electric tail lamps These include certain construction requirements and illumination tests The color of the tail lights is universally red, although some state laws permit an alternative

The color of the rear-signaling light, or stop light as it is sometimes called, is not so uniform—yellow, red and green have all been used for this purpose. The Committee on the Motor Vehicle of the National Conference on Street and Highway Safety recommended that such lights should be yellow, and this enables them to be clearly distinguished from red tail lights and parking lights. The conference itself left the matter open, but yellow (or amber) seems to be the accepted color It has been adopted by the Society of Automotive Engineers, and is included in the Code of Colors and Forms for Traffic Signals for Highways and Vehicles recently approved by the American Engineering Standards Committee.

BRAKES

Investigations carried out at the Bureau of Standards have demonstrated the possibilities of brake performance and have indicated the reaction times of typical drivers and the road performance of automobiles having typical brake equipment. As a result of this work, a Safety Code for Brakes and Brake Testing has been prepared by a representative committee sponsored by the American Automobile Association, the United States Bureau of Standards, and the Society of Automotive Engineers. This code has been approved by the American Engineering Standards Committee, and is recommended for adoption by the various states in regulating brake equipment and testing of brakes.

The code provides minimum stopping requirements for all classes of motor vehicles. Every passenger vehicle and every other motor vehicle weighing 6000 pounds gross or less, with certain exceptions, must be equipped with a foot brake capable of stopping it from a speed of 20 miles per hour within a distance of 50 feet. It must also have a hand brake capable of stopping it from the same speed within 75 feet.

Trucks, which exceed 6000 pounds in weight, and tractors must be capable of stopping within 50 feet upon simultaneous application of

foot and hand brakes and within 75 feet by either alone. After two years it is recommended that freight vehicles meet the same requirements as passenger vehicles.

It is required that all testing be done by means of instruments suitable for the purpose. Various types of decelerometers, under various trade names, are available and on the market for this purpose. In addition to instruments of this type, a machine has been recently introduced whereby stopping distances may be determined without road testing Massachusetts has approved, and is using to some extent, such machines. The braking forces are measured at each wheel, and from these data the stopping distance of the car may be determined, with the additional advantage of knowing how the forces are distributed It is believed that the code is so worded as not to preclude the use of this machine

Should four-wheel brakes become universally adopted, revision of the code will probably be expedient, and the requirements as to stopping distances could be made more severe

The full text of the code is appended to this report

SAFETY CODE FOR BRAKES AND BRAKE TESTING

(Tentative American Standard—D4—1927)

A Code to regulate the Brakes and Brake Testing of all Motor Vehicles in the State of ——————————, for the purpose of Public Safety, and for other purposes.

Part I

Section I Definitions

1. *"Shall"* and *"Should."* The "shall" is to be understood as mandatory and the word "should" as advisory.

2. *"Approved."* The word "approved" means approved by the authority having legal jurisdiction.

3. *"Independently Operated Brakes."* Brakes are independently operated when there are at least two means of operating the brakes, each of which means shall apply braking effort to at least two wheels, the braking mechanism being so constructed that no part which is likely to fail shall be common to the two.

4. *"Hand Brake."* A "Hand Brake" means a brake which is normally operated by the hand of the operator; provided, that in such cases where there are two brakes, both designed to be operated

by the foot, the one equipped with a ratchet or other device for holding the brake in the applied position shall be considered as taking the place of the "Hand Brake" as herein defined and the requirements for such a brake shall be the same as those required for hand brakes.

5. "*Foot Brake.*" A "Foot Brake" means a brake which is normally operated by the operator's foot

6 "*Motor Vehicle*" "Motor Vehicle" means any vehicle which is self-propelled by mechanical power, in, upon, or by which, any person or property is, or may be, transported upon a public highway.

7 "*Gross Weight of a Motor Vehicle*" The "Gross Weight of a Motor Vehicle" means the combined weight of the vehicle and its maximum allowable load, or any fraction thereof.

8. "*Motor Cycle.*" A "Motor Cycle" means any motor vehicle designed to travel on not more than three wheels in contact with the ground; provided, that this definition shall include ordinary two-wheeled motor cycles, motor cycles with side cars, or motor tricycles, but shall not include any three-wheeled tractor or other motor vehicle used, or designed to be used, for the hauling of other vehicles.

SECTION II GENERAL

RULE 20 *Approval of Methods* The Commissioner of Motor Vehicles of this State (or equivalent authority in states not having this officer) shall approve methods of test, type of test equipment, and calibration of such equipment, and such approval shall be based upon decisions made by an unprejudiced engineering authority of recognized standing. When necessary the United States Bureau of Standards may be called upon to act as referee concerning matters coming under this rule, and its decisions shall be final

RULE 21 *New and Old Installations.* After the date at which this code becomes effective, the equipment on all new motor vehicles shall conform to its provisions, and equipment on motor vehicles in service prior to that date shall be modified to conform to its provisions, except as may be hereinafter provided.

