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Road vehicles — Towed vehicles with compressed-air braking system and antilock braking system — Measurement of braking performance

Véhicules routiers — Véhicules tractés équipés de dispositifs de freinage à air comprimé comportant un dispositif antiblocage — Mesurage des performances de freinage

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Contents

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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 11509 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 — Towed vehicles with compressed-air braking system and 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 of full trailers, semi-trailers and centre-axle trailers fitted with compressed-air braking systems, corresponding to vehicles of category O as defined in UN-ECE Regulation No. 13.

The values in square brackets [ ] are taken from UN-ECE Regulation No. 13[1)] 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 3833:1977, *Road vehicles — Types — Terms and definitions.*

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

ISO 11835:1995, *Road vehicles — Motor vehicles with 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).

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. Superscript indices used have the following meanings.

a) The prime symbol (′) indicates the calculated value of the respective braking rate, taking the effects of the rolling resistance into account. This symbol

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

is used in z_0', z_1', $z^{*\prime}$, $z^{**\prime}$. These symbols are used for semi-trailers and centre-axle trailers where not all axles have at least one directly controlled wheel.

b) One asterisk (*) indicates that measurement is made at the vehicle with wheels mounted to one axle only which is directly controlled, but with the antilock brakes disconnected and the wheels not locking. The wheels of the other axles are removed. This symbol is used in l_R^*, F_{BR}^*, F_K^*, F_R^*, $F_{R,dyn}^*$, z^*.

c) The double asterisk (**) indicates that measurement is made at the vehicle with wheels mounted to all those axles which are directly or indirectly controlled, with the antilock brakes operational. This symbol is used in l_R^{**}, F_{BR}^{**}, F_K^{**}, F_R^{**}, $F_{R,dyn}^{**}$, z^{**}.

Table 1

Symbol	Unit[1)]	Description	Symbol as used in UN-ECE Regulation No. 13
F_{BR}	N	Sum of braking forces at the periphery of all wheels of the towed vehicle	TR
F_K	N	Normal static reaction of the fifth wheel on semi-trailer, or of the coupling of the towing vehicle on the drawbar of the centre-axle trailer	—
F_M	N	Normal static reaction of the road surface on all wheels of the towing vehicle	PM
F_R	N	Normal static reaction of the road surface on all wheels of the towed vehicle	PR
$F_{R,dyn}$	N	Normal dynamic reaction of the road surface on all wheels of the towed vehicle	PR dyn
F_{RU}	N	Normal static reaction of the road surface on all unbraked wheels of the towed vehicle	—
h_R	m	Height of centre of gravity of the towed vehicle	h_r
h_S	m	Height above ground of the kingpin pivot (for semi-trailers) or of the coupling (for centre-axle trailers)	h_s
k	1	Peak coefficient of adhesion	K
l_R	m	Distance from the kingpin to centre of axle(s) of semi-trailer	E_r
z	1	Braking rate of the vehicle	z
z_0	1	Maximum braking rate, achieved by braking one axle, with the antilock brakes disconnected	z_0
z_1	1	Maximum braking rate, achieved by braking one axle, with the antilock brakes in operation	z_1
z^*	1	Maximum braking rate achieved under conditions defined in clause 4 b)	z*
z^{**}	1	Maximum braking rate achieved under conditions defined in clause 4 c)	z**
ε	1	Adhesion utilization	ε

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

5 Instruments

5.1 Vehicle speed-measuring equipment capable of producing a permanent record of speed and time during braking.

5.2 Line pressure gauges and pressure transducers.

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

5.4 Suitable valves and regulators to enable the supply to the trailer reservoir to be cut off and to allow the trailer brakes to be operated independently of the towing vehicle. The installation shall be such that it is possible to modulate the control line pressure to the towed vehicle and also allow at least five applications at maximum control line pressure.

5.5 A straight and level **test area road** with a surface providing a coefficient of adhesion of about 0,8 (however, see footnote 7 to UN-ECE Regulation No. 13, annex 13, paragraph 6.1.1 and also 7.5 of this International Standard).

