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Road vehicles — Motor vehicles with antilock braking system — Measurement of braking performance

iTeh STANDARD PREVIEW

*Véhicules routiers — Automobiles équipées de dispositifs antiblocage —
Mesurage des performances de freinage*

ISO 11835:1995

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11835 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Brake systems and equipment*.

Annex A of this International Standard is for information only.

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Road vehicles — Motor vehicles with antilock braking system — Measurement of braking performance

1 Scope

This International Standard specifies the test method to be adopted when testing the antilock braking systems on motor vehicles of categories M and N¹⁾ as defined in UN-ECE Regulation No. 13.

The values in square brackets [] are taken from UN-ECE Regulation No. 13²⁾ for information.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 611:1994, *Road vehicles — Braking of automotive vehicles and their trailers — Vocabulary*.

ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes*.

ISO 3205:1976, *Preferred test temperatures*.

ISO 3833:1977, *Road vehicles — Types — Terms and definitions*.

ISO 7638:1985, *Road vehicles — Brake anti-lock device connector*.

ISO 11509:1995, *Road vehicles — Towed vehicles with compressed-air braking system and antilock braking system — Measurement of braking performance*.

UN-ECE Regulation No. 13, *Uniform provisions concerning the approval of vehicles with regard to braking*, incorporating the 06 series of amendments, Revision 2, Amendments 1 to 6.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 611, ISO 1176 and ISO 3833, and the following definitions apply.

3.1 directly controlled wheel: Wheel whose braking force is modulated according to data provided at least by its own sensor.

3.2 indirectly controlled wheel: Wheel whose braking force is modulated according to data provided by the sensor(s) of other wheel(s).

1) Definitions from UN-ECE Regulation No. 13:

Category M: Power-driven vehicles having at least four wheels or having three wheels when the maximum mass exceeds 1 t, and used for the carriage of passengers.

Category N: Power-driven vehicles having at least four wheels or having three wheels when the maximum mass exceeds 1 t, and used for the carriage of goods.

2) Pending the harmonization of national and international braking standards, regulations and directives, this test method is based on UN-ECE Regulation No. 13.

NOTE 1 Antilock brakes with select-high control are deemed to include both directly and indirectly controlled wheels. In devices with select-low control, all sensed wheels are deemed to be directly controlled wheels.

4 Symbols

For the purposes of this International Standard, the symbols given in table 1 apply.

Table 1

Symbol	Unit ¹⁾	Description	Symbol as used in UN-ECE Regulation No. 13
F_M	N	Normal static reaction force of road surface on all wheels of motor vehicle	P
F_{M1}	N	Normal static reaction force of road surface on all wheels of axle 1	P_1
F_{M2}	N	Normal static reaction force of road surface on all wheels of axle 2	P_2
F_{M3}	N	Normal static reaction force of road surface on all wheels of axle 3	P_3
F_{rr}	N	Rolling resistance	R
F_{rr1}	N	Rolling resistance of axle 1 ²⁾	—
F_{rr2}	N	Rolling resistance of axle 2 ²⁾	—
F_{rr3}	N	Rolling resistance of axle 3 ²⁾	—
g	m/s ²	Acceleration due to gravity	g
h	m	Height of centre of gravity	h
k	1	Peak coefficient of adhesion	K
k_{hi}	1	Peak coefficient of adhesion of the high-adhesion surface	K_1
k_{lo}	1	Peak coefficient of adhesion of the low-adhesion surface	K_2
l_M	m	Wheelbase	E
s	m	Braking distance	—
t	s	Time interval	t
v	km/h	Vehicle speed	—
v_{max}	km/h	Maximum speed of vehicle	V_{max}
v_U	km/h	Limit speed below which the antilock brakes do not function	—
z	1	Braking rate of vehicle	z
z_{al}	1	Braking rate of vehicle with antilock brakes in operation	z_{max}
z_{max}	1	Maximum braking rate with antilock brakes disconnected, braking with the front axle only	z_m
z_{split}	1	Braking rate of the vehicle on split-adhesion surfaces	z_3
ε	1	Adhesion utilization	ε
ε_1	1	Adhesion utilization of axle 1	—
ε_2	1	Adhesion utilization of axle 2	—
ε_3	1	Adhesion utilization of axle 3	—

1) In accordance with ISO 31-3:1992, *Quantities and units — Part 3: Mechanics*.

2) Arbitrarily fixed at 0,01 F_{M1} for a driven axle, 0,015 F_{M1} for a non-driven axle.

5 General

5.1 Three categories of antilock brakes are defined in UN-ECE Regulation No. 13, annex 13.

- a) Category 1: antilock brakes which meet all the requirements of UN-ECE Regulation No. 13, annex 13.
- b) Category 2: antilock brakes which meet all the requirements of UN-ECE Regulation No. 13, annex 13, except paragraph 5.3.5. (No braking rate on split-adhesion surfaces is prescribed.)
- c) Category 3: antilock brakes which meet all the requirements of UN-ECE Regulation No. 13, annex 13, except paragraphs 5.3.4 and 5.3.5. (All split-adhesion tests are omitted.)