Requirements for all motor vehicles shall be made the same as for motor vehicles in Part II two years after the adoption of this Code.

RULE 22. *Time of Effect of Code Following Adoption.* Unless otherwise expressly stated, this code shall become effective six months subsequent to its adoption.

SECTION X GENERAL REQUIREMENTS

RULE 100. *All Motor Vehicles* Every motor vehicle operating or designed to operate on the public highways of this state, unless herein excepted, shall be equipped with independently operated brakes, which shall, at all times, be capable of meeting the requirements of this code.

Exceptions to Rule 100

1 Motor cycles, unless used in the transportation of passengers for hire, need be equipped with only one brake In such cases as motor cycles are used in the transportation of passengers for hire, Rule 100 shall apply in full force and effect, and the requirements as to performance shall be in accordance with Rules 200 and 201 of this code

2 Electric vehicles of whatever gross weight purchased prior to the date at which this code becomes effective are exempted throughout their remaining life from the provisions of this rule, providing such vehicles comply with the requirements of Rule 200 of this code, and shall be capable of meeting all other requirements of this code

RULE 101. *Means of Holding Hand Brake* Means shall be provided to retain at least one brake in such a position as to restrain the vehicle from moving

RULE 102 *Method of Test.* The method of test to be used in determining if vehicles of the several classes mentioned meet the performance requirements of the code shall be by the use of instruments suitable for the purpose, which shall be approved after examination by an unprejudiced engineering authority of recognized standing When necessary, the United States Bureau of Standards may be called upon to act as referee concerning matters coming under this rule and its decision shall be final

RULE 103. *Loaded Vehicles* Enforcing authorities may, at their discretion, require that tests be conducted with the vehicles fully loaded.

RULE 104 *Clutch Disengaged* All testing shall be conducted with the clutch disengaged, provided, that, where the motor vehicle is not provided with a clutch, the testing shall be conducted with no motive power being supplied to the driving wheels, except in such instances as such testing is to be applied to electrical brakes.

PART II

SECTION XX ALL MOTOR VEHICLES WEIGHING 6000 POUNDS GROSS OR LESS, EXCEPT AS SPECIFICALLY PROVIDED HEREIN, AND MOTOR VEHICLES OF WHATEVER GROSS WEIGHT WHICH ARE FITTED FOR THE ACCOMMODATION OF PASSENGERS OR COMMONLY USED FOR THEIR TRANSPORTATION

RULE 200. *Foot Brakes.* On a dry, hard, level road free from loose material, the foot brake shall be capable of stopping the vehi-

cle from a speed of 20 miles per hour within a distance of 50 feet, or at a rate which corresponds to such performance.

RULE 201 *Hand Brakes* On a dry, hard, level road free from loose material, the hand brake shall be capable of stopping the vehicle from a speed of 20 miles per hour within a distance of 75 feet, or at a rate which corresponds to such performance.

PART III

SECTION XXX 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

RULE 300 During the two-year period following the adoption of this code any motor vehicle coming in this class, as defined under Section XXX, operating either singly or in combination, shall be capable of stopping on a dry, hard, level road, free from loose material, within the following distances, or at rates, corresponding, in each instance, to the several performances specified:

(a) Within 50 feet from 20 miles per hour upon simultaneous application of two brakes
(b) Within 75 feet from 20 miles per hour upon application of the foot brake alone.
(c) Within 75 feet from 20 miles per hour upon application of the hand brake alone.

RULE 301. Subsequent to the two-year period following the adoption of this code, Rule 300 shall not apply, and the requirements for motor vehicles coming in this class shall be in accordance with Rules 200 and 201 of this code.

RULE 302. *Vehicles in Combination.* When vehicles are operated in combination the "application of brakes" shall be construed to mean the application of all brakes on any vehicles of the train which are normally capable of being operated simultaneously by the driver.

DISCUSSION

GENERAL

Throughout the preparation of this code it has been continuously kept in mind that its object was to promote safety in the operation of motor vehicles While this has been the primary consideration, nevertheless, practicability of application had also to be considered. While it is realized that many of the provisions are not as stringent

as they might have been, it is believed that greater compliance, and hence greater safety, is likely to be obtained with its provisions than would be the case if they were made stricter. Should four-wheel brakes become universally adopted, revisions of this code would doubtless be both necessary and expedient.

Section II General

Rule 12. *Approval of Methods* This rule is designed so that the enforcing authorities may have the advantage of engineering opinion concerning methods of test, type of test equipment, and the calibration of such equipment. Where such engineering facilities as would be necessary are contained within the Departments of the State, they, of course, could be utilized The United States Bureau of Standards will calibrate instruments for state, municipal, or other authorities, when called upon to do so, and will act as referee, when called upon to do so, concerning matters coming under this rule.