5.6 Adjustable pressure-limiting valves will be necessary in the line to each wheel that will be used for measuring z_0 (see 8.1.1).

6 General checks

6.1 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.

6.2 Verify that the device includes provision to supply the appropriate signals to a specific optical warning device which will warn the driver should any break occur in the electrical supply or in the external wiring to the controller. Check that the supply is such 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.

If no provision in accordance with 6.3 has been made to supply the warning signal to the towing vehicle, a warning lamp shall be fitted on the towed vehicle. The lamp shall be such that it is situated in the field of view of the driver's rear-view mirror.

6.3 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.

6.4 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 manufacturer should provide the technical services with their test procedures and results.

6.5 Install the test instruments ensuring that it is possible to cut off the supply to the energy reservoir as required and that it is possible to operate the service braking system a number of times with maximum control line pressure and with modulated control line pressure.

6.6 With the towed vehicle unladen and the maximum design total mass as low as possible, weigh each axle of the combination in all the configurations to be tested (see 7.2 and 8.2.2).

6.7 Adjust the brakes, including automatically adjusted brakes, if necessary, prior to the static and dynamic tests in accordance with the vehicle manufacturer's recommendations for type approval testing.

7 Energy consumption, unladen vehicle

7.1 The manufacturer may adjust the brakes prior to the energy consumption test in accordance with 6.7. Check that the load-sensing valve, if fitted, is held in its fully laden position.

7.2 If the test vehicle is fitted with an axle whose wheel(s) is (are) neither directly nor indirectly controlled by the antilock brakes, it is necessary during operation according to 7.5 that the uncontrolled axle produces no braking effort. However, its application system shall function normally so that account is taken of its air consumption. This may be achieved by

a) suitable devices; or

b) limiting the stroke of the brake actuators for their normal stroke for brakes applied, but with the brake levers disconnected or brake adjustment slackened off; or

c) removing the wheels of the axle not being tested.

7.3 Disconnect the antilock brakes and with full pressure maintained in the trailer reservoir, check that the wheels controlled by the antilock brakes are capable of locking during braking.

7.4 Re-connect the antilock brakes and ensure that the pressure in the trailer reservoir is at the maximum value achievable with a pressure of [8,5] bar at the supply line coupling head. Cut off the supply to the trailer reservoir at the supply line coupling head.

7.5 While maintaining a speed of approximately 30 km/h and in any case higher than [15] km/h on the road as specified in 5.5, fully apply the trailer brakes for a period of [15] s. During this period the wheels shall remain under antilock brake control. Brief periods of locking of the wheels shall, however, be allowed, but stability shall not be affected.

If insufficient towing power is available to maintain a constant speed, it is acceptable to start at higher speed which drops throughout the test so long as it remains above [15] km/h.

By observing all conditions but speed as specified in the first paragraph, it is also acceptable to start at an initial vehicle speed above 50 km/h. The duration of application should be the time taken to reduce the vehicle to that speed, where the antilock brakes become ineffective. It is permissible to complete the period of [15] s in phases (up to a maximum of four) with the energy supply disconnected but taking into account one application of the service braking system per additional phase.

7.6 At the end of this braking period, bring the combination to rest without using any energy from the trailer reservoir(s), i.e. using the brakes of the towing vehicle.

7.7 Fully apply all the brakes of the towed vehicle. Check that the actuator pressures are sufficient to provide at least a total braking force of [22,5] % of F_R in the fully laden condition.

7.8 Check that there is no automatic application of any braking system not under the control of the antilock brakes during this procedure.

8 Adhesion utilization, unladen vehicle

8.1 Towed vehicles with at least one directly controlled wheel on each axle

8.1.1 On a road as specified in 5.5 ascertain the maximum braking rate z_0. This is achieved by carrying out a series of stops from [50] km/h at increments of line pressure. Having ascertained the critical pressure (which will probably be when slight locking occurs towards the end of the stop), [three] stops should be carried out at that pressure. Calculate the average, z_0, of the [three] tests.