5.2 The test method depends on the antilock braking system category. The manufacturer should therefore declare the category of the antilock brakes before testing commences.

5.3 In case type I and II tests are combined with this method, the antilock tests can be carried out after all the type 0 laden and unladen tests have been completed, but before the type I and type II tests are started.

An alternative is that all the measurements including the warm-up runs, the retarder tests and the antilock tests with the laden vehicle are performed first, followed by all the measurements with unladen vehicle. The sequence of the tests shall be noted.

5.4 Tests shall for preference be carried out at the temperatures defined in ISO 3205.

6 Instruments

6.1 Vehicle speed and, optionally, stopping distance and/or deceleration-measuring equipment capable of producing a permanent record of these criteria during braking. The recording system shall also produce a time base.

6.2 Pedal effort gauge and/or line pressure gauges and pressure transducers.

6.3 Optional equipment to ascertain when and for what period the wheels directly controlled by antilock brakes actually lock during the tests.

6.4 For motor vehicles authorized to draw an air-braked trailer, a 0,5 l **reservoir** (see 13.5).

6.5 For antilock brakes depending on non-muscular energy or on energy assistance, a **device to isolate the energy source** (see 13.5).

6.6 A test area consisting of a surface providing a peak coefficient of adhesion, k , of 0,4 or less, which shall be of sufficient size to enable the tests to be performed in safety. It shall be preceded and followed by a surface providing a peak coefficient of adhesion of about 0,8 which is of sufficient length on the approach side to enable the test speeds to be attained. For testing vehicles fitted with antilock brakes of category 1 or 2, it is also necessary for a low-adhesion surface to have a high-adhesion surface on at least one side to enable the split-adhesion tests to be performed. Both surfaces shall be sufficiently wide to be able to determine the peak coefficients of adhesion separately.

The surfaces used for the tests in 12.2 shall be such that k_{hi} is equal to or greater than [0,5] and k_{hi}/k_{lo} is equal or greater than [2]. If any doubt arises that this requirement is met, it will be necessary to ascertain the peak coefficients of adhesion by using the procedure detailed in clause 9. It will always be necessary to measure the peak coefficients of adhesion when testing a vehicle fitted with antilock brakes of category 1 in accordance with 12.2.5.

6.7 Adjustable pressure-limiting valves may be required in the line to each wheel that will be used during the determination of k (see 9.2).

6.8 Optional equipment to show the point of transition of the vehicle from the low- to the high-adhesion surface on the permanent record (see 12.2.3).

6.9 Optional means of measuring steering-wheel angles (see 12.1.2), only for vehicles fitted with antilock brakes of category 1 or 2.

7 General checks

7.1 For all motor vehicles authorized to draw an air-braked trailer, irrespective of the category of antilock brakes fitted, check the manufacturer's calculations of compatibility in the laden state and ensure that the results conform to the requirements of annex 10 of UN-ECE Regulation No. 13.

7.2 Verify that a specific optical warning device is fitted, which will warn the driver should any break occur in the electrical supply or in the external wiring to the antilock brake controller. Check that the warning device lights up when the antilock brakes are energized and goes off, if none of the above defects are present, before the vehicle's speed exceeds [10] km/h.

In addition, check that the warning light will be visible in daylight and that is easy for the driver to check that it is in working order.

7.3 For vehicles of categories other than M₁ and N₁ authorized to draw a trailer fitted with antilock brakes, verify that a separate optical warning device is provided for the trailer antilock brakes or a combined warning device which serves simultaneously for the towing and the towed vehicle (see ISO 11509). In the latter case there shall be a separate optical warning device indicating if a coupled towed vehicle is equipped with antilock brakes or not. These warning devices shall also comply with the requirements in 7.2 or shall be such that they light up not later than on any application of the service braking system, if the attached trailer is not equipped with antilock brakes. They shall automatically not function if no trailer is attached.

7.4 For vehicles of categories other than M₁ and N₁ authorized to draw a trailer fitted with antilock brakes, check that the electrical supply is through the special antilock connector conforming to ISO 7638.

NOTE 2 For a transitional period, alternative conditions are acceptable: see footnote 2 to paragraphs 4.1, 4.2 and 4.3 of UN-ECE Regulation No. 13, annex 13.

7.5 Check that the operation of the antilock brakes is not adversely affected by electromagnetic fields.

NOTE 3 Until uniform test procedures have been agreed, the manufacturers should provide the technical services with their test procedures and results.

7.6 Adjustment of the brakes, including automatically adjusted brakes, may be performed prior to the static and dynamic tests in accordance with the vehicle manufacturer's recommendations for type approval testing.