Rule 21. *New and Old Installations.* Attention is called to the fact that the requirements in Part III for performance of commercial vehicles exceeding 6000 pounds gross weight differs from those contained in Part II of this code and fixes the time after its adoption at which the requirements shall be the same for all vehicles.

The reason for this difference is that it appears from an analysis of the data at hand that about 75 per cent of the vehicles tested which would come under Part III of this code were incapable, as operating at the time of test, of meeting the requirements as outlined under Part II. About 25 per cent of such vehicles were, however, capable of meeting such requirements In both cases the vehicles tested covered the entire range from 6000 lbs. to 34,000 lbs gross weight No reason appears, therefore, why eventually the same requirements should not be made for all vehicles regardless of gross weight. It is believed that the two-year period allowed for meeting these requirements is sufficient.

Section X General Requirements

Rule 100. *All Motor Vehicles* It seems quite reasonable that all vehicles should be equipped with independently operated brakes (see definition of "independently operated brakes," Section 1 "Definitions").

It seems, however, that a large number of electric commercial vehicles would be adversely affected by this rule, if it were to be ap-

plied directly upon adoption of the code Consequently, an exception to this rule is made to apply only to such vehicles purchased prior to the adoption of the code.

Motor cycles are also excepted, it being deemed necessary for them to be equipped with but one brake excepting where they are used in the transportation of passengers for hire

The question has arisen as to the application of this rule to electrical brakes. Owing to the fact that some of these brakes vary in efficacy with, or depend in great measure upon, the speed of either the vehicle or the engine, the following interpretation is placed upon their use:

Any electrical brake shall be capable of the same performance as that required for foot brakes in the class in which the vehicle falls, and any mechanical or electrical feature which makes such a brake likely to become inoperative or less effective before bringing the vehicle to a complete stop shall be deemed sufficient cause for its rejection as one of two means of applying braking effort. In no case shall such a brake be substituted for a hand brake as defined in this code

Any subsidiary brake which depends for its action entirely upon the operation of the engine or whose efficacy is destroyed or adversely affected by the stopping of either engine or vehicle shall not be deemed one of two means of applying braking effort, (1) unless the brake be provided with mechanical means of applying braking effort in the event of its being thus adversely affected by engine or vehicle speed, or (2) unless the brake be so designed and constructed that the likelihood of its becoming ineffective or impaired in action is remote.

RULE 101 *Means of Holding Hand Brake* This rule means that at least one brake must be provided which at all times is capable of restraining the vehicle from motion. The necessity for having the vehicle equipped with at least one such brake is obvious.

RULE 102 *Method of Test.* This rule provides for means of testing vehicles provided for in this code. An adequate means of testing is desirable in which the personal equation both of the operator and of the testing official is as little concerned as possible. It is believed that this rule provides such a means.

RULE 103. *Loaded Vehicles.* The purpose of this rule is to provide authority to test a vehicle loaded to its full capacity, when its performance is such a part or no load as to lead the enforcing offi-

cials to believe that the performance at full load would fail to meet the performance requirements of this code for the class in which the vehicle falls

RULE 104. *Clutch Disengaged* Inasmuch as this code pertains to requirements for brakes only, it is believed that all testing should be done with the clutch disengaged, so that there will be no other retarding forces than those due to the brakes

PART II

SECTION II ALL MOTOR VEHICLES WEIGHING 6000 POUNDS GROSS OR LESS, EXCEPT AS SPECIFICALLY PROVIDED HEREIN, AND MOTOR VEHICLES OF WHATEVER GROSS WEIGHT WHICH ARE FITTED FOR THE ACCOMMODATION OF PASSENGERS, OR COMMONLY USED FOR THEIR TRANSPORTATION

This section includes motor vehicles which constitute about 95 per cent of the total volume of traffic All of such vehicles are capable of performing in accordance with the requirements as outlined in this section A considerable percentage of such vehicles already perform in accordance with such requirements

Large passenger-carrying vehicles, regardless of their gross weight, are included in this section for the reason that they travel at as great speeds as the average vehicle of less weight, and often maintain average speeds in excess thereof In addition to this fact, there is the additional mutual responsibility of operator and enforcing authority, to maintain good braking due to the fact that the " pay load " is always, literally, a " live load "

RULE 200 *Foot Brakes* The requirements for the performance of the foot brake is optionally expressed in terms of the number of feet to stop from 20 miles per hour, or the rate of stopping corresponding thereto This is for the reason that instruments might be developed in the future which would be calibrated to read in other units than a given number of feet to stop from a given speed It makes no difference in what units the requirements be expressed, so long as they are equivalent to those required in the code

The rates, expressed in various units, corresponding to a stopping distance of 50 feet from 20 miles per hour are 8 6 feet per second per second, 5 88 miles per hour per second, etc.

The requirements for hand brakes are expressed in a similar manner to those for foot brakes and the same reasoning applies in this case

The performance required is that which corresponds to an ability to hold a vehicle on a grade of more than 10 per cent.

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