NOTE 4 During this operation it is most important that both wheels lock simultaneously. If there is a degree of imbalance, the wheel with the lower braking force will not be close to locking and the z_0 value will be lower than the true value for this vehicle.

8.1.2 On the same test surface determine the maximum braking rate z_1, but otherwise with the same criteria as specified in 8.1.1. Again carry out three runs and calculate the average of the three decelerations.

NOTE 5 In each of the stops in 8.1.1 and 8.1.2, the braking rate is calculated by reference to the time taken for the speed to drop from 40 km/h to 20 km/h using the following formula:

$$z_0 \text{ or } z_1 = \frac{[0{,}56]}{t}$$

8.1.3 From the results in 8.1.1 and 8.1.2 and taking rolling resistance into account, calculate the values of z_0' and z_1' using the following formulae:

$$z_0' = \frac{z_0(F_M + F_R) - 0{,}01(F_{RU} + F_M)}{F_M + F_R}$$

and

$$z_1' = \frac{z_1(F_M + F_R) - 0{,}01(F_{RU} + F_M)}{F_M + F_R}$$

Calculate the adhesion utilization of the tested axle:

$$\varepsilon = \frac{z_1'}{z_0'}$$

and verify that it is equal to or greater than [0,75].

8.1.4 Repeat the operations in 8.1.1, 8.1.2 and 8.1.3 for the other axle(s) as necessary until all the axles have been tested individually.

8.2 Towed vehicles without at least one directly controlled wheel on each axle

8.2.1 Full trailers

In the case of a full trailer which does not have at least one directly controlled wheel on each axle, the coefficient of adhesion, k, and the adhesion utilization, ε, shall be determined as specified for motor vehicles in ISO 11835:1995, clauses 9 and 10, but performing the test on a surface of high adhesion with the vehicle unladen. In the calculations, include the mass of the towing vehicle in the mass of the unbraked axles.

8.2.2 Semi-trailers and centre-axle trailers

8.2.2.1 With the wheels fitted only to one axle which is directly controlled by the antilock brakes[2] and with the antilock brakes disconnected, ascertain the maximum braking rate, z^*, using the procedure specified in 8.1.1.

8.2.2.2 Calculate the maximum braking rate obtained, $z^{*\prime}$, using the following formula:

$$z^{*\prime} = \frac{F^*_{BR}}{F^*_{R,dyn}}$$

where

$$F^*_{BR} = z^*(F_M + F^*_R) - 0{,}01\ F_M$$

$$F^*_{R,dyn} = F^*_R - \frac{F^*_{BR}\ h_s + z^*(F^*_R + F^*_K)\,(h_R - h_S)}{l^*_R}$$

8.2.2.3 With the wheels refitted to all the axles directly or indirectly controlled by the antilock brakes and with the antilock brakes operational, ascertain the achievable braking rate, z^{**}. Calculate the maximum rate obtained, $z^{**\prime}$, using the following formula:

$$z^{**\prime} = \frac{F^{**}_{BR}}{F^{**}_{R,dyn}}$$

where

$$F^{**}_{BR} = z^{**}\ (F_M + F^{**}_R) - 0{,}01\ F_M$$

$$F^{**}_{R,dyn} = F^{**}_R - \frac{F^{**}_{BR}\ h_s + z^{**}(F^{**}_R + F^{**}_K)\,(h_R - h_S)}{l^{**}_R}$$

8.2.2.4 Calculate the adhesion utilization:

$$\varepsilon = \frac{z^{**\prime}}{z^{*\prime}}$$

and verify that it is equal to or greater than [0,75].

9 Additional checks, unladen vehicle

With all wheels fitted and all brakes fully operational check that the wheels directly controlled by the antilock brakes do not lock at speeds exceeding [15] km/h when the full force of the brakes is suddenly applied at initial speeds of [40] and [80] km/h on a road surface as defined in 5.5.

NOTE 6 Brief periods of locking above [15] km/h are permissible, providing directional stability is maintained.

2) For details on how to arrange the bogie, the manufacturer is to be consulted.