8 Dynamic tests, laden vehicle

8.1 Ensure that the vehicle is fully laden to its maximum mass in the same way as for the type 0 tests.

8.2 Disconnect the antilock brake functional power source and supply, and other electrical connections to the controller(s) and the sensor(s), one at a time. Check that it is still possible to achieve the prescribed residual braking performance via the service braking system control device, with any one of these electrical failures.

NOTE 4 This requirement does not replace the normal secondary braking system requirements in the event of any service braking system failure.

9 Determination of peak coefficient of adhesion on low-adhesion surface, laden vehicle

This series of tests shall be carried out last.

9.1 Disconnect the antilock brake device and the rear brakes of the service braking system. Determine the peak coefficient of adhesion, k , for the front axle. This result is used in the calculations in clause 10.

9.2 After ensuring that all the necessary test equipment is operational, carry out a number of brake applications on the test surface with a low peak coefficient of adhesion. During each application, the line pressure shall be kept constant but shall be increased for each run until optimum performance is established (this will normally be when slight locking occurs). To ensure that the highest possible result has been included, the series of increments is extended to the point where the wheels lock early in the stop. The tests shall be performed from an initial vehicle speed of [50] km/h and the braking rate is calculated by reference to the time t , in seconds, taken for the speed to reduce from [40] km/h to [20] km/h, using the following formula:

$$z = \frac{[0,56]}{t}$$

NOTES

5 This procedure may be most accurately carried out when some form of adjustable line pressure regulator is fitted.

6 In order to obtain a valid result both wheels of the axle need to reach lock point simultaneously. For the purposes of establishing the k value, it may be necessary to make special adjustments to individual line pressures to achieve this.

9.3 Calculate the value of k using the following formula where the highest value of z found in 9.2 is z_{\max} and taking into account the rolling resistance of the unbraked axle(s) and load transfer:

$$k = \frac{z_{\max} F_M - F_{rr2,3...}}{F_{M1} + \frac{h}{l_M} \times z_{\max} F_M}$$

Round the value to the second decimal place.

10 Determination of adhesion utilization on low-adhesion surface, laden vehicle

It is imperative that the tests performed to determine the adhesion utilization are carried out as soon as possible after the determination of peak coefficient of adhesion.

10.1 Vehicles fitted with antilock brakes of category 1 or 2

10.1.1 Reconnect the antilock brakes and ensure that when the service braking system control device is applied, all brakes function normally.

10.1.2 From an initial vehicle speed of [50] km/h, using the same test surface on which the peak coefficient of adhesion was determined, ascertain the braking rate which the antilock brakes can achieve. Perform the test with sufficient line pressure or pedal effort to ensure that the antilock brakes function. The result shall be calculated to the time t , in seconds, taken for the speed to reduce from [40] km/h to [20] km/h, using the following formula:

$$z_{al} = \frac{[0,56]}{t}$$

10.1.3 Repeat the test in 10.1.2 twice more and calculate the average of the three z_{al} values obtained to find the z_{al} value to be used in the adhesion utilization calculation. Round this final result to the second decimal place.

10.1.4 Calculate the adhesion utilization, ε , using the following formula:

$$\varepsilon = \frac{z_{al}}{k}$$

10.2 Vehicles fitted with antilock brakes of category 3

10.2.1 Reconnect the antilock brake device and ensure that when the service braking system control device is applied, only the brakes on one axle which has at least one directly controlled wheel will function normally and that the service braking system on the other axles is non-operational.

10.2.2 From an initial vehicle speed of [50] km/h, using the same test surface on which the peak coefficient of adhesion was determined, ascertain the braking rate which the antilock brakes can achieve. Perform the test with sufficient line pressure or pedal effort to ensure that the antilock brakes function. The result shall be calculated to the time t , in seconds, taken for the speed to reduce from [40] km/h to [20] km/h, using the following formula:

$$z_{al} = \frac{[0,56]}{t}$$

10.2.3 Repeat the test in 10.2.2 twice more and calculate the average of the three z_{al} values obtained to find the z_{al} value to be used in the adhesion utilization calculation. Round this final result to the second decimal place.

10.2.4 Calculate the adhesion utilization, ε , taking into account the rolling resistance of the unbraked axle(s) and load transfer, using the following formulae.

a) For front axle (axle 1):

$$\varepsilon_1 = \frac{z_{al} F_M - F_{rr2}}{k \left(F_{M1} + \frac{h}{l_M} \times z_{al} F_M \right)}$$

b) For rear axle (axle 2):

$$\varepsilon_2 = \frac{z_{al} F_M - F_{rr1}}{k \left(F_{M2} - \frac{h}{l_M} \times z_{al} F_M \right)}$$

10.2.5 If the vehicle has more than one axle having at least one directly controlled wheel, repeat the tests in 10.2.1 to 10.2.4 for the other axle(s) as necessary.

10.2.6 If the vehicle has an axle (or bogie) which does not include at least one directly controlled wheel, then check by calculation that the adhesion utilization and wheel-lock sequence requirements of annex 10 of UN-ECE Regulation No. 13 are satisfied by that axle (or bogie).