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U. S. DEPARTMENT OF COMMERCE

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BUREAU OF STANDARDS

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SAFETY CODE FOR BRAKES AND BRAKE TESTING

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The Safety Code for Brakes and Brake Testing has been approved by the American Standards Association (formerly the American Engineering Standards Committee), effective May 16, 1927, and is designated as American Tentative Standard on this subject. The American Standards Association designation is D4-1927.

PREFACE

Interest in automobile brakes and in requirements for their performance was greatly stimulated upon the advent of 4-wheel brakes. At that time a survey showed that the requirements for automobile braking ability were expressed almost universally in such indefinite terms as that "the brakes shall be good and sufficient," without any definition of what was meant by "good and sufficient."

At about this same time, and in response to the increased interest in the subject, a number of more or less arbitrary criteria were proposed to be enacted into law or regulation. Some of these criteria lay within the realm of possible compliance and some without. Apparently none of the criteria had as a basis a sound foundation of experimental evidence. It appeared that much legislation was impending with little information available as a basis for intelligent action.

Such was the situation in 1923, at which time the Bureau of Standards and the American Automobile Association, acting under the procedure of the American Standards Association (formerly the American Engineering Standards Committee), initiated the formation of a committee whose activities they subsequently sponsored, to obtain data on brake performance of motor vehicles and to formulate reasonable requirements with regard thereto.

This committee was gathered from as large a number of organizations, both public and private, as could conceivably have an interest in the problem. In addition, specialists and engineers, either specifically interested or exceptionally equipped for service on the committee, were invited to participate. As the problem is of such general interest to all persons, the committee personnel was quite large. More organizations were invited to participate than accepted, the interests of a number of these overlapping with those who did accept. A meeting was held at the time of the first Hoover Conference on Street and Highway Safety, and an organization effected. The process of organizing the committee was continuous throughout the following months. The personnel is shown on reverse page.

A technical subcommittee was appointed whose duties were to recommend methods for obtaining data, to examine the data when obtained, and to recommend to the committee what action should follow. The men before whose names asterisks appear on the attached list are members of the subcommittee.

Most of the technical work in connection with the formulation of the code was done at the Bureau of Standards in Washington, or in other places by members of the staff of the bureau. The Bureau of Public Roads assisted by lending its facilities and good offices in the field in connection with obtaining data which apply to motor trucks.

The commissioner of motor vehicles of the Commonwealth of Massachusetts was very helpful in supplying a large number of data on the brake performance of vehicles in that State.

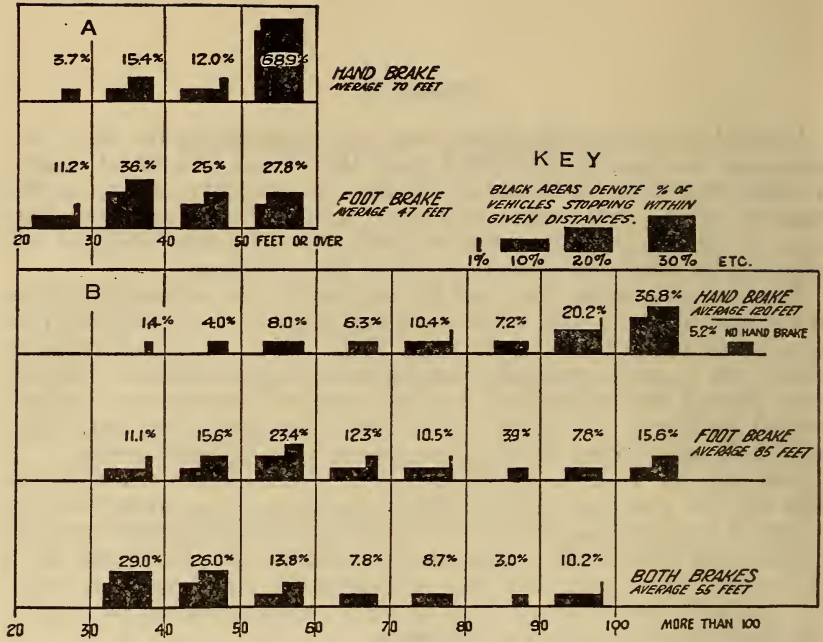


FIGURE 1.—Graphical analysis of statistical data

A, Passenger vehicles
B, Trucks

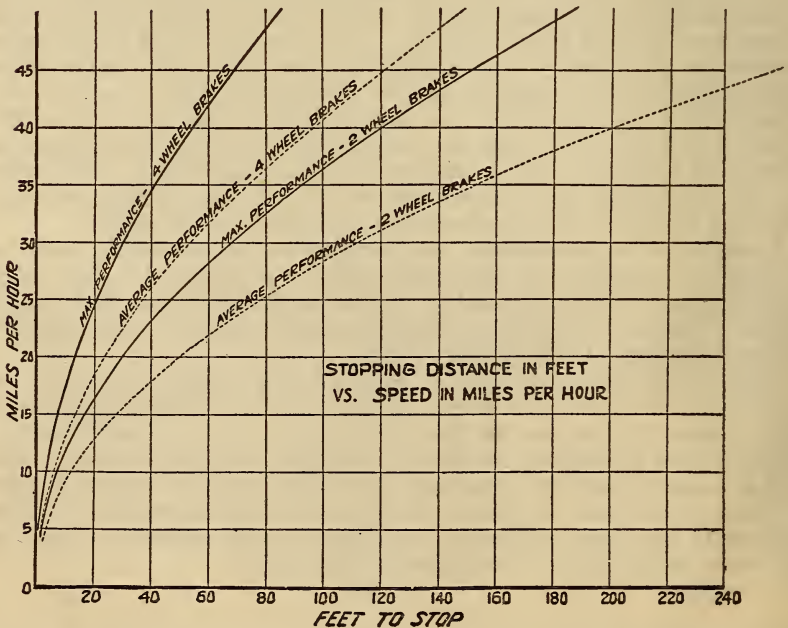


FIGURE 2.—Shows the theoretical maximum, as well as the average, braking performance of vehicles, plotted against speed in miles per hour

The code has been divided into two parts:

1. The main body of the code has been put into language and form such that it might be incorporated directly into law or regulation, either in whole or in part.

2. The discussion is included in order to give an idea as to the reasoning underlying some of the provisions of the code, to clarify ideas necessarily briefly worded in the text, and to explain the reasoning used in some cases in which there was controversy.

The instruments used throughout the brake-performance tests were of the indicating decelerometer type, and were developed at the Bureau of Standards.

The vehicles tested included those of all types, ages, weights, etc., likely to be found in traffic on the highways. Trucks of all capacities up to a gross weight of 34,000 pounds were tested. Tests of vehicles were made in Washington, Philadelphia, Baltimore, New York City, and in the vicinity of Cincinnati, Ohio, in addition to the results of tests furnished to the experimenters from Massachusetts.

As suggested in the discussion, it is certain that the code will need revision and amendment when vehicles equipped with 4-wheel brakes become universal upon the road, and possibly before that time.

Figure 1 shows statistical results representative of those obtained during the tests which form a basis for this code. Figure 2 shows the theoretical maximum as well as the average braking performance of vehicles, plotted against speed in miles per hour.

SAFETY CODE FOR BRAKES AND BRAKE TESTING

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 1. DEFINITIONS

1. "*Shall*" and "*should*."—The word "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 2-wheeled motor cycles, motor cycles with side cars, or motor tricycles, but shall not include any 3-wheeled tractor or other motor vehicle used, or designed to be used, for the hauling of other vehicles.

Section 2. 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 National 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 10. 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 National Bureau of Standards may be called upon to act as referee concerning matters coming under this rule, and its decisions 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 20. ALL MOTOR VEHICLES WEIGHING 6,000 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 vehicle 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 30. MOTOR VEHICLES EXCEEDING 6,000 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 30, 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 vehicle 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 of this code are not as stringent as they might have been made, 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 4-wheel brakes become universally adopted, revisions of this code would doubtless be both necessary and expedient.

Section 2. GENERAL

Rule 20. 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 National 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 6,000 pounds gross weight differ from those contained in Part II of this code and fix 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 6,000 to 34,000 pounds 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 10. 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 applied 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 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 at part or no load as to lead the enforcing officials 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 2. ALL MOTOR VEHICLES WEIGHING 6,000 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 vehicles 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 requirement 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.

Rule 201. Hand brakes.

The requirements for hand brakes are expressed in a similar manner as 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 3. MOTOR VEHICLES EXCEEDING 6,000 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 requirement 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 2-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.

